TRANSMITTAL FORM	Application Number	
	Confirmation Number	
	Attorney Docket Number	0644.000001US01
Please consider this a REQUEST FOR EXTENSION OF TIME and charge any fees required under 37 CFR §1.136 to Deposit Account No. 13-4895.	Customer Number	26813

☐ Applicant asserts small entity status
☐ Applicant asserts micro entity status

ENCLOSURES (check all that apply)

☑ Application:
  Description: 36 page(s)
  Claims: 3 page(s)
  Abstract: 1 page(s)
  Drawings: 3 page(s)
☑ Application Data Sheet
☐ Provisional Cover Sheet
☑ Inventor's Oath/Declaration
☐ Sequence Listing in ASCII format
☐ Sequence Communication

☐ Response to Pre-Exam Notice
☑ Preliminary Amendment
☑ Information Disclosure Statement
☑ List of Documents (SB08 or equivalent)
  ☑ copies of documents attached: 9
☐ Amendment/Response
  ☐ Restriction ☐ After Final
☐ Power of Attorney
☐ Statement Under 37 CFR §3.73

☐ Terminal Disclaimer
☐ Appeal Communication
☐ After Allowance Communication
☐ Issue Fee Transmittal
☐ Petition: ____
☑ Other: Certification and Request for Prioritized Examination

FEES (check all that apply)

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Deposit Account Name: MRG IP Law, P.A.
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☐ Charge all fees required EXCEPT for excess claims fees and/or multiple dependent claim fees under 37 CFR §1.16 (h), (i), or (j)

1. Basic Filing, Search, and Examination Fees

Application Type	**Filing Fee**	**Search Fee**	**Examination Fee**	**Total Fees:**
☐ Provisional	☐ $			$ 0
☑ Utility	☑ $ 320	☑ $ 700	☑ $ 800	$ 1820
☐ Design	☐ $	☐ $	☐ $	$ 0

2. Excess Claims Fees

Total Claims pending: 22 – 20 (20 or highest paid) = 2 x $ 100 = $ 200
Indep. Claims pending: ____ – ____ (3 or highest paid) = ____ x $____ = $ ____
☐ Multiply dependent claim $____

3. Application Size Fees (round up to whole numbers)
Total Sheets: ____ x 75% (if filing by EFS) = ____ - 100 = ____ / 50 = ____ x $____ (fee) = $ ____

4. Extension Fees
☐ 1st month $____ ☐ 2nd month $____ ☐ 3rd month $____ ☐ 4th month $____ ☐ 5th month $____

5. Additional Fees
☐ IDS fee $____
☐ Appeal fee $____
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☐ Issue fee $____
☑ Other: Prioritized Exam,Proc Fees and Petition Fee $ 4340.00

6. TOTAL AMOUNT OF PAYMENT: $ 6360

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	Mueting Raasch Group		
Signature	/Lotta Kiuru-Ribar/		
Printed Name	Lotta Kiuru-Ribar		
Date	1/30/2023	Registration No.	66979

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Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	RECYCLABLE HEAT SHRINK FILM FOR RECYCLABLE CONTAINER
First Named Inventor/Applicant Name:	Andrew Sharp
Filer:	Lotta Kristiina Kiuru-Ribar/Margaret Rausch
Attorney Docket Number:	0644.000001US01

Filed as Large Entity

Filing Fees for **Track I Prioritized Examination - Nonprovisional Application under 35 USC 111(a)**

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	320	320
UTILITY SEARCH FEE	1111	1	700	700
UTILITY EXAMINATION FEE	1311	1	800	800
REQUEST FOR PRIORITIZED EXAMINATION	1817	1	4200	4200
Pages:				
Claims:				
CLAIMS IN EXCESS OF 20	1202	2	100	200
Miscellaneous-Filing:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
PUBL. FEE- EARLY, VOLUNTARY, OR NORMAL	1504	1	0	0
PROCESSING FEE, EXCEPT PROV. APPLS.	1830	1	140	140
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**6360**

Electronic Acknowledgement Receipt

EFS ID:	47449994
Application Number:	18103234
International Application Number:	
Confirmation Number:	8140
Title of Invention:	RECYCLABLE HEAT SHRINK FILM FOR RECYCLABLE CONTAINER
First Named Inventor/Applicant Name:	Andrew Sharp
Customer Number:	26813
Filer:	Lotta Kristiina Kiuru-Ribar
Filer Authorized By:	
Attorney Docket Number:	0644.000001US01
Receipt Date:	30-JAN-2023
Filing Date:	
Time Stamp:	17:37:12
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$6360
RAM confirmation Number	E20231TH40193437
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		2023-01-30-PCTApplication.pdf	215093 061d12112c79181e301f0e129eb9300d6fba9629	yes	40

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	36
Claims	37	39
Abstract	40	40

Warnings:

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
2	Application Data Sheet	2023-01-30-AppDataSheet.pdf	2226083 2cf56b4faa68152653046f72c7c4a7875c2dfe8f	no	8

Warnings:

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
3	Oath or Declaration filed	2023-01-30-EXECUTED-Declarations.pdf	751754 61d5052b14c5bc7d6f4f6a711c7e4871fe1858c1	no	2

Warnings:

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
4		2023-01-30-PreliminaryAmendment.pdf	146199 6f6a18af205f6a3b3e818516c138fde0cc60107d	yes	7

Multipart Description/PDF files in .zip description

Document Description	Start	End
Preliminary Amendment	1	1

	Specification		2	2	
	Claims		3	6	
	Applicant Arguments/Remarks Made in an Amendment		7	7	
Warnings:					
Information:					
5	Transmittal Letter	2023-01-30-IDSTransmittal.pdf	98862 299e01cbf553ee63003d8d07eaf5f2877e640c4b	no	2
Warnings:					
Information:					
6	Information Disclosure Statement (IDS) Form (SB08)	2023-01-30-SB08.pdf	121354 b5d7f9a584c2b497723663bd50a22873530d6211	no	2
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
7	Track One Request	2023-01-30-TrackOneRequest.pdf	113872 58361886890fbc0348aa8830ad01991e1cfe39fa	no	2
Warnings:					
Information:					
8	Foreign Reference	FOR_EP2298665A1.pdf	1155696 510f027858ba426d1e5e84ed58c3f29346e048be	no	15
Warnings:					
Information:					
9	Foreign Reference	FOR_EP3854839A1.pdf	458856 364c4055a53650a7230a0054acbfc8aed7af5fda	no	22
Warnings:					
Information:					
10	Foreign Reference	FOR_WO2015026479A1.pdf	3025855 ee5aeaf0d4ea86e43eb5c1c743f38838b72cca2d	no	37
Warnings:					

Information:					
11	Non Patent Literature	NPL_APR-CriticalGuidanceProtocol_.pdf	506204 4c1ca8749b40129812bfe8908d8fc6d5bddc2967	no	11
Warnings:					
Information:					
12	Non Patent Literature	NPL_APR-EvaluationofNearInfrared_.pdf	1307147 14379c8a90056884bd1e3fda1718533cf36e91c4	no	15
Warnings:					
Information:					
13	Non Patent Literature	NPL_APR-EvaluationofSorting_.pdf	372999 eb7e4185a85005eb03674ac6b2a921d62f8d744a	no	10
Warnings:					
Information:					
14	Non Patent Literature	NPL_APR-PET-B-02-BenchmarkEvaluation_.pdf	462311 06b0a5f3702e1d78df81a62aa7c70c0cbefdc8a4	no	7
Warnings:					
Information:					
15	Non Patent Literature	NPL_APR-ShrinkSleeveLabels_.pdf	655073 bd7eb6f171dfb70f204015888d5c2949ab9b0339	no	10
Warnings:					
Information:					
16	Transmittal of New Application	2023-01-30-Transmittal.pdf	322741 11d82840f8df1bf25bde91365e06811b07d0026f	no	1
Warnings:					
Information:					
17	Fee Worksheet (SB06)	fee-info.pdf	53212 0a026c1522208f865e0b59c18ad148df7d4991b8	no	2
Warnings:					
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		Total Files Size (in bytes):	11993311		

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National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

RECYCLABLE HEAT SHRINK FILM FOR RECYCLABLE CONTAINER

RELATED APPLICATIONS

This application claims priority to U.S. Provisional Patent Application No. 63/188,794, filed on 14 May, 2021, which is incorporated herein in its entirety.

BACKGROUND

The consumer packaged-goods markets globally aspire to utilize recyclable packaging for most products. Clear PET packaging provides a cost effective recyclable option. The dairy, food, nutraceutical, and other markets also require light protective packaging to block ingredient harmful light waves from impacting the shelf life and performance of those products. Traditionally, color impregnated bottles or containers, and/or white shrink films printed with or sometimes without functional light blocking layers are used to block the harmful light waves. The market for recycling color impregnated PET is very small and most of those bottles and containers are not recycled.

Therefore, there remains a need for recyclable, light protective packaging options for many markets, including the food and nutraceutical markets.

Any discussion of prior publications and other prior knowledge does not constitute an admission that such material was published, known, or part of the common general knowledge.

SUMMARY

Disclosed herein are recyclable shrink labels.

According to an embodiment, a recyclable shrink label includes a heat shrink film having a first surface and a second surface opposite of the first surface; and a light blocking layer disposed adjacent the first surface and comprising a light blocking component, the light blocking layer being constructed for the recyclable shrink label to block at least 80 % of incident light having wavelengths in a range of 200 nm to 900 nm. The heat shrink film may have a thickness from 15 μm to 100 μm or 30 μm to 80 μm.

The recyclable shrink label may further include an indicia layer. The indicia layer may be disposed on the first surface. The recyclable shrink label may further include a high opacity layer. The high opacity layer may include a white pigment. The high opacity layer may be disposed between the indicia layer and the light blocking layer.

The heat shrink film may include or be made of polyester, polyolefin, or a combination thereof. In some cases, the heat shrink film includes or is made of polyethylene terephthalate (PET), polyethylene terephthalate glycol-modified (PETG or PET-G), polyvinyl chloride (PVC), polystyrene or oriented polystyrene (OPS), polylactic acid (PLA), polypropylene (PP), polyethylene (PE), or a combination thereof. In some cases, the heat shrink film consists of polyethylene terephthalate (PET), polyethylene terephthalate glycol-modified (PETG or PET-G), polyvinyl chloride (PVC), polystyrene or oriented polystyrene (OPS), polylactic acid (PLA), polypropylene (PP), polyethylene (PE), or a combination thereof. In some cases, the heat shrink film consists of polyethylene terephthalate (PET).

When heated to 100 °C, the heat shrink film may contract or shrink by about 1 % to about 90 %. The heat shrink film may contract of shrink by about 1 % to 90 % in the transverse direction. When the heated to 100 °C, the entire recyclable shrink label may contract or shrink by about 1 % to about 90 %. The entire recyclable shrink label may contract of shrink by about 1 % to 90 % in the transverse direction.

The high opacity layer may include a pigment selected from titanium dioxide (TiO2), precipitated calcium carbonate (PCC), aluminum silicate, aluminum oxide (alumina), mica-based pigments coated with thin layer(s) of white pigment, or a combination thereof.

The light blocking component may include a metal particulate. The metal particulate may have a particle size of 0.1 μm to 100 μm. The light blocking component may include or consist of zinc, aluminum, copper, silver, or an alloy thereof, titanium dioxide, carbon black, mica, a reflective pigment, a polymer capable of blocking light, a mineral capable of blocking light, or a combination thereof. The light blocking layer may be present on the label in an amount of 0.5 ppr to 25 ppr. The light blocking component may be present at 0.1 ppr to 10 ppr, from 0.2 ppr to 5 ppr, or from 0.3 ppr to 3 ppr.

According to an embodiment, an article includes a container comprising an external surface; and the recyclable shrink label described above, disposed on the container. In some embodiments, the first surface of the heat shrink film faces the external surface of the container. The container may include or be made of polymer, glass, metal, or a combination thereof. The container may include or be made (e.g., consist of) polyethylene terephthalate (PET). The container may include or be made (e.g., consist of) clear polyethylene terephthalate (PET). The recyclable shrink label may include or be made polyethylene terephthalate (PET). In some cases, the polyethylene terephthalate (PET) forms the outermost layer of the recyclable shrink label.

According to an embodiment, a method of making a label for a container includes depositing an indicia layer on a heat shrinkable film; optionally depositing a high opacity layer on the indicia layer; and depositing a light blocking composition on the indicia layer, on the heat shrinkable film, or on the high opacity layer, wherein the light blocking layer includes one or more light blocking components, and wherein the label is capable of blocking at least 80 % of incident light having wavelengths in a range of 200 nm to 900 nm.

According to an embodiment, a method of recycling an article including a container defining an external surface; and the recyclable shrink label described above, disposed on the container, optionally with the first surface facing the external surface of the container, the method including: determining that the container and recyclable shrink label comprise polyethylene terephthalate (PET); directing the article into a polyethylene terephthalate (PET) recycling stream; and washing the article to remove inks and pigments from the recyclable shrink label. The washed article may be clear and not be stained by the light blocking component or other pigments or inks. The article may be washed in a caustic bath. The article may be chopped into pieces prior to washing. According to an embodiment, during the recycling process, the inks and coating layers cleanly separate from the PET heat shrink film, allowing pure PET to be recovered and processed into reusable resin.

The above summary of the present invention is not intended to describe each disclosed embodiment or every implementation of the present invention. The description that follows more particularly exemplifies illustrative embodiments. In several places throughout the application, guidance is provided through lists of examples, which examples can be used in various combinations. In each instance, the recited list serves only as a representative group and should not be interpreted as an exclusive list.

DEFINITIONS

The words “preferred” and “preferably” refer to embodiments of the invention that may afford certain benefits, under certain circumstances. However, other embodiments may also be preferred, under the same or other circumstances. Furthermore, the recitation of one or more preferred embodiments does not imply that other embodiments are not useful and is not intended to exclude other embodiments from the scope of the invention.

The term “comprises” and variations thereof do not have a limiting meaning where these terms appear in the description and claims. Such terms will be understood to imply the inclusion of a stated step or element or group of steps or elements but not the exclusion of any other step or element or group of steps or elements.

By “consisting of” is meant including, and limited to, whatever follows the phrase “consisting of.” Thus, the phrase “consisting of” indicates that the listed elements are required or mandatory, and that no other elements may be present. By “consisting essentially of” is meant including any elements listed after the phrase and limited to other elements that do not interfere with or contribute to the activity or action specified in the disclosure for the listed elements. Thus, the phrase “consisting essentially of” indicates that the listed elements are required or mandatory, but that other elements are optional and may or may not be present depending upon whether or not they materially affect the activity or action of the listed elements.

The term “substantially” as used here has the same meaning as “nearly completely,” and can be understood to modify the term that follows by at least about 90 %, at least about 95 %, or at least about 98 %. The term “not substantially” as used here has the same meaning as “not significantly,” and can be understood to have the inverse meaning of “substantially,” i.e., modifying the term that follows by not more than 10 %, not more than 5 %, or not more than 2 %.

Unless otherwise specified, “a,” “an,” “the,” and “at least one” are used interchangeably and mean one or more than one.

As used herein, the term “or” is generally employed in its usual sense including “and/or” unless the content clearly dictates otherwise.

The term “and/or” means one or all of the listed elements or a combination of any two or more of the listed elements.

Any reference to standard methods (e.g., ASTM, TAPPI, AATCC, etc.) refer to the most recent available version of the method at the time of filing of this disclosure unless otherwise indicated.

Also herein, the recitations of numerical ranges by endpoints include all numbers subsumed within that range (e.g., 1 to 5 includes 1, 1.5, 2, 2.75, 3, 3.80, 4, 5, etc.).

Herein, “up to” a number (for example, up to 50) includes the number (for example, 50).

The term “in the range” or “within a range” (and similar statements) includes the endpoints of the stated range.

For any method disclosed herein that includes discrete steps, the steps may be conducted in any feasible order. And, as appropriate, any combination of two or more steps may be conducted simultaneously.

All headings are for the convenience of the reader and should not be used to limit the meaning of the text that follows the heading, unless so specified.

Reference throughout this specification to “one embodiment,” “an embodiment,” “certain embodiments,” or “some embodiments,” etc., means that a particular feature, configuration, composition, or characteristic described in connection with the embodiment is included in at least one embodiment of the disclosure. Thus, the appearances of such phrases in various places throughout this specification are not necessarily referring to the same embodiment of the disclosure. Furthermore, the particular features, configurations, compositions, or characteristics may be combined in any suitable manner in one or more embodiments.

Unless otherwise indicated, all numbers expressing quantities of components, molecular weights, and so forth used in the specification and claims are to be understood as being modified in all instances by the term “about.” As used herein in connection with a measured quantity, the term “about” refers to that variation in the measured quantity as would be expected by the skilled artisan making the measurement and exercising a level of care commensurate with the objective of the measurement and the precision of the measuring equipment used. Accordingly, unless otherwise indicated to the contrary, the numerical parameters set forth in the specification and claims are approximations that may vary depending upon the desired properties sought to be obtained by the present invention. At the very least, and not as an attempt to limit the doctrine of equivalents to the scope of the claims, each numerical parameter should at least be construed in light of the number of reported significant digits and by applying ordinary rounding techniques.

Notwithstanding that the numerical ranges and parameters setting forth the broad scope of the invention are approximations, the numerical values set forth in the specific examples are reported as precisely as possible. All numerical values, however, inherently contain a range necessarily resulting from the standard deviation found in their respective testing measurements.

The terms “polymer” and “polymeric material” include, but are not limited to, organic homopolymers, copolymers, such as for example, block, graft, random, and copolymers, terpolymers, etc., and blends and modifications thereof. Furthermore, unless otherwise specifically limited, the term “polymer” shall include all possible geometrical configurations of the material. These configurations include, but are not limited to, isotactic, syndiotactic, and atactic symmetries.

The term “copolymer” refers to polymers containing two or more different monomeric units or segments, including terpolymers, tetrapolymers, etc.

As used herein, the term "ink" refers to a colored material for writing and printing. Generally, ink has four main ingredients: (1) colorant, which is composed of a pigment, dye, or mixture of pigments and/or dyes which define the color of the colorant, (2) resin, which is a binder that can be soluble or in a solvent and the binder holds the colorant on a substrate, (3) optionally solvent or water to dissolve the resin (the solvent or water is removed after printing onto the label), and (4) optionally additives to adjust properties of the ink. Pigments can be organic and inorganic substances. Inks herein can be differentiated as metallic inks and non-metallic inks. As used herein, the term "metallic ink" refers to an ink to which metal flakes or powder are added as a pigment additive to the ink. Metallic inks when printed can appear to be reflective or shiny. Therefore, "non-metallic ink" herein referred to inks without such metal flakes or powder components.

As used herein, the term "opaque" refers to a substrate or printed substrate that has an opacity greater than or equal to 50 %.

As used herein, the term "opacity" refers to the property of a substrate or printed substrate which measures the capacity of the substrate to hide or obscure from view an object placed behind the substrate relative to the point from which an observation is made. Opacity can be reported as the ratio, in percent, of the diffuse reflectance of a substrate backed by a black body having a reflectance of 0.5 % to the diffuse reflectance of the same substrate backed with a white body having an absolute reflectance of 89 %. Opacity can be measured as described in ASTM D 589-97, Standard Test Method for Opacity of Paper (15°/Diffuse Illuminant A, 89 % Reflectance Backing and Paper Backing). A substrate high in opacity will not permit much, if any, light to pass through the substrate. A substrate having low opacity will permit much, if not nearly all, light to pass through the substrate. Opacity can range from 0 to 100 %. As used herein, the term "low opacity" refers to a substrate or printed substrate having opacity less than 50 %. As used herein, the term "high opacity" refers to a substrate or printed substrate having opacity greater than or equal to 50 %.

As used herein, the term "indicia" refers to markings or indications that can be used to convey a message. The message conveyed can be an indication of source, the characteristics of a product in a package, the quantity of a product in a package, the quality of a product in a package, or any other message. Indicia can be a symbol such as a graphic resembling a target used for training archers to indicate a particular retail store. Indicia can be text in any language or combination of languages representative of verbal communication. Indicia can be patterns of colors, lines, or combinations thereof. Indicia can be illustrations of tangible objects such as an apple indicating the source of a particular brand of computer. Indicia can be artwork depicting tangible objects or imaginary compositions or any kind of marking. A single dot of a single color can be indicia. Indicia can be the type, texture, smell, or sound when rustled of the material used to form a package. Indicia can be a combination of any and all of the indicia described previously.

As used herein, the term "ppr" refers to pounds per ream and is used as the unit of measurement of dry pounds of ink or coating per area of substrate (e.g., film or label). One ream is understood to mean 3000 sq ft (about 289 m^2).

As used herein, the term "BCM" refers to billion cubic microns per square inch ($\mu m^3/inch^2$) and is used as a unit of measurement of liquid volume of ink or coating.

As used herein, the term "line-screen" refers to how many halftone lines are printed per each linear inch.

As used herein, the term "viscosity" refers to the flowrate of a liquid and is measured using a calibrated #2 Zahn viscosity cup.

As used herein, the term "COF" refers to the kinetic and static coefficient of friction values. COF can be measured as described in ASTM D1894-14 Standard Test Method for Static and Kinetic Coefficients of Friction of Plastic Film and Sheeting.

BRIEF DESCRIPTION OF THE FIGURES

The disclosure will be further explained with reference to the drawings, wherein:

These figures, which are idealized, are not to scale and are intended to be merely illustrative and non-limiting.

FIG. 1A schematically depicts an embodiment of a disclosed article according to an embodiment.

FIG. 1B schematically depicts an embodiment of a disclosed article according to an embodiment.

FIG. 1C schematically depicts an embodiment of a disclosed article according to an embodiment.

FIG. 1D schematically depicts an embodiment of a disclosed article according to an embodiment.

FIG. 1E schematically depicts an embodiment of a disclosed article according to an embodiment.

FIG. 2 is a schematic representation of an article including the label of the present disclosure, according to an embodiment.

FIGS. 3-5 are graphical representations of data from Example 1.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

The present disclosure relates to labels that are opaque and recyclable. The present disclosure further relates to shrinkable labels that are opaque and recyclable.

The term label is used here broadly. Although many embodiments described herein may be characterized as shrink sleeves, the disclosure and the term label are not limited to such embodiments only. The label may cover at least some clear or transparent parts of a package. The label may serve to block light from reaching a product inside the package. The label may be used to provide graphic elements and information about the product, such as product information required by law, if applicable (e.g., ingredient list and/or nutritional facts).

According to an embodiment, the labels of the present disclosure have a layered construction. The layered construction may include one or more shrink film layers and one or more light blocking (opaque) layers. The layered construction may further include other layers, such as additional polymeric layers, indicia, adhesive layers, a slip coat, a protective top layer, another functional layer, or a combination thereof. Such additional layers may be placed between the shrink film, indicia layer, high opacity layer, or light blocking layer, or on the outside of any such layers. The shrink film has a first surface and a second surface opposite of the first surface. When the label is applied onto a container (e.g., a bottle), the first surface may be the side facing the container and the second surface may face the outside of the container. The light blocking layer may be disposed adjacent the first surface. That is, generally, the light blocking layer may be disposed between the shrink film and the container. The other layers, if included, may be disposed adjacent the first surface or the second surface. The term “adjacent” is used here to indicate which the side of the label the layer is closest. Additional optional layers may be disposed between adjacent layers. The term “immediately adjacent” is used to indicate that the layers in question are in contact with one another and there are no intervening layers.

It is desirable that the label blocks light (e.g., ambient light and sun light, e.g., from 200 nm to 900 nm) such that the contents of a container covered by the label can be protected from light. It is further desirable that the label is recyclable. Generally clear crystallizable heat shrink films (e.g., PET shrink films) are considered recyclable if no inks are retained on the film after a caustic wash cycle typically used in PET reclaiming processes.

Previously, white PET films with a black coating printed on the inside of the label were the only shrink label solution that met the desirable light blocking thresholds. White PET cannot be recycled with clear PET bottles or containers and therefore those products are not recycled and go to the landfill. According to an embodiment, the labels of the present disclosure are light blocking and offer the ability to maintain and improve product shelf life with a light blocking clear shrink film while preserving the recyclability of the clear PET package.

According to an embodiment, the inks utilized in the labels of the present disclosure, including the light blocking inks, are designed to wash off the film during a reclaiming process allowing the labels and containers they cover to be recycled.

Further according to an embodiment, the labels of the present disclosure allow the use of a clear PET underlying container or bottle, which preserves the recyclability of the container or bottle. The labels may also potentially reduce or remove the need to include any additional additives in the container itself (e.g., pigments). For example, the labels may be used on clear, rigid PET containers and bottles. Any inks and coatings printed onto the PET shrink film may be formulated to wash off the film during the recycling process, allowing the underlying clear PET film and the clear PET rigid plastic to be recycled together. The inks and coatings may be formulated to group together during the wash off process in a coagulation-like reaction, which prevents or reduces the ink and coatings from staining the clear film and rigid PET that resides at the bottom of the PET caustic recycling bath process. For example, the inks and coatings may be crosslinked and/or have additives that help the smaller particles glomerate into larger particles during the wash off process. Such larger particles can then be filtered out of the wash water, helping to prevent staining of the PET film and clear PET rigid plastic.

FILMS

According to an embodiment, the label includes a heat shrinkable film or heat shrink film. The terms heat shrink film and shrink film are used here interchangeably. Any suitable heat shrink film may be used. In some embodiments, the heat shrink film is a polyester heat shrink film, of the type that is used in the packaging industry. The heat shrink film can also be described as a film that is not heat stabilized so that it will shrink when exposed to heat.

The heat shrink film is a polymeric film that is substantially two-dimensional with two major surfaces. The term substantially two-dimensional is used to refer to an object having a significantly large size measurement in two dimensions compared to a significantly small size measurement in the third dimension (e.g., the thickness). In some embodiments, useful heat shrink films or articles including such heat shrink films shrink from 1 % to 90 % in the transverse direction (TD) and up to 10% in the machine direction (MD). In some embodiments, useful heat shrink films or articles including such heat shrink films shrink from 1 % to 90 % in the machine direction and up to 10% in the transverse direction. As used herein, transverse direction means a direction perpendicular to the direction of working. As used herein, machine direction means a direction parallel to the direction of working.

The composition of the heat shrink film, whether two- or three-dimensional, is not particularly limited and can comprise high- or low-density polymers, or combinations thereof. Low density polymers that have a density of less than 1 g/cm^3 may be preferred. Such low densities allow for water flotation separation from a denser substrate during recycling processes. In some embodiments, the label includes a heat shrink film having a density of 1 g/cm^3 or less.

According to an embodiment, the label includes a heat shrink film having a thickness of 15 µm or greater, 30 µm or greater, 35 µm or greater, 37 µm or greater, 40 µm or greater, 45 µm or greater, 50 µm or greater, or even 60 µm or greater. The preferred heat shrinkable film is comprised of a film having a thickness of not greater than 100 µm or less, 90 µm or less, 90 µm or less, 85 µm or less, 80 µm or less, 75 µm or less, 70 µm or less, 65 µm or less, or even 60 µm or less. In some embodiments, the heat shrink film has a thickness ranging from 15 µm to 100 µm, 30 µm to 80 µm, 40 µm to 60 µm, or even 40 µm to 55 µm.

According to an embodiment, the label includes a heat shrink film that shrinks when heated to or above a shrink initiation temperature. The shrink initiation temperature may be above 22.5 °C or in the range from about 40 °C to about 200 °C. Shrinkage of heat shrink films is typically measured using a hot water bath method, where the film is immersed in a heated water bath for 10 seconds. The measurement may be repeated at different temperatures, such as at 100 °C and 80 °C. Shrinkage may be reported at a given temperature, or shown as a shrink curve. Shrinkage numbers here are given as measured at 100 °C. When heated to 100 °C, the heat shrink film shrinks 1 % or more, 2 % or more, 5 % or more, 10 % or more, 20 % or more, 30 % or more, 40 % or more, or 50 % or more of the size it was before heating. When heated to 100 °C, the heat shrink film shrinks 90 % or less, 80 % or less, 75 % or less, 70 % or less, or 50 % or less of the size it was before heating. When heated to 100 °C, the heat shrink film may shrink from 1 % to 90 %, from 2 % to 80 %, or from 5 % to 70 %. The shrinkage may be in the machine direction, the transverse direction, or both.

In some embodiments, the heat shrink film shrinks primarily in the transverse direction only. In some embodiments, the heat shrink film shrinks primarily in the machine direction only.

In some embodiments, the polymeric films useful in the label possess balanced shrink properties. The balanced shrink properties allow the film to tighten darts and wrinkles initially formed in the label when the label is applied over curved surfaces and allow the darts and wrinkles to be wiped down with minimal graphics distortion of the label. In some embodiments, the films used in the label have unbalanced shrink properties. Films having unbalanced shrink, that is, films having a high degree of shrink in one direction and low to moderate shrink in the other direction may be particularly useful. In some embodiments, particularly useful films are those that have one dimensional shrink (e.g., in the transverse direction) because they may provide the ability to pre distort indicia formed thereon more easily versus those that have biaxial shrinkage. In some embodiments, the film may be used in a process called “roll-on-shrink-on,” where the film shrinks primarily in the machine direction.

Preferably, the shrink film is thermally shrinkable and yet has sufficient stiffness (e.g., modulus) to be dispensed using conventional labeling application equipment and converting processes, including treating, printing, coating, slitting, seaming, cutting, and label application. The desired stiffness of the film depends on the size of the label, the speed of application, the shape and moisture content on the surface of the container, and the labeling equipment being used.

The shrink film may be made by conventional processes. For example, the shrink film may be produced using blown, calendared, or tentered extrusion processes.

The shrink film useful in the label may be a single layer construction or a multilayer construction. The layer or layers of the shrink film may be formed from a polymer chosen from numerous types of polymers, including for example polyesters and polyolefins. Illustrative specific polymers or polymer types that can be utilized to form shrink films can include, for example, polyethylene terephthalate (PET), polyethylene terephthalate glycol-modified (PETG or PET-G), polyvinyl chloride (PVC), polystyrene or oriented polystyrene (OPS), polylactic acid (PLA), copolymers, non-petroleum based biopolymers, and copolymers and blends thereof. Additional illustrative specific types of polymers that can be utilized to form shrink films can include, polyolefins, such as polypropylene (PP), polyethylene (PE), and copolymers and blends thereof. In some embodiments, illustrative specific copolymers can include copolymers of PP and PE, for example. In a preferred embodiment, the shrink film includes polyethylene terephthalate (PET) and is recyclable with PET bottles. In some embodiments, the shrink film consists of polyethylene terephthalate (PET).

Shrink films are typically polymeric films that are applied over or around a substrate or, for example, a container (e.g., a bottle, jar, tube, or the like) or multiple containers (e.g., a multipack of containers). Two portions (e.g., two edges) of the film can be bonded together to form a seal or seam that results in a sleeve or tube configuration. When heated to 100 °C, the shrink film contracts or shrinks by 1 % or more, 2 % or more, 5 % or more, 10 % or more, 20 % or more, 30 % or more, 40 % or more, or 50 % or more. When heated to 100 °C, the shrink film may contract or shrink by 90 % or less, 80 % or less, 75 % or less, 70 % or less, or 50 % or less of the size it was before heating.. The shrink film may contract or shrink 1 % to 90 %, from 2 % to 80 %, or from 5 % to 70 % upon heating to or above the shrink initiation temperature. The shrinkage may be in the machine direction, the transverse direction, or both. In some embodiments, the heat shrink film shrinks primarily in the transverse direction only. In some embodiments, the heat shrink film shrinks primarily in the machine direction only. The amount that a shrink film shrinks can be largely dependent or may be chosen based on the container which it is to be shrunk around. The film shrinks to conform to the contours of the underlying article. In one embodiment, the shrink film is microperforated to allow trapped air to be released from the interface between the label and the article to which it is adhered. In another embodiment, the shrink film is permeable to allow fluid to escape from the adhesive or from the surface of the article. In one embodiment, vent holes or slits are provided in the shrink film. In some embodiments, perforations, pin holes, or such features may desirably be avoided in order to maximize light blocking characteristics.

The layers of the shrink film, or layers applied to the shrink films may optionally contain pigments, fillers, stabilizers, light protective agents, or other suitable modifying agents if desired.

The shrink film may have any suitable color. However, for recyclability, useful shrink films may specifically include clear shrink films and white shrink films (e.g., white floatable films). Clear shrink films may be made white by including an additional layer or layers that includes a pigment that makes the heat shrink film appear white when viewed. White shrink films may also be made by adding white pigments during the extrusion or formation process for example.

Useful shrink films may also contain a layer of an ink-receptive composition that enhances the printability of the shrink film, and the quality of the print layer thus obtained. A variety of such compositions are known in the art, and these compositions generally include a binder and a pigment, such as silica or talc, dispersed in the binder. The presence of the ink-receptive composition may decrease the drying time of some inks. Such ink-receptive compositions are described in U.S. Pat. No. 6,153,288 (Shih et al.) and the disclosure of this patent is hereby incorporated by reference.

The adhesion of the ink to the surface of the polymeric shrink film can be improved, if necessary or desired, by techniques well known to those skilled in the art. For example, as mentioned above, an ink primer or other ink adhesion promoter can be applied to the surface layer of the shrink film before application of the ink. Alternatively, the surface of the shrink film can be treated by methods such as corona treated or flame treated, for example, to improve the adhesion of the ink to the polymeric film layer.

Useful ink primers may be transparent or opaque and the primers may be solvent based, water-based, or UV-based, digital printing ink diluted with known solvents and/or additives to achieve a desired viscosity for the specific printing process. In one embodiment, the primers are radiation curable (e.g., UV). The ink primer may comprise a lacquer and a diluent. The lacquer may be comprised of one or more polyolefins, polyamides, polyesters, polyester copolymers, polyurethanes, polysulfones, polyvinylidene chloride, styrene-maleic anhydride copolymers, styrene-acrylonitrile copolymers, ionomers based on sodium or zinc salts or ethylene methacrylic acid, polymethyl methacrylates, acrylic polymers and copolymers, polycarbonates, polyacrylonitriles, ethylene-vinyl acetate copolymers, and mixtures of two or more thereof. Examples of the diluents that can be used include alcohols such as ethanol, isopropanol and butanol; esters such as ethyl acetate, propyl acetate and butyl acetate; aromatic hydrocarbons such as ketones such as acetone and methyl ethyl ketone; aliphatic hydrocarbons such as heptane; and mixtures thereof. The ratio of lacquer to diluent is dependent on the viscosity desired for application of the ink primer, the selection of such viscosity being within the skill of the art. The ink primer layer may have a thickness of from about 0.5 μm to about 20 μm, about 1 μm to about 4 μm, or from about 1.5 μm to about 3 μm.

A transparent or non-transparent polymer topcoat or overcoat layer may be present in the labels of the present disclosure. The topcoat or overcoat layer could provide desirable protective properties to the label before and after the label is affixed to an article, such as a container. The presence of a transparent or non-transparent topcoat layer over the print layer may, in some embodiments, provide additional properties such as antistatic properties, stiffness, and/or weatherability, and the topcoat may protect the print layer from, e.g., weather, sun, abrasion, moisture, water, etc. The transparent or non-transparent topcoat layer can enhance the properties of the underlying print layer to provide a glossier and richer image. The transparent or non-transparent topcoat layer could change the aesthetics of the underlying print layer or label (e.g., matte finish or soft touch finish). The protective transparent protective layer may also be designed to be abrasion resistant, radiation resistant (e.g., UV resistant), chemically resistant, thermally resistant, thereby protecting the label and, particularly the print layer from degradation from such causes. The overcoat may also contain antistatic agents or anti-block agents to provide for easier handling when the labels are being applied to containers at high speeds. The layer may be applied to the print layer by techniques known to those skilled in the art. The polymer film may be deposited from a solution or applied as a preformed film (laminated to the print layer), or by any other suitable means known in the art.

When a transparent or non-transparent topcoat or overcoat layer is present, it may have a single layer or a multilayered structure. The thickness of the protective layer is generally in the range of about 1 µm to about 125 µm, about 12.5 µm to about 125 µm, and in one embodiment about 25 µm to about 75 µm. Examples of topcoat layers are described in U.S. Pat. No. 6,106,982 (Mientus et al.) which is incorporated herein by reference.

The topcoat or overcoat layer may comprise polyolefins, thermoplastic polymers of ethylene or propylene, polyesters, polyurethanes, polyacryls, polymethacryls, epoxy, vinyl acetate homopolymers, co- or terpolymers, ionomers, and mixtures thereof.

The transparent topcoat or overcoat may contain UV light absorbers and/or other light stabilizers. Suitable UV light absorbers include those available from BASF under the trade designations “Tinuvin” and “Chimassorb,” for example Tinuvin 111, Tinuvin 123, Tinuvin 622, Tinuvin 770, Tinuvin 783, Chimassorb 119, and Chimassorb 944. The concentration of the UV light absorber and/or light stabilizer is in the range of up to about 2.5 % by weight of the transparent protective layer and in one embodiment about 0.05 % to about 1 % by weight. However, in some embodiments, the transparent topcoat or overcoat does not include a UV light absorber or stabilizer.

The transparent topcoat or overcoat layer may contain an antioxidant. Any antioxidant useful in making thermoplastic films can be used.

According to an embodiment, an exemplary label includes clear recyclable shrink PET film having an optional anti-static coating, high TD shrinkage, low MD shrinkage, very low shrink force, and gradual shrink curve. According to an embodiment, the labels of the present disclosure can meet certain industry standards, including for example the Association for Plastic Recyclers (APR) Critical Guidance Protocol for Clear PET Articles with Labels and Closures (PET-CG-02), which can be considered as certifying that the film is fully recyclable with the container or bottle. In some embodiments, the labels of the present disclosure are recyclable according to Evaluation of the Near Infrared (NIR) Sorting Potential of a Whole Plastic Article (SORT-B-01), Evaluation of Sorting Potential for Plastic Articles Utilizing Metal, Metalized or Metallic Printed Components (SORT-B-03), or both. That is, according to an embodiment, the labels of the present disclosure are fully recyclable. For example, the labels may include inks that can be washed off in a typical PET recycling wash (caustic wash) and the polymers used in the labels are preferably clear (preferably clear PET). According to an embodiment, the labels are free or substantially free of inks that cannot be washed off in a caustic wash. According to an embodiment, the labels are free or substantially free of colored plastics (including white plastics) that cannot be recycled.

HIGH OPACITY COATING COMPOSITIONS

According to an embodiment, the label includes a high opacity layer formed from a high opacity coating composition. In some embodiments where clear shrink films are used, it may be useful for disclosed articles to include an optional high opacity layer applied thereon or on a layer applied onto the clear shrink film. The high opacity layer may be applied by applying a high opacity coating composition to one or more layers of the label.

Useful high opacity coating compositions can include aqueous or non-aqueous ink compositions. In some embodiments, the high opacity coating composition includes a white pigment. Examples of useful white pigments include, for example, titanium dioxide (TiO_2), precipitated calcium carbonate (PCC), aluminum silicate, aluminum oxide (i.e., alumina), mica-based pigments coated with thin layer(s) of white pigment (such as TiO_2), and combinations thereof.

In some embodiments, a high opacity coating composition can include a white pigment, an anionic surfactant, latex particles, and a balance of water. In other instances, high opacity coating composition can include additives, such as an optical brightener, a biocide, additional surfactant, a co-solvent, and/or a humectant.

Useful high opacity coating compositions can include compositions formulated for use as rotogravure inks (e.g., rotogravure solvent-based inks), flexographic inks, lithographic inks, or digital printing inks (e.g., ink jet, nanographic), for example.

The high opacity coating composition can be placed on the shrink film using any methods known in the art including but not limited to gravure printing (e.g., rotogravure printing), flexographic printing, and lithographic printing (e.g., offset lithographic), plateless printing (e.g., digital), post press applications, and screen printing for example. Gravure printing is the direct transfer of liquid ink to substrate from a metal image carrier. The image is lower than the surface of the image carrier base. Flexographic printing is the direct transfer of liquid ink to substrate, typically from a photopolymer image carrier although other image carriers exist. The image is raised above the surface of the image carrier base. Offset lithographic printing is the indirect transfer of paste ink to substrate from a rubber ‘blanket’ that is intermediate to substrate and the thin planographic metal image carrier. Some examples of plateless printing include liquid toner electrophotography, dry toner electrophotography, drop on demand inkjet, continuous inkjet, or NANOGRAPHY™.

In embodiments where the high opacity coating composition is applied to the shrink film or layer on the shrink film via rotogravure coating or printing, the high opacity coating composition can have a viscosity from 16 seconds to 40 seconds, from 16 seconds to 25 seconds, or from 19 seconds to 24 seconds, measured with a #2 Zahn Cup, for example.

In embodiments where the high opacity coating composition is applied to the shrink film or layer on the shrink film via gravure coating or rotogravure coating, the high opacity coating composition can be applied using a one or more rotogravure cylinders. The cylinder(s) may be adjusted to provide a desired amount of coating composition on the surface of the shrink film or layer. The cylinder(s) may have a cell volume of 1.0 BCM or greater, 5 BCM or greater, 10 BCM or greater, or 15 BCM or greater. The cell volume may be 2 BCM or less, 25 BCM or less, or 20 BCM or less. The cell volume may range, for example, from 1.0 BCM to 30.0 BCM, or from 5 BMC to 25 BCM. The cylinder(s) may have cell width values of 25 μm or greater, 50 μm or greater, or 100 μm or greater. The cylinder(s) may have cell width values of 300 μm or less, 250 μm or less, or 200 μm or less. The cell width values may range, for example, from 25 μm to 300 μm. The cylinder(s) may have channel widths of 1 μm or greater, 5 μm or greater, 10 μm or greater, 20 μm or greater, or 30 μm or greater. The channel widths may be 75 μm or less or 50 μm or less. The channel widths may range from 1 μm to 75 μm. The cylinder(s) may have line screen values of 25 LPI or greater, 50 LPI or greater, 100 LPI or greater, 150 LPI or greater, or 200 LPI or greater. The line screen values may be 400 LPI or less, 350 LPI or less, 300 or less, 250 or less, or 200 or less. The line screen values may range from 25 LPI to 400 LPI. According to exemplary embodiments, a desired dry coat weight may be 0.5 ppr or greater, 1 ppr or greater, 5 ppr or greater, 10 ppr or greater, or 15 ppr or greater. The desired dry coat weight may be 25 ppr or less, 20 ppr or less or 15 ppr or less. The desired dry coat weight may range from 0.5 ppr to 25 ppr.

Application of the high opacity coating composition onto the shrink film or onto a layer on the shrink film forms a high opacity layer. The high opacity layer need not be constant, continuous, or complete across the entirety of the shrink film. In some embodiments, the high opacity layer forms a pattern of discrete dots of ink. In other embodiments, the high opacity layer forms a continuous layer of ink.

LIGHT BLOCKING LAYER

According to an embodiment, the label includes a layer of light blocking material, such as light blocking ink. The light blocking material may be applied onto the shrink film or on a layer applied onto the shrink film, including for example onto the high opacity layer discussed above. The light blocking material may be applied in the form of a light blocking composition that includes one or more light blocking components.

According to an embodiment, the label containing the light blocking layer blocks at least 80 %, at least 90 %, at least 95 %, at least 96 %, at least 98 %, at least 99 %, or even almost 100 % or 100 % of incident light having wavelengths from 200 nm to 900 nm. According to an embodiment, the label containing the light blocking layer blocks at least 95 %, at least 96 %, at least 98 %, at least 99 %, at least 99.5 %, about 100 %, or 100 % of incident light having wavelengths from 220 nm to 800 nm. According to an embodiment, the label containing the light blocking layer blocks at least 98 %, at least 99 %, at least 99.5 %, about 100 %, or 100 % of incident light having wavelengths from 220 nm to 750 nm. According to an embodiment, the label containing the light blocking layer blocks at least 99 %, at least 99.5 %, about 100 %, or 100 % of incident light having wavelengths from 220 nm to 600 nm. According to an embodiment, the label containing the light blocking layer blocks at least 99 %, at least 99.5 %, about 100 %, or 100 % of incident light having wavelengths from 220 nm to 500 nm. According to an embodiment, the label containing the light blocking layer blocks at least 99 %, at least 99.5 %, about 100 %, or 100 % of incident light having wavelengths from 220 nm to 450 nm. The amount of light blocked by the label may be measured using a UV-Vis spectrophotometer, such as the Shimadzu model UV-2600i.

According to an embodiment, the label includes a light blocking layer containing one or more light blocking components. In some embodiments, the light blocking components include one or more metals. In some embodiments, useful light blocking components can include pigments that are encapsulated with a metal or metal containing compound. Examples of light blocking components include but are not limited to organic and inorganic pigments, e.g., metallic pigments, that are designed for solvent printing or water-based printing. The pigments may be encapsulated or non-encapsulated. Useful metallic pigments can include, for example, zinc, copper, silver, aluminum, and alloys and combinations thereof. In other embodiments, the light blocking components include titanium dioxide and associated fillers, carbon black, mica, reflective pigments, and other polymers and minerals capable of blocking light.

According to an embodiment, the light blocking component is a particulate material. The particles of the light blocking component may have a particle size of 0.1 µm or greater, 0.5 µm or greater, 1 µm or greater, 2 µm or greater, 3 µm or greater, 4 µm or greater, or 5 µm or greater. The particle size of the particles of the light blocking component may be 100 µm or smaller, 50 µm or smaller, 25 µm or smaller, 15 µm or smaller, 12 µm or smaller, 10 µm or smaller, 8 µm or smaller, 7 µm or smaller, or 6 µm or smaller. In some embodiments, the particle size of the light blocking component is in the range of 0.1 µm to 100 µm, 1 µm to 50 µm, or 2 µm to 25 µm. The particle size referred to here is an average particle size diameter measured by laser diffraction.

Useful light blocking coating compositions can include compositions formulated for use as rotogravure inks (e.g., rotogravure solvent-based inks), flexographic inks, lithographic inks, or digital printing inks (e.g., ink jet, nanographic), for example.

In addition to the light blocking components, the light blocking composition may further include solvents such as alcohols, esters, ketones, or hydrocarbon mixtures, resins such as nitrocellulose, polyamide, vinyl, or acrylic, or additives such as waxes, plasticizers, surfactants, corrosion inhibitors, or crosslinkers to adjust properties of the composition.

The amount of light blocking component in the light blocking composition may be 3.0 wt-% or greater, 5.0 wt-% or greater, or 10 wt-% or greater. The amount of light blocking component in the light blocking composition may be 50.0 wt-% or less, 40 wt-% or less, 30 wt-% or less, or 25 wt-% or less. The amount of light blocking component in the light blocking composition may be from 3.0 wt-% to 50 wt-%, 5.0 wt-% to 40 wt-%, or from 10 wt-% to 25 wt-%. The amount of light blocking component on the label may vary based on the desired amount of light blocking and on the specific light blocking component used. In some embodiments, the light blocking component may be present on the label at 0.1 ppr to 10 ppr, from 0.2 ppr to 5 ppr, or from 0.3 ppr to 3 ppr.

The light blocking coating composition can be applied on the shrink film (or on a layer thereon) using any methods known in the art including but not limited to gravure printing (e.g., rotogravure printing), flexographic printing, and lithographic printing (e.g., offset lithographic), plateless printing (e.g., digital), post press applications, and screen printing for example. Gravure printing is the direct transfer of liquid ink to substrate from a metal image carrier. The image is lower than the surface of the image carrier base. Flexographic printing is the direct transfer of liquid ink to substrate, typically from a photopolymer image carrier although other image carriers exist. The image is raised above the surface of the image carrier base. Offset lithographic printing is the indirect transfer of paste ink to substrate from a rubber 'blanket' that is intermediate to substrate and the thin planographic metal image carrier. Some examples of plateless printing include liquid toner electrophotography, dry toner electrophotography, drop on demand inkjet, continuous inkjet, or NANOGRAPHY™.

In embodiments where the light blocking coating composition is applied to the shrink film or layer on the shrink film via rotogravure coating or printing, the light blocking coating composition can have a viscosity from 16 seconds or greater, 17 seconds or greater, 18 seconds or greater, or 19 seconds or greater, measured with a #2 Zahn Cup. The viscosity may be 40 seconds or less, 25 seconds or less, or 24 seconds or less. For example, the viscosity may range from 16 seconds to 40 seconds, from 15 seconds to 25 seconds, or even from 19 seconds to 24 seconds.

The light blocking composition may be applied onto the label at a suitable rate to result in the desired light blocking performance. When gravure coating or rotogravure coating is used, the amount of composition used may be controlled by adjusting the engraving specifications of the gravure cylinder(s). The cylinder(s) may have a cell volume of 1.0 BCM or greater, 5 BCM or greater, 10 BCM or greater, or 15 BCM or greater. The cell volume may be 2 BCM or less, 25 BCM or less, or 20 BCM or less. The cell volume may range, for example, from 1.0 BCM to 30.0 BCM, or from 5 BMC to 25 BCM. The cylinder(s) may have cell width values of 25 μm or greater, 50 μm or greater, or 100 μm or greater. The cylinder(s) may have cell width values of 300 μm or less, 250 μm or less, or 200 μm or less. The cell width values may range, for example, from 25 μm to 300 μm. The cylinder(s) may have channel widths of 1 μm or greater, 5 μm or greater, 10 μm or greater, 20 μm or greater, or 30 μm or greater. The channel widths may be 75 μm or less or 50 μm or less. The channel widths may range from 1 μm to 75 μm. The cylinder(s) may have line screen values of 25 LPI or greater, 50 LPI or greater, 100 LPI or greater, 150 LPI or greater, or 200 LPI or greater. The line screen values may be 400 LPI or less, 350 LPI or less, 300 or less, 250 or less, or 200 or less. The line screen values may range from 25 LPI to 400 LPI. According to exemplary embodiments, a desired dry coat weight may be 0.1 ppr or greater, 0.2 ppr or greater, 0.3 ppr or greater, 0.4 ppr or greater, 0.5 ppr or greater, 1 ppr or greater, 5 ppr or greater, 10 ppr or greater, or 15 ppr or greater. The desired dry coat weight may be 25 ppr or less, 20 ppr or less or 15 ppr or less. The desired dry coat weight may range from 0.1 ppr to 25 ppr, from 0.4 ppr to 15 ppr, or from 0.5 ppr to 10 ppr.

In embodiments the light blocking coating composition may be applied to the shrink film or layer on the shrink film via rotogravure coating or printing using a single (1) rotogravure cylinder having a line screen number ranging from 25 LPI to 400 LPI. In some embodiments, the light blocking coating composition may be applied to the shrink film or layer on the shrink film via rotogravure coating using a single (1) rotogravure cylinder having a line screen number of 120 LPI or using two (2) rotogravure cylinders having a line screen number of 200 LPI. The resulting dry coat weight may be in a range of 0.5 ppr to 10 ppr.

Application of the light blocking coating composition onto the shrink film or onto a layer on the shrink film forms a light blocking layer. The light blocking layer need not be constant, continuous or complete across the entirety of the shrink film. In some embodiments, the high opacity layer forms a pattern of discrete dots of light blocking component. In other embodiments, the high opacity layer forms a continuous layer of light blocking component.

INDICIA LAYER

Disclosed labels may also include an indicia layer applied thereon or on a layer applied onto the shrink film, including for example the high opacity layer discussed above. The indicia layer can be applied by applying one or more layers or one or more partial layers of an image-forming composition.

Useful image-forming compositions can include compositions formulated for use as rotogravure inks (e.g., rotogravure solvent-based inks), flexographic inks, lithographic inks, or digital printing inks (e.g., ink jet, nanographic), for example. Virtually any ink or combination of ink compositions that are useful in forming indica (e.g., an image and associated text for forming a product label) can be utilized in forming an indicia layer as disclosed herein.

Suitable components of the image-forming composition are not particularly limited. Some examples of suitable components that may be used in the image-forming composition are disclosed below.

In some embodiments, the image-forming composition includes a solvent, such as an organic solvent or water or a combination thereof. The amount of solvent in the composition may be adjusted to provide a desirable color density and viscosity (e.g., as measured using a calibrated #2 Zahn cup.).

The image-forming composition may include any suitable inorganic or organic pigment. Examples of the inorganic pigments include pigments such as titanium dioxide, chrome yellow, molybdate orange, iron blue, cadmium yellow, milori green, ultramarine blue, calcium carbonate, magnesium carbonate, silica aerogel or kaolin, for example. Examples of the organic pigments include Hansa yellow, lampblack, phthalocyanine, red lake C, diarylide yellow, phloxine, channel black, or rhodamine for example. Typical amounts of pigment in the ink composition for gravure printing may range from 1 wt-% to 20 wt-%.

The image-forming composition may include a binder resin, such as a polyamides, nitrocellulose, shellac, vinyl polymers, rosin esters, or acrylic polymers..

The image-forming composition can be placed on the shrink film (or on a layer thereon) using any methods known in the art including but not limited to gravure printing (e.g., rotogravure printing), flexographic printing, and lithographic printing (e.g., offset lithographic), plateless printing (e.g., digital), post press applications, and screen printing for example. Gravure printing is the direct transfer of liquid ink to substrate from a metal image carrier. The image is lower than the surface of the image carrier base. Flexographic printing is the direct transfer of liquid ink to substrate, typically from a photopolymer image carrier although other image carriers exist. The image is raised above the surface of the image carrier base. Offset lithographic printing is the indirect transfer of paste ink to substrate from a rubber ‘blanket’ that is intermediate to substrate and the thin planographic metal image carrier. Some examples of plateless printing include liquid toner electrophotography, dry toner electrophotography, drop on demand inkjet, continuous inkjet, or NANOGRAPHY™.

Application of the image-forming composition onto the shrink film or onto a layer on the shrink film forms an indicia layer. The indicia layer need not be constant, continuous, or complete across the entirety of the shrink film.

The indicia layer may be an ink or graphics layer, and the indicia layer may be a mono-colored or multi-colored print layer depending on the printed message and/or the intended pictorial design. These include variable imprinted data such as serial numbers, bar codes, trademarks, etc. The thickness of the indicia layer is typically in the range of about 0.5 to about 10 μm, and in one embodiment about 1 to about 5 μm, and in another embodiment about 3 μm. The inks used in the indicia layer may include commercially available water-based, solvent-based, oil-based, or energy-curable inks. Examples of commercially available inks include INXFlex Contour (a product of INX identified as an energy curable ink for shrink sleeve applications), Genesis GS (a product of INX identified as gravure solvent-based ink for shrink sleeve and roll fed applications), FlexiTech Shrink-U (a product of Flint Group identified as a flexographic solvent-based ink for shrink sleeve applications), or PluriTech Shrink-U (a product of Flint Group identified as a gravure solvent-based ink for shrink sleeve applications).

In one embodiment, the indicia layer may comprise a polyester/vinyl ink, a polyamide ink, an acrylic ink and/or a polyester ink. The indicia layer may be formed in the conventional manner by, for example, rotogravure, flexographic or lithographic printing processes, or the like, an ink composition comprising a resin of the type described above, a suitable pigment or dye and one or more suitable volatile solvents onto one or more desired areas of the shrink film or a layer formed thereon. After application of the indicia forming composition, the volatile solvent component(s) of the ink composition evaporate(s), leaving only the non-volatile ink components to form the indicia layer.

The total amount of inks on the label depends on the graphics (indicia layer), the background (e.g., white) layers, and the light blocking layer(s). The total amount of inks may be 0.5 ppr or greater, 1 ppr or greater, 5 ppr or greater, 10 ppr or greater, or 15 ppr or greater. The total amount of inks may be 30 ppr or less, 25 ppr or less, 20 ppr or less or 15 ppr or less. The total amount of inks may range from 0.5 ppr to 30 ppr.

ARTICLES AND CONTAINERS

FIG. 1A shows an article 10 (e.g., a bottle or other container) having a heat shrink label 100 applied on its outside surface. The heat shrink label 100 includes a heat shrink film 120, upon which indicia layer 125 (e.g., graphics) is disposed on one surface thereof and an opposing surface includes a high opacity layer 110 and a light blocking layer 115 on the high opacity layer 110. In this embodiment, the light blocking layer 115 is the closest to the article that the heat shrink label 100 is applied to.

FIG. 1B shows an article 10 (e.g., a bottle or other container) having a heat shrink label 101 applied on its outside surface. The heat shrink label 101 includes a heat shrink film 120, upon which a light blocking layer 115 is disposed on one surface and an opposing surface having a high opacity layer 110. Disposed on the surface of the high opacity layer 110 opposite the heat shrink film 120 is an indicia layer 125. In this embodiment, the light blocking layer 115 is the closest to the article 10 that the heat shrink label 101 is applied to.

FIG. 1C shows an article 10 (e.g., a bottle or other container) having a heat shrink label 102 applied on its outside surface. The heat shrink label 102 includes a heat shrink film 120, upon which an indicia layer 125 is disposed on its surface, a high opacity layer 110 is disposed on the surface of the indicia layer 125, and a light blocking layer 115 is disposed on the high opacity layer 110. In this embodiment, the light blocking layer 115 is the closest to the article 10 that the heat shrink label 102 is applied to.

FIG. 1D shows an article 10 (e.g., a bottle or other container) having a heat shrink label 103 applied on its outside surface. The heat shrink label 103 includes a heat shrink film 120, upon which a light blocking layer 115 is disposed on one surface and an opposing surface has an indicia layer 125 disposed thereon. In this embodiment, the light blocking layer 115 is the closest to the article 10 that the heat shrink label 103 is applied to. Such an embodiment could be useful for example, in circumstances where it is acceptable or desirable for the background of the printed label to be dark or black.

FIG. 1E shows an article 10 (e.g., a bottle or other container) having a heat shrink label 104 applied on its outside surface. The heat shrink label 104 includes a heat shrink film 120, upon which an indicia layer 125 is disposed on its surface and a light blocking layer 115 is disposed on the surface of the indicia layer 125. In this embodiment, the light blocking layer 115 is the closest to the article 10 that the heat shrink label 104 is applied to.

It should also be noted that additional layers not depicted in these embodiments, including tie layers, adhesion layers, primer layers, etc. could optionally be included in between or adjacent any of the depicted layers.

The article or container to which the label is applied can be provided in a variety of forms or shapes. Non-limiting examples of suitable articles include containers with and without closures, such as bottles, jars, tubes, trays, lids, toys, appliances, etc. An exemplary article 1 is shown in FIG. 2. The article 1 includes a container 10 (e.g., a bottle) defining an outer surface 11. A recyclable shrink label 100’ according to embodiments of this disclosure is disposed on the outer surface 11. The first side of the recyclable shrink label 100’ faces the container 10 and the second side 150 faces out. The article or container may be made of any polymer (e.g., conventional polymer or biopolymer), glass, or metal such as aluminum. Examples of suitable polymeric materials include high density polyethylene (HDPE), low density polyethylene (LDPE), polyethylene terephthalate

(PET), polypropylene (PP), polylactic acid (PLA), polyvinyl chloride, polycarbonate, nylon, fluorinated ethylene propylene, polystyrene, etc. The article or container may be made of a recyclable material. The article or container may be made of the same or similar polymer as the label, e.g., PET. The article or container can be made by a number of various processes known in the art, such as blow molding, injection molding, thermoforming, rotational molding and the like.

Useful containers include, for example, a bottle with a closure, a tube with a closure, a jar, or the like. In some embodiments, useful beverage containers may include one or more recyclable synthetic pigments and/or resins. Preferably the container may be processed in existing recycling streams, such as mechanical PET recycling streams. Non-limiting examples of suitable pigments and/or resins include, but not limited to, high melting point PET fines; PET comonomers; reactants or byproducts of PET polymerization; polyethylene naphthalate (PEN); terephthalic acid (TPA or PTA); bis(hydroxyethyl) terephthalate (BHET); dimethyl terephthalate (DMT); dimethyl-2,6 naphthalenedicarboxylate (NDC); and isophthalic acid (IPA).

The container or article may have a transparent appearance. In one embodiment, the container or article has a translucent appearance. The translucent appearance can be achieved by, for example, treatments of the transparent container or article, the addition of ingredients such as dyes and pearlescent agents to base polymers, the use of polypropylene and/or polyethylene that are mixed with clarifying agents. The treatments include, for example, spray coating, sandblasting, and mold surface treatment.

In one embodiment, a continuous roll label according to embodiments of the present disclosure can be applied to the article or container in an automated labeling line process. The automated labeling line process may have a line speed of at least 10 units per minute, at least 25 units per minute, at least 50 units per minute, at least 100 units per minute, or at least 250 units per minute. While there is no desirable upper limit, in practice, the automated labeling line process may have a line speed of up to 2000 units per minute, e.g., not more than 500, not more than 600, not more than 700, not more than 800, not more than 900, or not more than 1000 units per minute.

The invention is defined in the claims. However, below there is provided a non-exhaustive listing of non-limiting exemplary aspects. Any one or more of the features of these aspects may be combined with any one or more features of another example, embodiment, or aspect described herein.

According to one exemplary embodiment, clear shrink films (e.g., clear PET shrink films) with thicknesses ranging from 15 μm to 100 μm, 20 μm to 80 μm, or 25 μm to 70 μm (for example) are formed from a wide master roll. The process provides the correct width for the production orders material size requirement. Typically, artwork is printed repeatedly across the film's web width to maximize the total number of labels printed from the respective roll. The slitting step allows the film to be converted into the correct width for the seaming process. The shrink films can be printed using a rotogravure press (for example) with solvent based inks (for example). A light blocking ink can be printed in one or more print stations on either side of the film. An optional high opacity coating layer can also be applied along with the light blocking layer on either side of the film to provide a white opaque background for the label's artwork or graphics provided in the indicia layer. When clear films are used, the graphics may be printed directly onto the film, followed by the high opacity layer (e.g., a white ink) and then the light blocking layer. The graphics are visible through the clear film and are protected by the film. Alternatively, the graphics may be printed on top of the white opaque background. When the graphics are printed using a rotogravure printing press, typically the graphics are printed repeatedly across the film's web and then slit into individual label rolls. Any number of colors can be printed, each color having its own printing cylinder and ink station to apply the different inks, colors, and/or coatings. The ink is then dried with hot air convection blowers at each print station. Line screens ranging from not less than 25 LPI to up to 300 LPI can be utilized for the rotogravure printing. Viscosity readings ranging from 16 – 28 measured using a #2 Zahn Cup are typical for the inks. The light blocking layer can be a solvent-based or water-based composition, diluted with known solvents, and/or additives to achieve a desired viscosity for the specific printing process. Multiple engravings can be used for both the light blocking and the high opacity layer (when utilized) to afford the desired ink coverage at commercial press speeds of 100 meters per minute to 300 meters per minute, in some embodiments. All layers including the high opacity layer and the light blocking layer can shrink along with the shrink film to ensure proper adhesion and color density after being subjected to the shrink process. The layers can preferably pass an adhesion tape test using the recommended tape type for the ink system, a Sutherland ink rub tester of over 100 rubs using the 4 lb block, or both. The light blocking layer is typically designed to have low kinetic coefficients of friction (COF), for example less than 0.22.

The printed film can then be converted from a flat wound roll and formed into a continuous tube with the application of a solvent applied to one side of the film's edge. A seaming machine can fold the solvent edge side of the film onto the un-solvent coated edge, creating a chemical bond of the two sides resulting in a continuous tube of film wound into a large roll. Standard seaming speeds can range from 200 meters per minute up to 500 meters per minute for example. The seamed/tubed label rolls can then be wound into smaller length finished rolls to be shipped to a customer and applied onto intended containers, for example. The label including the light blocking can block at least 80 %, at least 90 %, at least 95 %, at least 96 %, at least 98 %, at least 99 %, or even almost 100 % or 100 % of incident light having wavelengths from 200 nanometers to 900 nanometers for example.

According to an embodiment, a method of recycling the article includes determining the type of material (e.g., type of plastic) that the container and recyclable shrink label are made of, directing the article into a corresponding recycling stream, and washing the article to remove inks and pigments from the recyclable shrink label. In some cases, the article and label include or are made of PET and can be recognized as PET and be directed into a PET recycling stream. In other cases, the article and label may include or be made of another resin and be directed to a corresponding recycling stream. In some preferred embodiments, the label applied to the article includes or is made of the same resin as the article. The washed article may be clear and not be stained or substantially stained by the light blocking component. The article may be washed in a caustic bath. The article may be chopped into pieces prior to washing. According to an embodiment, during the recycling process, the inks and coating layers cleanly separate from the heat shrink film, allowing pure resin to be recovered and processed into reusable resin.

Exemplary Embodiments

Embodiment 1 is a recyclable shrink label comprising a heat shrink film having a first surface and a second surface opposite of the first surface, optionally wherein the heat shrink film has a thickness from 15 µm to 100 µm or 30 µm to 80 µm; and a light blocking layer disposed adjacent the first surface and comprising a light blocking component, the light blocking layer being constructed to block at least 80 % of incident light having wavelengths in a range of 200 nm to 900 nm.

Embodiment 2 is the recyclable shrink label of embodiment 1 further comprising an indicia layer, optionally wherein the indicia layer is disposed on the first surface. The indicia layer may be immediately adjacent the first surface. The indicial layer may be immediately adjacent the light blocking layer. The indicial layer may be disposed between the first surface and another layer, e.g., a high opacity layer.

Embodiment 3 is the recyclable shrink label of embodiment 1 further comprising a high opacity layer, the high opacity layer optionally comprising a white pigment.

Embodiment 4 is the recyclable shrink label of embodiment 3, wherein the high opacity layer is disposed between the indicia layer and the light blocking layer. The high opacity layer may be immediately adjacent the indicia layer. The high opacity layer may be immediately adjacent the light blocking layer.

Embodiment 5 is the recyclable shrink label according to any of embodiments 1 to 4, wherein the heat shrink film comprises polyester, polyolefin, or a combination thereof.

Embodiment 6 is the recyclable shrink label according to any of embodiments 1 to 5, wherein the heat shrink film comprises polyethylene terephthalate (PET), polyethylene terephthalate glycol-modified (PETG or PET-G), polyvinyl chloride (PVC), polystyrene or oriented polystyrene (OPS), polylactic acid (PLA), polypropylene (PP), polyethylene (PE), or a combination thereof. The heat shrink film may consist of polyethylene terephthalate (PET), polyethylene terephthalate glycol-modified (PETG or PET-G), polyvinyl chloride (PVC), polystyrene or oriented polystyrene (OPS), polylactic acid (PLA), polypropylene (PP), polyethylene (PE), or a combination thereof. The heat shrink film may consist of only one of polyethylene terephthalate (PET), polyethylene terephthalate glycol-modified (PETG or PET-G), polyvinyl chloride (PVC), polystyrene or oriented polystyrene (OPS), polylactic acid (PLA), polypropylene (PP), or polyethylene (PE). The heat shrink film may consist of polyethylene terephthalate (PET).

Embodiment 7 is the recyclable shrink label according to any of embodiments 1 to 6, wherein the heat shrink film comprises a seam.

Embodiment 8 is the recyclable shrink label according to any of embodiments 1 to 7, wherein the heat shrink film is in the form of a sleeve or tube. The heat shrink film may be constructed to be fitted over a bottle.

Embodiment 9 is the recyclable shrink label according to any of embodiments 1 to 8, wherein when heated to 100 °C, the heat shrink film contracts or shrinks by about 1 % to about 90 %. The heat shrink film may shrink 1 % or more, 2 % or more, 5 % or more, 10 % or more, 20 % or more, 30 % or more, 40 % or more, or 50 % or more of the size it was before heating. When heated to 100 °C, the heat shrink film may shrink 90 % or less, 80 % or less, 75 % or less, or 70 % or less of the size it was before heating. The heat shrink film may shrink in the transverse direction.

Embodiment 10 is the recyclable shrink label according to any of embodiments 1 to 9, wherein when heated to 100 °C, the entire recyclable shrink label contracts or shrinks by about 1 % to about 90 %. The entire recyclable shrink label may shrink in the transverse direction.

Embodiment 11 is the recyclable shrink label of embodiment 1, wherein the high opacity layer comprises a pigment selected from titanium dioxide (TiO2), precipitated calcium carbonate (PCC), aluminum silicate, aluminum oxide (alumina), mica-based pigments coated with thin layer(s) of white pigment, or a combination thereof.

Embodiment 12 is the recyclable shrink label according to any of embodiments 1 to 11, wherein the light blocking component comprises a metal particulate, optionally wherein the metal particulate has a particle size of 0.1 μm to 100 μm.

Embodiment 13 is the recyclable shrink label according to any of embodiments 1 to 12, wherein the light blocking component comprises zinc, aluminum, copper, silver, or an alloy thereof, titanium dioxide, carbon black, mica, a reflective pigment, a polymer capable of blocking light, a mineral capable of blocking light, or a combination thereof. The light blocking component may consist of an aluminum-based component.

Embodiment 14 is the recyclable shrink label according to any of embodiments 1 to 13, wherein the light blocking layer is present in an amount of 0.5 ppr to 25 ppr. The light blocking layer may have a dry coat weight of 0.1 ppr or greater, 0.2 ppr or greater, 0.3 ppr or greater, 0.4 ppr or greater, 0.5 ppr or greater, 1 ppr or greater, 5 ppr or greater, 10 ppr or greater, or 15 ppr or greater. The dry coat weight may be 25 ppr or less, 20 ppr or less or 15 ppr or less. The dry coat weight may range from 0.1 ppr to 25 ppr, from 0.4 ppr to 15 ppr, or from 0.5 ppr to 10 ppr.

Embodiment 15 is the recyclable shrink label according to any of embodiments 1 to 14, wherein the light blocking layer comprises from 0.1 ppr to 10 ppr, from 0.2 ppr to 5 ppr, or from 0.3 ppr to 3 ppr of the light blocking component.

Embodiment 16 is the recyclable shrink label according to any of embodiments 1 to 15, wherein the label including the light blocking layer blocks at least 80 %, at least 90 %, at least 95 %, at least 96 %, at least 98 %, at least 99 %, or even almost 100 % or 100 % of incident light having wavelengths from 200 nm to 900 nm. The label including the light blocking layer may block at least 95 %, at least 96 %, at least 98 %, at least 99 %, at least 99.5 %, about 100 %, or 100 % of incident light having wavelengths from 220 nm to 800 nm. The label including the light blocking layer may block at least 98 %, at least 99 %, at least 99.5 %, about 100 %, or 100 % of incident light having wavelengths from 220 nm to 750 nm. The label including the light blocking layer may block at least 99 %, at least 99.5 %, about 100 %, or 100 % of incident light having wavelengths from 220 nm to 600 nm. The label including the light blocking layer may block at least 99 %, at least 99.5 %, about 100 %, or 100 % of incident light having wavelengths from 220 nm to 500 nm.

The label including the light blocking layer may block at least 99 %, at least 99.5 %, about 100 %, or 100 % of incident light having wavelengths from 220 nm to 450 nm.

Embodiment 17 is an article comprising: a container comprising an external surface; and the recyclable shrink label of any one of embodiments 1 to 16 disposed on the container, optionally with the first surface facing the external surface of the container.

Embodiment 18 is the article according to embodiment 17, wherein the container comprises polymer, glass, metal, or a combination thereof.

Embodiment 19 is the article according of any one of embodiments 16 to 18, wherein the container comprises polyethylene terephthalate (PET), optionally wherein the container consists of polyethylene terephthalate (PET), optionally wherein the container comprises clear polyethylene terephthalate (PET).

Embodiment 20 is the article of any one of embodiments 16 to 19, wherein the recyclable shrink label comprises polyethylene terephthalate (PET), and optionally wherein the polyethylene terephthalate (PET) forms the outermost layer of the recyclable shrink label.

Embodiment 21 is the article of any one of embodiments 16 to 20, wherein the container and the recyclable shrink label comprise the same material. The container and the recyclable shrink label may comprise polyethylene terephthalate (PET).

Embodiment 22 is a method of making a label for a container, the method comprising depositing an indicia layer on a heat shrinkable film; optionally depositing a high opacity layer on the indicia layer; and depositing a light blocking composition on the indicia layer, on the heat shrinkable film, or on the high opacity layer, wherein the light blocking layer comprises one or more light blocking components, and wherein the light blocking layer is capable of blocking at least 80 % of incident light having wavelengths in a range of 200 nm to 900 nm.

Embodiment 23 is a method of recycling an article comprising a container defining an external surface; and the recyclable shrink label of any one of embodiments 1 to 16 disposed on the container, optionally with the first surface facing the external surface of the container, the method comprising determining that the container and recyclable shrink label comprise polyethylene terephthalate (PET); directing the article into a polyethylene terephthalate (PET) recycling stream; and washing the article to remove inks and pigments from the recyclable shrink label.

Embodiment 24 is the method of embodiment 23, wherein the washed article is clear and is not stained by the light blocking component or other pigments or inks.

Embodiment 25 is the method of embodiment 24, wherein washing comprises washing in a caustic bath.

Embodiment 26 is the recyclable shrink label of any one of embodiments 1 to 16, further comprising an additional layer comprising an additional polymeric layer, an additional indicia layer, an adhesive layer, a slip coat, a protective top layer, another functional layer, or a combination thereof.

The present invention is illustrated by the following examples. It is to be understood that the particular examples, materials, amounts, and procedures are to be interpreted broadly in accordance with the scope and spirit of the invention as set forth herein.

Objects and advantages of this disclosure are further illustrated by the following examples, but the particular materials and amounts thereof recited in these examples, as well as other conditions and details, should not be construed to unduly limit this disclosure.

Unless otherwise noted, all parts, percentages, ratios, etc. in the Examples and the rest of the specification are by weight. These abbreviations are used in the following examples: g = gram, min = minute, hr = hour, mL = milliliter, L = liter. If not otherwise indicated in the table, below, chemicals were obtained from Sigma-Aldrich, St. Louis, MO.

EXAMPLES

EXAMPLE 1

Exemplary articles were made as seen in Table 1A below. The samples were tested with a UV-Vis spectrophotometer (Shimadzu model UV-2600i) for their light blocking ability at wavelengths of 400 nm, 500 nm, 600 nm, and 700 nm. The samples were tested prior to shrinking. Samples 6 and 7 were also tested after shrinking. The results are shown in TABLE 1B.

First and second layers were high opacity layers printed using white ink. The third layer included white ink and for Samples 1-3 also blue ink. The fourth and fifth layers were light blocking layers. The light blocking component was a metallic particulate exhibiting a bronze color.

TABLE 1A: Samples

Sample	1st Layer (# line screens)	2nd Layer (# line screens)	3rd layer (# line screens and pigment color)	4th Layer – Light blocking (# line screens)	5th Layer – Light blocking (# line screens)
1	120	150	150 white + blue	---	----
2	120	150	150	200	--

			white + blue		
3	120	150	150 white + blue	200	175
4	150	150	120 white	175	200
5	150	150	120 white	175	--
6	150	150	120 white	200	--
7	120	150	150 white	175	200

TABLE 1B: Light Blocking Percentage at Various Wavelengths

Sample	400 nm (% Light blocked)	500 nm (% Light blocked)	600nm (% Light blocked)	700 nm (% Light blocked)
Black + White Film	100.0	99.7	99.4	99.0
1	97.2	79.0	79.9	71.9
2	99.1	93.6	92.9	89.8
3	99.7	97.9	97.3	96.1
4	99.5	96.9	95.2	94.4
5	98.6	93.6	91.1	89.7
6	99.5	93.8	91.5	89.9
6 – shrunk	99.7	95.6	93.6	92.3
7	99.6	98.5	97.5	97.2
7-shrunk	99.9	99.5	99.1	98.9

Figures 3-5 show UV-Vis spectra of the samples. Figure 3 shows the transmittance of each of the samples in TABLE 1B. Figure 4 is a close-up of the lower section, showing samples 2-7. Figure 5 compares samples 6 and 7 (before shrinking) to samples 6—shrunk and 7—shrunk.

EXAMPLE 2

Samples with various color graphics were prepared to evaluate the effect of the color on the light blocking and the effect of the light blocking layer on the appearance of the color.

Samples were prepared using APR certified recyclable 40 μm clear PET shrink sleeve film. The inks were printed onto the film with solvent rotogravure inks. The film was first printed with a single color (yellow, red, or reflex blue). The printed color was then overlaid with three layers of white ink. Over the white ink layers, a light blocking composition was applied by a rotogravure cylinder that had a volume of 12 BCM (billion cubic micron per square inch, or 10^9 $\mu m^3/inch^2$).

The samples were tested with a UV-Vis spectrophotometer (Shimadzu model UV-2600i) or their light blocking ability (prior to shrinking) at wavelengths ranging from 220 nm to 900 nm. The results are shown in TABLE 2. The samples were also visually observed to evaluate the effect of the light blocking layer on the appearance of the color.

TABLE 2. Light blocking.

Wavelength (nm)	**Yellow film**	**Red film**	**Blue film**
220	100.0 %	100.0 %	100.0 %
300	100.0 %	100.0 %	100.0 %
400	100.0 %	100.0 %	100.0 %
500	99.8 %	99.9 %	99.9 %
600	98.6 %	99.1 %	100.0 %
700	98.3 %	98.5 %	99.9 %
800	98.2 %	98.3 %	98.6 %
900	97.9 %	98.2 %	98.3 %

It was observed that lower L* value (darker color on the L*a*b* scale) inks slightly improved light blocking at certain wave lengths (e.g., 600-700 nm). It was also observed that the light blocking composition had an effect on the visual appearance of the color. It was concluded that more saturated or more opaque colors may be used to produce the intended color effect.

EXAMPLE 3

The impact of the thickness of the light blocking layer on the ability to block light was evaluated. Various samples were prepared using APR certified recyclable 40 μm clear PET shrink sleeve film. The inks were printed onto the film with solvent rotogravure inks. The film was first printed with three layers of white ink. Over the white ink layers, various thicknesses of a light blocking composition were applied, using a “banded” rotogravure cylinder (each printing lane has different engraving specifications) with lanes having volumes ranging from 5 BCM to 12 BCM (billion cubic micron per square inch, or 10^9 $\mu m^3/inch^2$). The light blocking composition included a metallic light blocking component having a gray or silver appearance.

The samples were tested with a UV-Vis spectrophotometer (Shimadzu model UV-2600i) for their light blocking ability (prior to shrinking) at wavelengths ranging from 220 nm to 900 nm. The results are shown in TABLE 3. The samples were also visually observed to evaluate the effect of the light blocking layer on the appearance of the white layer printed before it. It was observed that the thickness of the light blocking layer had an inverse correlation with the lightness of the white. As the thickness of the light blocking layer increased, the lightness of the white decreased. As the thickness of the light blocking layer decreased, the lightness of the white layer increased.

TABLE 3. Light blocking

Wavelength (nm)	**5 BCM**	**6 BCM**	**7 BCM**	**8 BCM**	**10 BCM**	**12 BCM**
220	99.9 %	99.9 %	100.0 %	100.0 %	100.0 %	100.0 %
300	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %
400	99.8 %	99.8 %	99.9 %	99.9 %	100.0 %	100.0 %
500	95.4 %	96.1 %	97.6 %	98.1 %	99.1 %	99.6 %
600	94.5 %	95.3 %	97.1 %	97.7 %	98.9 %	99.5 %
700	93.5 %	94.4 %	96.6 %	97.3 %	98.6 %	99.4 %
800	92.6 %	93.7 %	96.2 %	96.9 %	98.5 %	99.3 %
900	91.8 %	93.0 %	95.7 %	96.5 %	98.3 %	99.2 %

EXAMPLE 4

The light blocking performance of labels prepared according to the present disclosure was compared to commercially available light blocking labels.

The sample labels were prepared similar to Example 3 by a “banded” rotogravure cylinder that had lanes engraved with 12 BCM, 10 BCM, 8 BCM, and 6 BCM volumes to apply the light blocking layer.. The comparative samples were two (2) different commercially available white PET films, each printed on one side with black ink by a rotogravure cylinder that had a volume of 10 BCM. The comparative samples are non-recyclable.

The samples were tested as described in Example 3. The results are shown in TABLE 4. above.

TABLE 4. Light blocking

Wavelength (nm)	**Comparative Sample 1**	**Comparative Sample 2**	**12 BCM**	**10 BCM**	**8 BCM**	**6 BCM**
220	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %
300	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %

400	99.9 %	99.9 %	99.8 %	99.8 %	99.7 %	99.5 %
500	99.8 %	99.6 %	98.3 %	98.0 %	97.8 %	96.0 %
600	99.5 %	99.3 %	98.0 %	97.6 %	97.0 %	94.5 %
700	99.1 %	98.8 %	97.7 %	97.2 %	96.3 %	93.4 %
800	98.4 %	97.9 %	97.4 %	96.9 %	95.8 %	92.4 %
900	97.8 %	97.0 %	97.2 %	96.6 %	95.3 %	91.7 %

It was observed that the labels according to the present disclosure provided comparable light blocking properties to the commercially available labels when the light blocking layer was thicker. When the light blocking layer was less thick, the light blocking properties decreased as seen in Example 3.

It was observed upon visual comparison that the labels according to the present disclosure exhibited better lightness properties.

EXAMPLE 5

The light blocking performance of labels prepared according to the present disclosure was compared to comparative labels that are used to block light and are commercially available in the market.

The sample label was prepared using APR certified recyclable 40 μm clear PET shrink sleeve film. The inks were printed onto the film with solvent rotogravure inks. The film was first printed with an indicia layer (four different colored inks). The printed indicia layer was then overlaid with three layers of white ink. Over the white ink layers, a light blocking composition was applied by a rotogravure cylinder that had a volume of 12 BCM (billion cubic micron per square inch, or 10^9 $\mu m^3/inch^2$).

The comparative samples (Comparative Sample 3 and Comparative Sample 4) were two (2) different printed labels that are currently used for a product that needs to block light to protect its contents. Comparative Sample 3 was printed on white film, had graphics that were almost identical to the sample label, and black print on the inside to help block light. Comparative Sample 4 was printed on white film, had graphics that were different than the sample label or Comparative Sample 3, and had black print on the inside to help block light. The comparative samples are non-recyclable.

The samples were tested as described in Example 3. The light blocking results are shown in TABLE 5 below.

TABLE 5. Light blocking

Wavelength (nm)	**Sample label**	**Comparative Sample 3**	**Comparative Sample 4**
220	100.0%	100.0%	100.0%
300	100.0%	100.0%	100.0%
400	99.9%	99.8%	99.8%
500	99.3%	99.7%	99.7%
600	99.1%	99.5%	99.5%
700	98.9%	99.3%	99.3%
800	98.8%	99.1%	99.1%
900	98.7%	98.9%	98.9%

It was observed that the labels according to the present disclosure provided comparable light blocking properties as the commercially available labels.

It was observed upon visual comparison that the labels according to the present disclosure exhibited better lightness properties with the colors of the indicia layer appearing more vibrant.

EXAMPLE 6

The ability of typical recycling equipment to correctly sort bottles with labels according to the present disclosure was tested to test compatibility with APR sorting requirements. The samples were tested according to APR Document number SORT-B-03, Evaluation of Sorting Potential for Plastic Articles Utilizing Metal, Metalized, or Metallic Printed Components, published on May 15, 2018. Further guidance can be found in APR documents PET-CG-02, Critical Guidance Protocol for Clear PET Articles with Labels and Closures; and PET-B-02, Benchmark Evaluation for Clear PET Articles with Labels and Closures.

Labels were prepared as described in Example 2 with 12 BCM a light blocking layer. The labels were applied onto clear PET bottles. The bottles with labels were tested in an Eriez Xtreme Test Line in both vertical and horizontal orientation. Before testing begins candidate articles are compressed. Articles are the determined to be ferrous or not. Ferrous articles are tested with a plate magnet. Articles are then passed through a tunnel-style metal detector at vertical and horizontal orientations and the spherical equivalent of the of the sample is calculated. Sphere sizes of 0-2 mm indicate a recyclable sample.

The sample was found to exhibit a sphere size of 0.5 mm in the portrait orientation and 0.6 mm in the landscape orientation.

The bottles were also run through an eddy current sorter and an NIR sorter that is used to identify PET articles. The bottles were recognized as PET by the NIR sorter The bottles were also not caught by the eddy current sorter. In other words, the bottles passed the recycling criteria for plastic (e.g., PET) bottles.

The complete disclosure of all patents, patent applications, and publications, and electronically available material cited herein are incorporated by reference. In the event that any inconsistency exists between the disclosure of the present application and the disclosure(s) of any document incorporated herein by reference, the disclosure of the present application shall govern. The foregoing detailed description and examples have been given for clarity of understanding only. No unnecessary limitations are to be understood therefrom. The invention is not limited to the exact details shown and described, for variations obvious to one skilled in the art will be included within the invention defined by the claims.

What is claimed is:

1. A recyclable shrink label comprising:

a heat shrink film having a first surface and a second surface opposite of the first surface, the heat shrink film having a thickness from 15 μm to 100 μm or 30 μm to 80 μm; and

a light blocking layer disposed adjacent the first surface and comprising a light blocking component, the light blocking layer being constructed for the recyclable shrink label to block at least 80 % of incident light having wavelengths in a range of 200 nm to 900 nm.

2. The recyclable shrink label of claim 1 further comprising an indicia layer, optionally wherein the indicia layer is disposed on the first surface.

3. The recyclable shrink label of claim 1 or 2 further comprising a high opacity layer, the high opacity layer optionally comprising a white pigment.

4. The recyclable shrink label of claim 3, wherein the recyclable shrink label comprises an indicia layer and wherein the high opacity layer is disposed between the indicia layer and the light blocking layer.

5. The recyclable shrink label according to any of claims 1 to 4, wherein the heat shrink film comprises polyester, polyolefin, or a combination thereof.

6. The recyclable shrink label according to any of claims 1 to 5, wherein the heat shrink film comprises polyethylene terephthalate (PET), polyethylene terephthalate glycol-modified (PETG or PET-G), polyvinyl chloride (PVC), polystyrene or oriented polystyrene (OPS), polylactic acid (PLA), polypropylene (PP), polyethylene (PE), or a combination thereof.

7. The recyclable shrink label according to any of claims 1 to 6, wherein the heat shrink film comprises a seam.

8. The recyclable shrink label according to any of claims 1 to 7, wherein the heat shrink film is in a form of a sleeve or tube.

9. The recyclable shrink label according to any of claims 1 to 8, wherein when heated to 100 °C, the heat shrink film contracts or shrinks by about 1 % to about 90 %, optionally wherein the heat shrink film contracts of shrinks by about 1 % to 90 % in a transverse direction.

10. The recyclable shrink label according to any of claims 1 to 9, wherein when heated to 100 °C, the entire recyclable shrink label contracts or shrinks by about 1 % to about 90 %, optionally wherein the entire recyclable shrink label contracts of shrinks by about 1 % to 90 % in a transverse direction.

11. The recyclable shrink label according to any of claims 3 to 10, wherein the high opacity layer comprises a pigment selected from titanium dioxide (TiO_2), precipitated calcium carbonate (PCC), aluminum silicate, aluminum oxide (alumina), mica-based pigments coated with thin layer(s) of white pigment, or a combination thereof.

12. The recyclable shrink label according to any of claims 1 to 11, wherein the light blocking component comprises a metal particulate, optionally wherein the metal particulate has a particle size of 0.1 μm to 100 μm.

13. The recyclable shrink label according to any of claims 1 to 12, wherein the light blocking component comprises zinc, aluminum, copper, silver, or an alloy thereof, titanium dioxide, carbon black, mica, a reflective pigment, a polymer capable of blocking light, a mineral capable of blocking light, or a combination thereof.

14. The recyclable shrink label according to any of claims 1 to 13, wherein the light blocking layer is present in an amount of 0.5 ppr to 25 ppr.

15. The recyclable shrink label according to any of claims 1 to 14, wherein the light blocking layer comprises from 0.1 ppr to 10 ppr, from 0.2 ppr to 5 ppr, or from 0.3 ppr to 3 ppr of the light blocking component.

16. An article comprising:

a container comprising an external surface; and

the recyclable shrink label of any one of claims 1 to 15 disposed on the container, optionally wherein the first surface of the heat shrink film faces the external surface of the container.

17. The article according to claim 16, wherein the container comprises polymer, glass, metal, or a combination thereof.

18. The article according of claim 16 or 17, wherein the container comprises polyethylene terephthalate (PET), optionally wherein the container consists of polyethylene terephthalate (PET), optionally wherein the container comprises clear polyethylene terephthalate (PET).

19. The article of any one of claims 16 to 18, wherein the recyclable shrink label comprises polyethylene terephthalate (PET), and optionally wherein the polyethylene terephthalate (PET) forms an outermost layer of the recyclable shrink label.

20. A method of making a label for a container, the method comprising:

depositing an indicia layer on a heat shrinkable film;

optionally depositing a high opacity layer on the indicia layer; and

depositing a light blocking composition on the indicia layer, on the heat shrinkable film, or on the high opacity layer,

wherein the light blocking layer comprises one or more light blocking components, and wherein the label is capable of blocking at least 80 % of incident light having wavelengths in a range of 200 nm to 900 nm.

21. A method of recycling an article comprising a container defining an external surface; and the recyclable shrink label of any one of claims 1 to 15 disposed on the container, optionally with the first surface facing the external surface of the container, the method comprising:

determining that the container and recyclable shrink label comprise polyethylene terephthalate (PET);

directing the article into a polyethylene terephthalate (PET) recycling stream; and

washing the article to remove inks and pigments from the recyclable shrink label.

22. The method of claim 21, wherein the washed article is clear and is not stained by the light blocking component or other pigments or inks.

ABSTRACT

A recyclable shrink label includes a heat shrink film having a first surface and a second surface opposite of the first surface; and a light blocking layer disposed adjacent the first surface and comprising a light blocking component, the light blocking layer being constructed for the recyclable shrink label to block at least 80 % of incident light having wavelengths in a range of 200 nm to 900 nm. The recyclable shrink label may further include an indicia layer. The recyclable shrink label may further include a high opacity layer. The recyclable shrink label may be applied to a container, e.g., a recyclable container. Articles including the recyclable shrink label may be recycled in a process where both the container and the label are recognized as a resin and may be directed into a corresponding recycling stream. In some cases, both the container and the label include PET.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	0644.000001US01
	Application Number	
Title of Invention	RECYCLABLE HEAT SHRINK FILM FOR RECYCLABLE CONTAINER	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	**Given Name**	**Middle Name**	**Family Name**	**Suffix**
	Andrew		Sharp	

Residence Information (Select One) ● US Residency Non US Residency Active US Military Service

City	Orchard Park	**State/Province**	NY	**Country of Residence** i	

Mailing Address of Inventor:

Address 1	215 John Glenn Drive		
Address 2			
City	Amherst	**State/Province**	NY
Postal Code	14127	**Country** i	US

Inventor 2 Remove

Legal Name

Prefix	**Given Name**	**Middle Name**	**Family Name**	**Suffix**
	Mitchell	J.	Morgan	

Residence Information (Select One) ● US Residency Non US Residency Active US Military Service

City	Buffalo	**State/Province**	NY	**Country of Residence** i	US

Mailing Address of Inventor:

Address 1	215 John Glenn Drive		
Address 2			
City	Amherst	**State/Province**	NY
Postal Code	14127	**Country** i	US

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

PTO/AIA/14 (01-22)
Approved for use through 05/31/2024. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	0644.000001US01
	Application Number	
Title of Invention	RECYCLABLE HEAT SHRINK FILM FOR RECYCLABLE CONTAINER	

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	26813
Email Address	Add Email Remove Email

Application Information:

Title of the Invention	RECYCLABLE HEAT SHRINK FILM FOR RECYCLABLE CONTAINER		
Attorney Docket Number	0644.000001US01	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	3	**Suggested Figure for Publication (if any)**	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	● Customer Number	US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	26813		

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	0644.000001US01
	Application Number	
Title of Invention	RECYCLABLE HEAT SHRINK FILM FOR RECYCLABLE CONTAINER	

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the “Application Number” field blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	PCT/US2022/029280	2022-05-13
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2022/029280	Claims benefit of provisional	63/188794	2021-05-14

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	0644.000001US01
	Application Number	
Title of Invention	RECYCLABLE HEAT SHRINK FILM FOR RECYCLABLE CONTAINER	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	0644.000001US01
	Application Number	

Title of Invention	RECYCLABLE HEAT SHRINK FILM FOR RECYCLABLE CONTAINER

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

● Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
Person to whom the inventor is obligated to assign.	Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	BROOK & WHITTLE LIMITED		
Mailing Address Information For Applicant:			
Address 1	215 John Glenn Drive		
Address 2			
City	Amherst	**State/Province**	NY
Country	US	Postal Code	14127
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	0644.000001US01
	Application Number	
Title of Invention	RECYCLABLE HEAT SHRINK FILM FOR RECYCLABLE CONTAINER	

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

Remove

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

Remove

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Lotta Kiuru-Ribar/			Date (YYYY-MM-DD)	2023-01-30
First Name	Lotta	Last Name	Kiuru-Ribar	Registration Number	66979

Additional Signature may be generated within this form by selecting the Add button. Add

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	0644.000001US01
	Application Number	

Title of Invention	RECYCLABLE HEAT SHRINK FILM FOR RECYCLABLE CONTAINER

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1 The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3 A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent CooperationTreaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Attorney Docket No.: 0644.000001WO01

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	RECYCLABLE HEAT SHRINK FILM FOR RECYCLABLE CONTAINER

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number PCT/US2022/029280

filed on May 13, 2022 .

The above-identified application was made or authorized to be made by me.

I also declare that I have reviewed and understand the contents of the application, including the claims, and am aware of the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in 37 CFR §1.56.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Andrew Sharp Date: 07/6/2022

Signature:

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

Attorney Docket No.: 0644.000001WO01

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	RECYCLABLE HEAT SHRINK FILM FOR RECYCLABLE CONTAINER

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number PCT/US2022/029280

filed on May 13, 2022.

The above-identified application was made or authorized to be made by me.

I also declare that I have reviewed and understand the contents of the application, including the claims, and am aware of the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in 37 CFR §1.56.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Mitchell J. Morgan Date: 07/06/2022

Signature:

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.:	Unassigned	Attorney Docket No.:	0644.000001US01
Confirmation No.:	Unassigned	Customer No.:	26813
Filing Date:	Herewith	Examiner Name:	Unassigned
First Named Inventor:	Andrew Sharp	Group Art Unit:	Unassigned
Title of Invention:	RECYCLABLE HEAT SHRINK FILM FOR RECYCLABLE CONTAINER		

PRELIMINARY AMENDMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

Prior to taking up the above-identified application for examination, please amend the application as follows:

Amendments to the Specification begin on the page entitled "Amendments to the Specification."

Amendments to the Claims are reflected in the listing of claims which begins on the page entitled "Amendments to the Claims."

Remarks begin on the page entitled "Remarks."

Amendments to the Specification

Please replace the RELATED APPLICATIONS, with the following amended paragraph.

The present application is a continuation application of International Application No. PCT/US2022/029280 filed 13 May 2022, which claims the priority to U.S. Provisional Patent Application No. 63/188,794, filed on 14 May[[,]] 2021, which ~~is~~ are incorporated herein in their entireties ~~its~~ ~~entirety~~.

Amendments to the Claims

This listing of claims replaces all prior versions, and listings, of claims in the above-identified application:

Listing of Claims

1. (**Currently Amended**) A recyclable shrink label comprising:

a heat shrink film having a first surface and a second surface opposite of the first surface, the heat shrink film having a thickness from 15 μm to 100 μm ~~or 30 μm to 80 μm~~; and

a light blocking layer disposed adjacent the first surface and comprising a light blocking component, the light blocking layer being constructed for the recyclable shrink label to block at least 80 % of incident light having wavelengths in a range of 200 nm to 900 nm.

2. (Original) The recyclable shrink label of claim 1 further comprising an indicia layer, optionally wherein the indicia layer is disposed on the first surface.

3. (**Currently Amended**) The recyclable shrink label of claim 1 ~~or 2~~ further comprising a high opacity layer, the high opacity layer optionally comprising a white pigment.

4. (Original) The recyclable shrink label of claim 3, wherein the recyclable shrink label comprises an indicia layer and wherein the high opacity layer is disposed between the indicia layer and the light blocking layer.

5. (**Currently Amended**) The recyclable shrink label according to ~~any of claims 1 to 4~~ claim 1, wherein the heat shrink film comprises polyester, polyolefin, or a combination thereof.

6. (**Currently Amended**) The recyclable shrink label according to ~~any of claims 1 to 5~~ claim 1, wherein the heat shrink film comprises polyethylene terephthalate (PET), polyethylene terephthalate glycol-modified (PETG or PET-G), polyvinyl chloride (PVC), polystyrene or oriented polystyrene (OPS), polylactic acid (PLA), polypropylene (PP), polyethylene (PE), or a combination thereof.

7. (**Currently Amended**) The recyclable shrink label according to ~~any of claims 1 to 6~~ claim 1, wherein the heat shrink film comprises a seam.

8. (**Currently Amended**) The recyclable shrink label according to ~~any of claims 1 to 7~~ claim 1, wherein the heat shrink film is in a form of a sleeve or tube.

9. (**Currently Amended**) The recyclable shrink label according to ~~any of claims 1 to 8~~ claim 1, wherein when heated to 100 °C, the heat shrink film contracts or shrinks by about 1 % to about 90 %, optionally wherein the heat shrink film contracts of shrinks by about 1 % to 90 % in a transverse direction.

10. (**Currently Amended**) The recyclable shrink label according to ~~any of claims 1 to 9~~ claim 1, wherein when heated to 100 °C, the entire recyclable shrink label contracts or shrinks by about 1 % to about 90 %, optionally wherein the entire recyclable shrink label contracts of shrinks by about 1 % to 90 % in a transverse direction.

11. (**Currently Amended**) The recyclable shrink label according to ~~any of claims 3 to 10~~ claim 3, wherein the high opacity layer comprises a pigment selected from titanium dioxide (TiO_2), precipitated calcium carbonate (PCC), aluminum silicate, aluminum oxide (alumina), mica-based pigments coated with thin layer(s) of white pigment, or a combination thereof.

12. (**Currently Amended**) The recyclable shrink label according to ~~any of claims 1 to 11~~ claim 1, wherein the light blocking component comprises a metal particulate, optionally wherein the metal particulate has a particle size of 0.1 μm to 100 μm.

13. (**Currently Amended**) The recyclable shrink label according to ~~any of claims 1 to 12~~ claim 1, wherein the light blocking component comprises zinc, aluminum, copper, silver, or an alloy thereof, titanium dioxide, carbon black, mica, a reflective pigment, a polymer capable of blocking light, a mineral capable of blocking light, or a combination thereof.

14. (**Currently Amended**) The recyclable shrink label according to ~~any of claims 1 to 13~~ claim 1, wherein the light blocking layer is present in an amount of 0.5 ppr to 25 ppr.

15. (**Currently Amended**) The recyclable shrink label according to ~~any of claims 1 to 14~~ claim 1, wherein the light blocking layer comprises from 0.1 ppr to 10 ppr~~, from 0.2 ppr to 5 ppr, or from 0.3 ppr to 3 ppr~~ of the light blocking component.

16. (**Currently Amended**) An article comprising:

a container comprising an external surface; and

the recyclable shrink label of ~~any one of claims 1 to 15~~ claim 1 disposed on the container, optionally wherein the first surface of the heat shrink film faces the external surface of the container.

17. (**Currently Amended**) The article according to claim 16, wherein the container comprises polymer, glass, metal, or a combination thereof.

18. (**Currently Amended**) The article according of claim 16 ~~or 17~~, wherein the container comprises polyethylene terephthalate (PET), optionally wherein the container consists of polyethylene terephthalate (PET), optionally wherein the container comprises clear polyethylene terephthalate (PET).

19. (**Currently Amended**) The article of ~~any one of claims 16 to 18~~ claim 16, wherein the recyclable shrink label comprises polyethylene terephthalate (PET), and optionally wherein the polyethylene terephthalate (PET) forms an outermost layer of the recyclable shrink label.

20. (Original) A method of making a label for a container, the method comprising:

depositing an indicia layer on a heat shrinkable film;

optionally depositing a high opacity layer on the indicia layer; and

depositing a light blocking composition on the indicia layer, on the heat shrinkable film, or on the high opacity layer, wherein the light blocking layer comprises one or more light blocking components, and wherein the label is capable of blocking at least 80 % of incident light having wavelengths in a range of 200 nm to 900 nm.

21. **(Currently Amended)** A method of recycling an article comprising a container defining an external surface; and the recyclable shrink label of ~~any one of claims 1 to 15~~ claim 1 disposed on the container, optionally with the first surface facing the external surface of the container, the method comprising:

determining that the container and recyclable shrink label comprise polyethylene terephthalate (PET);

directing the article into a polyethylene terephthalate (PET) recycling stream; and

washing the article to remove inks and pigments from the recyclable shrink label.

22. (Original) The method of claim 21, wherein the washed article is clear and is not stained by the light blocking component or other pigments or inks.

Remarks

Please enter and consider the changes to the specification as indicated herein. Please enter and consider amended claims 1, 3, 5-19, and 21 and original claims 2, 4, 20, and 22. No new matter is added.

Conclusion

The Examiner is invited to contact Applicant's Representatives at the telephone number listed below if there are any questions regarding this Preliminary Amendment or if prosecution of this application may be assisted thereby.

Respectfully submitted by
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1/30/2023
Date

/Lotta Kiuru-Ribar/
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.:	Unassigned	Attorney Docket No.:	0644.000001US01
Confirmation No.:	Unassigned	Customer No.:	26813
Filing Date:	Herewith	Examiner Name:	Unassigned
First Named Inventor:	Andrew Sharp	Group Art Unit:	Unassigned
Title of Invention:	RECYCLABLE HEAT SHRINK FILM FOR RECYCLABLE CONTAINER		

INFORMATION DISCLOSURE STATEMENT

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

In compliance with the duty imposed by 37 C.F.R. § 1.56, and in accordance with 37 C.F.R. §§ 1.97(b) – (d) and 1.98, Applicant brings the materials enclosed herewith to the attention of the Examiner as possibly being of interest in connection with the above-identified patent application. Pursuant to M.P.E.P. § 609 and 37 C.F.R. § 1.97(h), the information cited in the present Information Disclosure Statement shall not be construed to be an admission that the information is, or is considered to be, material to patentability. Applicant requests that the Examiner consider each of the documents listed on the attached list of documents. Pursuant to the provisions of M.P.E.P. § 609, Applicant further requests that a copy of the list of documents marked as being considered and initialed by the Examiner, be returned along with the next official communication.

Applicant wishes to bring the Examiner's attention to any issued U.S. Patents and/or pending U.S. Applications cited in the list of documents submitted herewith, as well as any documents, Office Actions that may include rejections of similar claims, and any provisional U.S. Patent Applications referenced in the pending U.S. Applications or in their file wrappers.

Applicant believes that no fee is due, as this Information Disclosure Statement is filed prior to the receipt of any Action on the merits. However, in the event a fee is due, please charge any fee or credit any overpayment to Deposit Account No. 13-4895.

Applicant invites the Examiner to contact the undersigned Applicant's Representative at the telephone number listed below if doing so may advance prosecution of this application.

Respectfully submitted by

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1/30/2023
Date

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

Application Number:	Unassigned
Filing Date:	Herewith
First Named Inventor:	Andrew Sharp
Art Unit:	Unassigned
Examiner Name:	Unassigned
Attorney Docket No.:	0644.000001US01
Sheet 1 of 2	**IDS filed on:**

U.S. PATENTS

Examiner Initial	Patent Number (Number - Kind Code)	Issue Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
	None			

U.S. PATENT APPLICATION PUBLICATIONS

Examiner Initial	Publication Number (Number - Kind Code)	Publication Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
	2003/0068453	04/10/2003	Kong	
	2009/0233067	09/17/2009	Doornheim	
	2013/0126462	05/23/2013	Georgeson	

U.S. PATENT APPLICATIONS BY SERIAL NUMBER

Examiner Initial	Copy Enclosed	Document Number (Number - Kind Code)	Filing Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
		None			

FOREIGN PATENT DOCUMENTS

Examiner Initial	Copy Enclosed	Country Code	Foreign Document Number	Kind Code	Publication Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments	translation	
								yes	no
	X	EP	2298665		03/23/2011	Okura Industrial Co. Ltd.			
	X	WO	2015/026479		02/26/2015	Sun Chemical Corporation			
	X	EP	03854839		07/28/2021	SKC Co., Ltd.			

NON-PATENT LITERATURE DOCUMENTS

Examiner Initial	Copy Enclosed	Document Description (Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.)
	X	PCT Search Report and Written Opinion for PCT/US2022/029280 dated August 11, 2022 (9 pages).
	X	Shrink Sleeve Labels on PET Containers APR Resource Document, The Association of Plastic Recyclers, 1/4/2021, 10 pages.
	X	Benchmark Evaluation for Clear PET Articles with Labels and Closures, The Association of Plastic Recyclers, 04/11/2019 (7 pages).
	X	Critical Guidance Protocol for Clear PET Articles with Labels and Closures, The Association of Plastic Recyclers, 08/17/2021 (11 pages).

Examiner Signature		Date Considered	

***EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.**

INFORMATION DISCLOSURE STATEMENT BY APPLICANT		**Application Number:**	Unassigned
		Filing Date:	Herewith
		First Named Inventor:	Andrew Sharp
		Art Unit:	Unassigned
		Examiner Name:	Unassigned
		Attorney Docket No.:	0644.000001US01
Sheet __2__ of __2__		**IDS filed on:**	

Examiner Initial	**Copy Enclosed**	**Document Description** (Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.)
	X	Evaluation of the Near Infrared (NIR) Sorting Potential of a Whole Plastic Article, The Association of Plastic Recyclers, 05/15/2018 (15 pages).
	X	Evaluation of Sorting Potential for Plastic Articles Utilizing Metal, Metalized, or Metallic Printed Components, The Association of Plastic Recyclers, 05/15/2018 (10 pages).

Examiner Signature		Date Considered	

***EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.**

Doc Code: TRACK1.REQ
Document Description: TrackOne Request

PTO/AIA/424 (04-14)

CERTIFICATION AND REQUEST FOR PRIORITIZED EXAMINATION UNDER 37 CFR 1.102(e) (Page 1 of 1)

First Named Inventor:	SHARP, Andrew	Nonprovisional Application Number (if known):	
Title of Invention:	RECYCLABLE HEAT SHRINK FILM FOR RECYCLABLE CONTAINER		

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS PRIORITIZED EXAMINATION FOR THE ABOVE-IDENTIFIED APPLICATION.

1. The processing fee set forth in 37 CFR 1.17(i)(1) and the prioritized examination fee set forth in 37 CFR 1.17(c) have been filed with the request. The publication fee requirement is met because that fee, set forth in 37 CFR 1.18(d), is currently $0. The basic filing fee, search fee, and examination fee are filed with the request or have been already been paid. I understand that any required excess claims fees or application size fee must be paid for the application.

2. I understand that the application may not contain, or be amended to contain, more than four independent claims, more than thirty total claims, or any multiple dependent claims, and that any request for an extension of time will cause an outstanding Track I request to be dismissed.

3. The applicable box is checked below:

I. ☑ Original Application (Track One) - Prioritized Examination under § 1.102(e)(1)

i. (a) The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a). This certification and request is being filed with the utility application via EFS-Web.

---OR---

(b) The application is an original nonprovisional plant application filed under 35 U.S.C. 111(a). This certification and request is being filed with the plant application in paper.

ii. An executed inventor's oath or declaration under 37 CFR 1.63 or 37 CFR 1.64 for each inventor, **or** the application data sheet meeting the conditions specified in 37 CFR 1.53(f)(3)(i) is filed with the application.

II. ☐ Request for Continued Examination - Prioritized Examination under § 1.102(e)(2)

i. A request for continued examination has been filed with, or prior to, this form.
ii. If the application is a utility application, this certification and request is being filed via EFS-Web.
iii. The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a), or is a national stage entry under 35 U.S.C. 371.
iv. This certification and request is being filed prior to the mailing of a first Office action responsive to the request for continued examination.
v. No prior request for continued examination has been granted prioritized examination status under 37 CFR 1.102(e)(2).

Signature /Lotta Kiuru-Ribar/	Date 1/30/2023
Name (Print/Typed) Lotta Kiuru-Ribar	Practitioner Registration Number 66979

Note: *This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required.**

☐ *Total of ________ forms are submitted.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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(54) SHRINK FILM FOR LIGHT-SHIELDING PACKAGING

(57) Disclosed is a light-shielding shrink film for packaging that excels in light-shielding performance, printability, and appearance. The light-shielding shrink film for packaging comprises a light-shielding resin layer, a concealing resin layer provided to conceal the color of the light-shielding resin layer, and transparent resin layers provided as both outer layers. The light-shielding shrink film for packaging has a thickness of 10 to 30 μm. The concealing resin layer is a resin composition containing a 25 to 70 weight% of white pigment, and has a thickness of 2.4 to 8.0 μm.

EP 2 298 665 A1

Printed by Jouve, 75001 PARIS (FR)

Description

Technical Field

[0001] The present invention relates to light-shielding shrink films for packaging, particularly to light-shielding shrink films for packaging, comprising a light-shielding resin layer and a white resin layer provided to conceal the color of the light-shielding resin layer. Specifically, the invention provides a light-shielding shrink film for the individual or multiple-unit packaging of containers, capable of preventing deterioration or discoloration by light of the container contents such as food, drinks, and cosmetics, and that can be clearly printed or decorated thereon.

Background Art

[0002] Shrink packaging using heat-shrinkable shrink films has been widely used for articles such as foods and sundries, because it allows for fast, tight, simultaneous packaging of multiple products regardless of the shape and size of the packaged articles. It also provides good appearance and display effects for the packaged products, increasing commodity values, and keeps good hygiene for the contents, in addition, it enables an easy quality check by visual inspection. For example, there has been proposed a polypropylenic laminated shrink film that has desirable stretchability and excellent thermal shrinkability with strong impact-resistance when used at a fuse-sealed portion (see Patent Document 1).

[0003] Recently, the qualities required for the shrink film packaging include not only the simple protection of the products from dust or dirt and improvement of commodity value, but the protection of the contents from ultraviolet light or visible light. For example, packaging using a shrink film having ingredients such as an ultraviolet light absorber is used to provide ultraviolet absorbing capability has been proposed (see Patent Document 2).
There have also been proposed a shrink film that uses a white or white opaque film to provide good contrast for the design made on the film, and that therefore has defined and clear contrast for the design while exhibiting sufficient light-shielding performance with the light-shield printed on the shrink film; and a light-shielding shrink film provided with a layer that includes a white ink layer and an aluminum paste-containing white ink layer successively printed over the whole surface by solid printing, and that therefore excels in light-shielding performance in the visible light and ultraviolet light ranges, and has superior white concealability (whiteness level) after the printing (see Patent Documents 3 and 4).
There has also been proposed a heat-shrinkable opaque-white film that includes a core layer of achromatic color, or of chromatic-color that suppresses the passage of the light of a 380 to 500 nm wavelength band, and white front and back layers which is used for a shrink label for a labeled container, and that can therefore suppress the light discoloration or deterioration of the container contents while clearly showing the printed design or the like and leaving a good impression of the container contents (see Patent Document 5). The publication also proposes a heat-shrinkable opaque-white film and a shrink label that are useful for the production of such labeled containers.

[0004] On the other hand, laminated films for light-shielding packaging are also available that include a light-shielding resin layer formed as a thermoplastic resin blended with a light-shielding pigment, and a white resin layer formed as a white colorant-containing resin composition, and that can therefore exhibit light-shielding performance while preventing the adverse effects of the light-shielding pigment. For example, there have been proposed laminated resin films of a transparent resin layer/white resin layer/light-shielding resin layer/white resin layer/transparent resin layered structure, in which a black pigment is used for the light-shielding resin layer (see Patent Document 6), a brown pigment is used for the light-shielding resin layer (see Patent Document 7), and an argent pigment is used for the light-shielding resin layer (see Patent Document 8).

Prior Art Documents

Patent Documents

[0005]

Patent Document 1: JP-A-H01-195043
Patent Document 2: JP-A-H09-328164
Patent Document 3: JP-A-2003-26252
Patent Document 4: JP-A-2003-200966
Patent Document 5: International Publication WO2004/09413
Patent Document 6: JP-A-2003-305811
Patent Document 7: JP-A-2004-114515
Patent Document 8: JP-A-2004-114523

Disclosure of the Invention

Problems that the Invention is to Solve

[0006] As described above, the light-shielding shrink films described in Patent Documents 3 and 4 involve solid printing of the light-shielding layer or solid printing of the light-shielding layer and the white layer over the whole surface after the production of the shrink film. This is problematic because it adversely affects the shrink characteristics when a thick print layer is formed, in addition to increasing the manufacturing steps.
While these problems are absent in the light-shielding shrink film described in Patent Document 5, the total film thickness is considerably thick because the film is intended for labeled containers. For example, as is clear from Examples, the thicknesses of the shrink film and the white surface-layer are as thick as 50 μm and 13 to 21 μm respectively, and it has not been easy to directly use the film as a packaging shrink film of 10 to 30μm in thickness.
[0007] The light-shielding laminated packaging films described in Patent Documents 6 to 8 are not intended for shrink packaging but for ordinary packaging. As such, each layer, including the light-shielding resin layer and the white resin layer, has a considerable thickness sufficient to block light such as sunlight and fluorescent light. For this reason, the white resin layer for these packaging films contains a 5 to 20 weight% of white pigment, and is as thick as 10 to 30 μm. The film thickness is about 50 to 100 μm, and the thickness is completely out of the range of the film for shrink packaging. Thus, it has not been easy to apply such a light-shielding laminated packaging film technique to the shrink film.
[0008] Under these circumstances, there have been some following problems to overcome in order to provide a light-shielding shrink film for packaging.
The packaging shrink film currently in use generally has a thickness of 10 to 30 μm, particularly preferably 10 to 20 μm. Given such a thin thickness, there is a limitation for the thickness of the concealing resin layer provided to conceal the color of the light-shielding resin layer for improved appearance. For this reason, it has been difficult to directly apply the non-shrink film techniques that use the 10 μm to 30 μm thickness range for the white resin layer itself.
It is known that the color of the underlying light-shielding resin layer can be concealed more effectively by increasing the thickness of the white resin layer. However, the problem remaining is not yet solved with regard to manufacture of a light-shielding shrink film that has sufficient light-shielding performance, and an opaque-white color for appearance and ease of design, and that has superior shrink characteristics, even with a thickness as thin as 10 to 30 μm.
It is an object of the present invention to solve such problems, and provide a high-performance light-shielding shrink film for packaging.

Means for Solving the Problems

[0009] Under these circumstances, the present inventors have reached the present invention after intensive studies, conducted in the light of the foregoing conventional techniques to develop a light-shielding shrink film for packaging that has superior shrink characteristics, and an excellent appearance that enables decoration such as printing while having superior light-shielding performance at the same time.
[0010] The present invention solves the foregoing problems based on the following technical means.

(1) A light-shielding shrink film for packaging, comprising a light-shielding resin layer, a concealing resin layer provided to conceal the color of the light-shielding resin layer, and transparent resin layer provided as both outer layers,
characterized in that the light-shielding shrink film for packaging has a thickness of 10 to 30 μm, and that the concealing resin layer is a resin composition containing a 25 to 70 weight% of white pigment, and has a thickness of 2.4 to 8.0 μm.
(2) The light-shielding shrink film for packaging of (1), wherein the shrink film is a laminate in order of transparent resin layer/concealing resin layer/light-shielding resin layer/concealing resin layer/transparent resin layer.
(3) The light-shielding shrink film for packaging of (1), wherein the shrink film is a laminate in order of transparent resin layer/concealing resin layer/light-shielding resin layer/transparent resin layer.
(4) The light-shielding shrink film for packaging of (1), wherein the shrink film comprises a white pigment-containing white resin layer, and is a laminate in order of transparent resin layer/concealing resin layer/light-shielding resin layer/white resin layer/transparent resin layer.
(5) The light-shielding shrink film for packaging of any one of (1) to (4), wherein the transparent resin layer has a thickness of 1 μm or more.
(6) The light-shielding shrink film for packaging of any one of (1) to (5), wherein the light-shielding resin layer has a thickness of 2 to 8 μm.
(7) The light-shielding shrink film for packaging of any one of (1) to (6), wherein the white pigment is titanium dioxide.
(8) The light-shielding shrink film for packaging of any one of (1) to (7), wherein the resin in the layers of the shrink

film is olefinic resin.
(9) The light-shielding shrink film for packaging of any one of (1) to (8), wherein at least one of the surfaces of the shrink film has a JIS Z8729 luminance (L*) of 70 or more.
(10) A shrink package formed of the light-shielding shrink film for packaging of any one of (1) to (9).
(11) The shrink package of (10), wherein an article is packaged in such a manner that the concealing resin layer is on the outer side of the light-shielding resin layer.
(12) The shrink package of (10) or (11), wherein an outer surface of the shrink package has a JIS Z8729 luminance (L*) of 70 or more.

Advantage of the Invention

[0011] The present invention is advantageous in the following respects.

(1) By the provision of the light-shielding resin layer and the concealing resin layer, the light-shielding shrink film for packaging excels not only in light-shielding performance but also in appearance.
(2) Because of the structure including the transparent resin layers as both outer layers, the light-shielding shrink film for packaging has a smooth surface and thus excels in printability.
(3) Because the thickness of the concealing resin layer and the content of the white pigment are specified, a light-shielding shrink film for packaging having superior light-shielding performance and appearance can easily be produced even with a thickness of 10 to 30 μm.
(4) Because the light-shielding shrink film for packaging has high surface luminance (L*) , the film is clearly printable.
(5) The light-shielding shrink film for packaging excels in fuse-sealability.

Best Mode for Carrying Out the Invention

[0012] The present invention is described below in detail.
A light-shielding shrink film for packaging of the present invention comprises a light-shielding resin layer, a concealing resin layer provided to conceal the color of the light-shielding resin layer, and transparent resin layers provided as both outer layers.
The light-shielding shrink film for packaging has a thickness of 10 to 30 μm, preferably 10 to 20 μm, most preferably 15 to 20 μm. With a thickness of less than 10 μm, sufficient thicknesses cannot be provided for the light-shielding resin layer and the concealing resin layer, and the light-shielding shrink film for packaging fails to have good light-shielding performance and appearance, or light-shielding performance. On the other hand, while light-shielding performance and good appearance can be obtained at the same time with a thickness of exceeding 30 μm, it leads to increased costs and is not usable, because the "shrink film" as used in the present invention is not intended for the direct packaging of contents but for the packaging of containers with their contents.
[0013] The rate of thermal shrinkage of a light-shielding shrink film for packaging of the present invention can be appropriately set according to the shape of the packaged article. However, the preferred rate of thermal shrinkage is 15% or more, preferably 20% or more, along the length direction (MD), and 20% or more, preferably 25% or more along the width direction (TD) as measured after being immersed in 110°C glycerin for 10 seconds.
[0014] The light-shielding resin layer forming the light-shielding shrink film for packaging of the present invention contains a light-shielding pigment. The thickness of the light-shielding resin layer and the pigment content can be appropriately selected within the ranges that satisfy the light-shielding performance. The preferred light-shielding performance is 3% or less light transmittance as measured in the wavelength range of 200 to 600 nm, with a spectrophotometer. However, considering practical deterioration of food and other contents by light, the preferred light-shielding performance should be 3% or less of light transmittance in the wavelength range of 340 to 550 nm, approximately the ultraviolet to visible light (green) range.
[0015] Inorganic pigments are mainly used for the light-shielding pigments for the light-shielding resin layer. For example, carbon black (average particle diameter of 0.03 μm, irregular particle) can be used for black, an iron oxide powder (average particle diameter of 0.17 μm, irregular particle) can be used for brown, and an aluminum powder (average particle diameter of 6 to 10 μm, scale-like) can be used for argent. In addition to these examples, the black may be appropriately selected from iron black and graphite, the brown from chrome yellow, molybdenum red, iron blue, ultramarine, red oxide, cadmium-based pigment, and cobalt-based pigment, and the argent from a metal powder of brass and copper. The light-shielding pigment has an average particle diameter of, for example, about 0.01 to 10 μm. An average particle diameter of less than 0.01 μm is not preferable because it tends to lower dispersibility. An average particle diameter of exceeding 10 μm is not preferable either, because it makes it difficult to obtain sufficient light-shielding performance. The pigment content in the light-shielding resin layer is preferably, for example, 2 to 10 wt% for the black pigment, 10 to 40 wt% for the brown pigment, and 10 to 40 wt% for the argent pigment. When the content falls below

the lower limit, the advantages of the light-shielding layer become smaller. Above the upper limit, it becomes difficult to provide good film appearance, even though it increases the light-shielding performance. Further, the excess pigment content may lower the ability to melt and knead the resin in the film manufacturing steps, and cause discoloration. Another disadvantage is the weakened film strength, including, for example, tear strength, tensile strength, and puncture strength. It should be noted that the light-shielding resin layer may additionally contain a white pigment.

[0016] The light-shielding resin layer has a thickness of preferably 2 to 8 μm. A thickness of less than 2 μm is not preferable because it lowers light-shielding performance, and makes the light-shielding performance heavily dependent on thickness changes, even when the content of the light-shielding pigment satisfies the foregoing conditions. A thickness of exceeding 8 μm is not preferable either, because, despite improved light-shielding performance, it makes the thickness proportion of the light-shielding resin layer in the light-shielding shrink film for packaging too large, and makes it difficult to obtain a desirable light-shielding shrink film for packaging as a whole.

[0017] The concealing resin layer forming the light-shielding shrink film for packaging of the present invention is provided to completely conceal the color of the light-shielding resin layer, and thus to improve the appearance of the film viewed from the concealing resin layer side, and to enable clear prints to be made on the surface. In this manner, the concealing resin layer serves to conceal the light-shielding resin layer and improve the appearance and ease of design. The concealing resin layer additionally serves to reflect or diffuse the light in the ultraviolet light region, and inhibit or block the passage of the light in this wavelength range, thereby preventing light deterioration such as degradation, discoloration, and fading of the packaged contents.

[0018] The concealing resin layer has a thickness of preferably 2.4 to 8 μm, preferably 3 to 6 μm, further preferably 4 to 6 μm. A thickness of less than 2.4 μm is not preferable because it makes it difficult to conceal the color of the light-shielding resin layer even with an increased white pigment content, and thus makes the appearance of the filmpoor. The concealing resin layer thickness of exceeding 8 μm improves the color concealability for the light-shielding resin layer; however, it is not preferable because it takes away from the thin total thickness for the light-shielding shrink film for packaging, for example, the required thicknesses of the light-shielding resin layer to shield light and the transparent resin layer provided on both outer layers as transparent resin layers are not attained, in addition to the poor stretchability.

[0019] Inorganic pigments are used for the white pigments for the concealing resin layer. However, the type of inorganic pigment is not particularly limited, and, for example, titanium dioxide, zinc oxide (zinc white), zinc sulfide, barium sulfate, and white lead can be used. Among them, titanium dioxide is most preferable for its fine grain size and excellent properties such as luminance, concealability, color-imparting property, lightfastness, heat resistance, and chemical resistance. The average particle diameter of the white pigment is, for example, 0.01 to 5 μm, more preferably about 0.1 to 1 μm. The white pigment exhibits high concealability within these ranges. The pigment content is 25 to 70 weight%, more preferably 30 to 60 weight%. Outside these preferable content ranges, specifically, when the content is less than 25 weight%, it becomes difficult to conceal the light-shielding resin layer, and the appearance or other cosmetic qualities of the film suffers in a concealing resin layer having a thickness of 2.4 to 8 μm. A content in excess of 70 weight% may significantly lower the ability to melt and knead the resin in film manufacture, causing discoloration. Another disadvantage is the weakened film strength, including, for example, tear strength, tensile strength, and puncture strength.

[0020] The most notable feature of the light-shielding shrink film for packaging of the present invention is that, even with a thin thickness of 10 to 30 μm, the shrink film can completely conceal the color of the light-shielding resin layer with the concealing resin layer, and can have a high-luminance opaque-white or white appearance (described later) and thus enables clear prints to be made, provided that the concealing resin layer has the specific composition and thickness presented above. Specifically, as is well known in the art, luminance improves as the thickness of the concealing resin layer and the content of the white pigment is increased, as is the case for the films used for the direct packaging of contents, or for the labels that are more decorative. While completely concealing the color of the light-shielding resin layer is not much of a problem in these applications that require less thickness restriction and thus allow the thickness of the concealing resin layer to be selected relatively more freely, it does pose a problem in other applications. The present invention solves such a problem in an extremely thin light-shielding shrink film for packaging having a thickness of 10 to 30 μm.

[0021] The effect of the concealing resin layer of the present invention can be evaluated by the luminance (L*) measurement specified by JIS Z8729 for light-shielding shrink films for packaging. In the present invention, it is preferable that the luminance (L*) is 70 or more in at least one of the surfaces. Generally, the surface appears opaque-white with a luminance of 70 or more, and the color of the light-shielding resin layer underlying the concealing resin layer does not appear on the surface, enabling clear prints to be made. There is no upper limit for luminance, because the whiteness only increases as the luminance increases. On the other hand, a luminance of less than 70 is not preferable, because the color of the underlying light-shielding resin layer is seen through the layer, and the surface no longer appears opaque-white, degrading the appearance and design of the light-shielding shrink film for packaging.
In the present invention, the luminance as measured from at least the concealing resin layer side can have a value of 70 or more when the concealing resin layer has the specific resin composition and thickness presented above. It should be noted that the concealing resin layer that satisfies the luminance for the black film used for the light-shielding resin

layer (described alter) can sufficiently exhibit the shielding effect also for the brown or argent film used for the light-shielding resin layer.

[0022] The transparent resin layers, provided as the both outer layers of the light-shielding shrink film for packaging, have the effects to improve stretchability during the manufacture of shrink film, and to impart good weld-cut sealability. The transparent resin layer does not generate build-up around the die lip, or deposit the pigment adhesion to the rollers, provided that inorganic or other pigments are not added to the resin, or when the pigment is transparent and added only in small amounts that do not inhibit the foregoing effects. Further, because the transparent resin layer provides a smooth surface, the printed image appears even clearer, and cosmetically appealing print patterns can be reproduced or presented.

The thickness of the transparent resin layer is preferably 1 μm or more, more preferably 1.5 μm or more. With a transparent resin layer thickness of 1 μm or more, sufficient seal strength can be provided for, for example, a weld-cut and sealed package. Further, in a stretch step required for the manufacture of the light-shielding shrink film for packaging, the provision of the transparent resin layers as both outer layers advantageously widens the optimal stretch temperature and stretch rate ranges even with large amounts of pigments contained in the light-shielding resin layer and the concealing resin layer.

[0023] In the present invention, another resin layer may be provided, in addition to the light-shielding resin layer, the concealing resin layer, and the transparent resin layer. An example of such an additional layer is a white pigment-containing white resin layer. Unlike the concealing resin layer, the thickness of the white resin layer and the white pigment content therein are not particularly limited.

[0024] The resin used for the light-shielding shrink film for packaging of the present invention is preferably olefinic resin. Examples of the olefinic resin include low-density polyethylene (LDPE); linear low-density polyethylene (LLDPE); medium-density polyethylene (MDPE); high-density polyethylene (HDPE) ; polyethylene resin containing copolymers of ethylene and a polymerizable double bond-containing monomer, such as an ethylene-acetic acid vinyl copolymer, an ethylene-(meth)acrylic acid copolymer, and an ethylene-(meth)acrylic acid ester copolymer; and polypropylene resin such as a propylene homopolymer, a propylene-ethylene random copolymer, a propylene-butene random copolymer, and a propylene-ethylene-butene ternary random copolymer. Among these olefinic resins, the polypropylene resin is preferable. The melt index (MI) of the polypropylene resin is preferably, for example, about 1 to 12 (g/10 min). The resin has stable moldability in this range of melt index. The resins may be used either alone or as a mixture of two or more. The same or different resins may be used for each layer of the light-shielding shrink film for packaging of the present invention.

[0025] The light-shielding resin layer, the concealing resin layer, and the transparent resin layer forming the light-shielding shrink film for packaging of the present invention may contain a lubricant, an antioxidant, an ultraviolet light absorber, a light stabilizer, a filler, an antistatic agent, a dispersant, a surfactant, a blocking preventing agent, and other plastic compounding agents and additives in accordance with intended usages, provided that the properties of each layer are not lost. Other components, such as modifying resin, may also be used.

[0026] The light-shielding shrink film for packaging of the present invention has a laminate structure comprising two transparent resin layers (outer layers) provided as the outermost layers of the film, and the concealing resin layer and the light-shielding resin layer provided as the inner layers. Specific examples of the layer structure comprise a transparent resin layer/concealing resin layer/light-shielding resin layer/concealing resin layer/transparent resin layer structure, a transparent resin layer/concealing resin layer/light-shielding resin layer/transparent resin layer structure, and a transparent resin layer/concealing resin layer/light-shielding resin layer/white resin layer/transparent resin layer structure with a white pigment-containing white resin layer.

[0027] The resin in each layer of the light-shielding shrink film for packaging of the present invention may be such that, for example, polypropylene (hereinafter, "PP") or polyethylene resin (hereinafter, "PE") is used for all layers of the 5-layered structures such as , transparent resin layer/concealing resin layer/light-shielding resin layer/concealing resin layer/transparent resin layer, or transparent resin layer/concealing resin layer/light-shielding resin layer/white resin layer/transparent resin layer.

Alternatively, the layered structures may be selected from PP/PP-PE mixture (hereinafter simply "mixture")/mixture/mixture/PP, PP/mixture/PP/mixture/PP, PP/mixture/PE/mixture/PP, PE/mixture/mixture/mixture/PE, PE/mixture/PP/mixture/PE, or PE/mixture/PE/mixture/PE. Note that the bondability between the layers can be increased by using the mixture between polypropylene layer and polyethylene layer.

[0028] The light-shielding shrink film for packaging of the present invention can be produced using a coextrusion method. More specifically, the shrink film can be produced by the tenter stretch of a film obtained by using a tubular biaxial stretch method or a T-die method. Use of a tubular biaxial stretch method is particularly preferable. The preferred stretch temperature is the ambient temperature that makes the resin temperature 80 to 130°C. The draw rate is 3. 5 to 6 for the length direction (MD) and the width direction (TD).

For example, the 5-layered light-shielding shrink film for packaging can be produced using a tubular biaxial stretch method, as follows. Three extruders are prepared. A light-shielding pigment-containing resin composition, a 25 to 70 weight% of white pigment-containing resin composition, and a pigment-free synthetic resin are respectively supplied to these extruders, and the resins are extruded into a tube through the 5-layer extrusion annular die to obtain an original tube. After cooling, the resins are biaxially stretched to obtain a light-shielding shrink film for packaging of the present invention having a transparent resin layer/white layer/light-shielding resin layer/white layer/transparent resin layer structure. Here, when the both white layers have a thickness of 2.4 to 8 μm, the layer structure of the light-shielding shrink film for packaging becomes transparent resin layer/concealing resin layer/light-shielding resin layer/concealing resin layer/transparent resin layer. When one of the white layers has a thickness of 2.4 to 8 μm and the other with a thickness outside this range, the layer structure of the light-shielding shrink film for packaging becomes transparent resin layer/concealing resin layer/light-shielding resin layer/white resin layer/transparent resin layer.

[0029] In the present invention, because the thickness of the light-shielding shrink film for packaging is as thin as 10 to 30 μm, it is preferable that, when two resin layers of the same resin composition are provided, the thicknesses of the two resin layers be differentiated, instead of providing the same thickness for the two resin layers as commonly practiced. In this way, one of the resin layers can be provided as a concealing resin layer that excels in concealability, and the luminance (L*) measured on the concealing resin layer side can be increased at the expense of the luminance on the side of the other resin layer.

[0030] Exemplary use of the light-shielding shrink film for packaging of the present invention for packaging applications is the individual or multiple-unit packaging of, for example, containers. The container contents may be, for example, foods, drinks, or cosmetics. The shrink film is particularly suited for the packaging of products that give the buyers impressions with the color of the package film, and that easily undergo discoloration or degradation under light. Specific examples of food and drink include dairy products, lactic acid bacteria-containing drinks, alcoholic beverages, green tea, and vitamin-supplemented drinks.

[0031] In packaging an article with the light-shielding shrink film for packaging of the present invention, it is preferable that the article be packaged in such a manner that the concealing resin layer is on the outer side of the light-shielding resin layer. It is also preferable that the luminance (L*) of the outer surface of the shrink package be 70 or more as measured according to JIS Z8729.

Examples

[0032] The following specifically describes the present invention based on Examples. The present invention, however, is in no way limited by the following Examples.
Rate of thermal shrinkage, luminance, and light-shielding performance were evaluated as follows.

(1) Rate of Thermal Shrinkage
The rate of thermal shrinkage was measured after 10 seconds in 110°C glycerin according to ASTM D 2732.
(2) Luminance
Luminance (L*) was measured using a spectrophotometer (CM-2500d, Konica Minolta), according to JIS K7105 (reflection method).
(3) Light-Shielding Performance (Light Transmittance)
For the measurement of light-shielding performance, light transmittance was measured in the measurement wavelength range of 200 nm to 600 nm using a spectrophotometer (U-3500, Hitachi High-Tech).

[0033] In the Examples, an ethylene-propylene random copolymer (melt flow rate = 2.5 g/10 min; ethylene content: 4.5% (hereinafter, "PP")) was used as the thermoplastic resin.
The following light-shielding pigments were used:

Black light-shielding pigment: carbon black (average particle diameter of 0.03 μm, irregular particle)
Brown light-shielding pigment: iron oxide powder (average particle diameter of 0.17 μm, irregular particle)
Argent light-shielding pigment: aluminum powder (average particle diameter of 6 to 10 μm, scale-like)
Titanium dioxide (average particle diameter: 0.2 μm; hereinafter, "TiO_2") was used as white pigment. Note that the white pigment content in the white pigment-containing resin layer was adjusted by appropriately using PP to dilute a polypropylene master batch whose white-pigment content in PP was 70 weight%.

[Examples 1 to 4]

[0034] Using three extruders, a transparent resin layer, a concealing resin layer, a light-shielding resin layer, a white resin layer (of the same resin composition as the concealing resin layer), and a transparent resin layer were coextruded from the annular die at 220°C in order to prepare for the transparent resin layer/concealing resin layer/light-shielding resin layer/white resin layer/transparent resin layer. As a result, an original tube containing PP resin for all the layers was obtained with the layer thicknesses presented in Table 1. After cooling, the tube was stretched 5 times along the length and width directions at an ambient temperature of 157°C selected to make the resin temperature 80 to 130°C. After thermosetting, a light-shielding shrink film for packaging of the 5-layered structure of transparent resin layer/concealing resin layer/light-shielding resin layer/white resin layer/transparent resin layer presented in Table 1 was obtained. There was no generation of build-up around the die during the molding, and no problem was presented in the continuous production. Stretchability was also desirable. Table 1 also presents the rate of thermal shrinkage, luminance, and light-shielding performance of the film.

[0035]

[Table 1]

		Ex. 1	Ex. 2	Ex. 3	Ex. 4
Original thickness (μm)		240	240	300	300
Stretch rate (MD × TD) (times)		5x5	5x5	5x5	5x5
Total thickness (μm)		15	15	20	20
Transparent resin layer	Thickness (μm)	3.0	2.5	4.0	4.0
Concealing resin layer	TiO_2 content (weight%)	42	35	42	42
	Thickness (μm)	4.8	5.5	5.0	5.0
Light-shielding resin layer	Light-shield ing pigment	Carbon black	Carbon black	Iron oxide	Aluminum powder
	Content	6.0	6.0	15.0	15.0
	Thickness (μm)	3.2	3.0	5.0	5.0
White resin layer	TiO_2 content (weight%)	42	35	42	42
	Thickness (μm)	1.0	1.5	2.0	2.0
Transparent resin layer	Thickness (μm)	3.0	2.5	4.0	4.0
Stretchability		Good	Good	Good	Good
Luminance (L*)	Concealing resin layer side	80.45	79.02	81.18	83.1
	White resin layer side	50.61	51.51	59.17	72.28
Rate of thermal shrinkage (MD/TD) (%)		31/37	27/32	22/34	28/35
Light transmittance (%)	400 nm	0.1	0.2	0.1	0.3
	450 nm	0.8	0.7	0.5	1.3
	550 nm	1.5	1.4	1.3	1.6

*1) Thickness of each layer is a preset value

:2) Light transmittance is the transmittance at a representative wavelength. The maximum value did not exceed this value.

[0036] As can be clearly seen in Table 1, the light-shielding shrink films for packaging of the present invention according to Examples 1 to 4 had luminances of 70 or more on the concealing resin layer-side surface, and were substantially opaque-white such that the colors, including black, brown, and argent, of the light-shielding resin layer were almost unnoticeable. The films also had good printability. Further, the shrink films had sufficient rates of thermal shrinkage, and excelled in heat-shrinkability and light-shielding performance. On the other hand, the luminance was only about 50 on the white resin layer side in Examples 1 to 3 in which carbon black and iron oxide were used for the light-shielding pigments, because the white resin layer, despite the same TiO_2 content as that of the concealing resin layer, had a thickness of less than 2.4 μm. Accordingly, the appearance was poor, and clear printing was difficult. Luminance was high on both sides when the aluminum powder was used for the light-shielding pigment.

The light-shielding shrink films for packaging of the present invention according to Examples 1 to 4 were used to wrap beverage plastic bottles in such a manner that the concealing resin layer was on the outer side of the light-shielding resin layer. The weld-cut sealability was desirable in all samples, and the shrink packages had almost an opaque-white appearance.

[Example 5]

[0037] As in Example 1, a light-shielding shrink film for packaging of the 5-layered structure of transparent resin layer/concealing resin layer/light-shielding resin layer/white resin layer (of the same resin composition as the concealing resin layer)/transparent resin layer presented in Table 2 was obtained.

As can be clearly seen in Table 2, the light-shielding shrink film for packaging of the present invention according to Example 5 had a luminance of 70 or more and was substantially opaque-white on the concealing resin layer-side surface such that the black color of the light-shielding resin layer was almost unnoticeable. The shrink film also had good printability. Further, the film had a sufficient rate of thermal shrinkage, and excelled in heat-shrinkability and light-shielding performance. On the other hand, the luminance on the white resin layer side was less than 60, because carbon black was used for the light-shielding pigment, and because the white resin layer, despite the same TiO_2 content as that of the concealing resin layer, had a thickness of less than 2.4 μm. Accordingly, the appearance was poor, and clear printing was difficult. The light-shielding shrink film for packaging of the present invention according to Example 5 was used to wrap beverage plastic bottles in such a manner that the concealing resin layer was on the outer side of the light-shielding resin layer. The weld-cut sealability was desirable in all samples, and the shrink packages had almost an opaque-white appearance.

[0038]

[Table 2]

		Ex. 5	Ex. 6
Original thickness (μm)		300	300
Stretch rate (MD × TD) (times)		5×5	5×5
Total thickness (μm)		20	20
Transparent layer	resin Thickness (μm)	3.4	3.4
Concealing resin layer	TiO_2 content (weight%)	35	35
	Thickness (μm)	7.1	6.6
Light-shielding resin layer	Light-shielding pigment	Carbon black	Carbon black
	Content	7	7
	Thickness (μm)	4	4
White resin layer	TiO_2 content (weight%)	35	35
	Thickness (μm)	2.1	2.6
Transparent resin layer	Thickness (μm)	3.4	3.4
Stretchability		Good	Good
Luminance (L*)	Concealing resin layer side	81.1	81.1
	White resin layer side	58.2	65.6
Rate of thermal shrinkage (MD/TD) (%)		24/33	23/32
Light transmittance (%)	400 nm	0.1	0.1
	450 nm	0.4	0.2
	550 nm	0.8	0.5

[Example 6]

[0039] As in Example 1, a light-shielding shrink film for packaging of the 5-layered structure of transparent resin layer/concealing resin layer/light-shielding resin layer/white resin layer (of the same resin composition as the concealing resin layer)/transparent resin layer presented in Table 2 was obtained.
As can be clearly seen in Table 2, the light-shielding shrink film for packaging of the present invention according to Example 6 had a luminance of 70 or more, and was substantially opaque-white on the concealing resin layer-side surface such that the black color of the light-shielding resin layer was almost unnoticeable. The shrink film also had good printability. Further, the film had a sufficient rate of thermal shrinkage, and excelled in heat-shrinkability and light-shielding performance. On the other hand, the luminance was less than 70 on the concealing resin layer side, because carbon black was used for the light-shielding pigment, despite that the concealing resin layer had the same TiO_2 content as the concealing resin layer. Accordingly, the appearance was poor, and clear printing involved some difficulty. The light-shielding shrink film for packaging of the present invention according to Example 6 was used to wrap beverage plastic bottles in such a manner that the concealing resin layer was on the outer side of the light-shielding resin layer. The weld-cut sealability was desirable in all samples, and the shrink packages had almost an opaque-white appearance.
Table 2 also presents the rate of thermal shrinkage, luminance, and light-shielding performance.

[Example 7]

[0040] A light-shielding shrink film for packaging with a thickness of 14 μm (layer thicknesses (preset values) : 3.0 μm for transparent resin layer/4.8 μm for concealing resin layer/3.2 μm for light-shielding resin layer/3.0 μm for transparent resin layer) was obtained as in Example 1, except that the film had the 4-layered structure of transparent resin layer/concealing resin layer/light-shielding resin layer/transparent resin layer. There was no deposition of build-up around die during the molding of the light-shielding shrink film for packaging, and no problem was presented in the continuous production. Stretchability was also desirable. Further, the film had a rate of thermal shrinkage of 30% along the MD direction and 35% along the TD direction, and a luminance of 80.45 on the concealing resin layer side as in Example 1. The light-shielding performance was about the same as that in Example 1. The light-shielding shrink film for packaging of the present invention was used to wrap beverage plastic bottles in such a manner that the concealing resin layer was on the outer side of the light-shielding resin layer. The weld-cut sealability was desirable in all samples, and the shrink packages had almost an opaque-white appearance.

[Reference Example 1]

[0041] The relationship between the thickness of the concealing resin layer and luminance was elucidated by measuring the luminance of the film provided with the concealing resin layer of various thicknesses (Table 3) formed on the light-shielding resin layer of Table 3. The results are shown in Table 3. Note that a resin composition containing 42 weight% of TiO_2 in the PP resin was used as the concealing resin layer.
[0042]

[Table 3]

	Light-shielding resin layer		Thickness of concealing resin layer (μm)	Luminance (L*)
Experiment No.	Light-shielding pigment	Concentration (wt%)		
1	Carbon black	6	3.6	75.28
2	Carbon black	6	2.3	66.86
3	Iron oxide	15	3.5	76.25
4	Iron oxide	15	2.4	70.44
5	Aluminum	15	3.2	79.10
6	Aluminum	15	2.4	75.22

[0043] As is clear from Table 3, while the concealing resin layers with the experiment numbers 1, and 3 to 6 had luminances of 70 and higher, sufficient concealing performance was not obtained with a thickness less than 2.4 μm.

[Reference Example 2]

[0044] The relationship between the white pigment titanium dioxide content in the white resin layer and luminance was elucidated by measuring the luminance of films provided with a 5 μm-thick concealing resin layer of 14 to 56 weight% of TiO_2 contents (Table 4) formed on the top surface of the light-shielding resin layer that contained 6 wt% carbon black. The results are shown in Table 4.

[0045]

[Table 4]

	Concealing resin layer		Luminance (L*)
Experiment No.	TiO_2 content (w%)	Thickness (μm)	
7	14	5.0	62.16
8	21	5.0	69.82
9	28	5.0	70.16
10	56	5.0	88.47

[0046] As is clear from Table 4, a luminance of 70 or more was obtained with the 5.0μm thickness when the white pigment (titanium dioxide) content was 25 weight% or more. Specifically, it can be seen that sufficient concealability cannot be obtained with a thickness of about 5.0 μm when the titanium dioxide content is 10 to 20 weight% as in conventional techniques.

Industrial Applicability

[0047] The present invention concerns a light-shielding shrink film for packaging. A light-shielding shrink film for packaging of the invention comprises a light-shielding resin layer, a concealing resin layer provided to conceal the color of the light-shielding resin layer, and a transparent resin layer provided as both outer layers. The light-shielding shrink film for packaging has a thickness of 10 to 30 μm. The concealing resin layer is a resin composition that contains a 25 to 70 weight% of white pigment, and has a thickness of 2.4 to 8.0 μm. The light-shielding shrink film for packaging provided by the present invention excels in light-shielding performance, printability, and appearance, and has an opaque-white appearance even with an extremely thin thickness. The shrink film is therefore useful as novel packaging material suited for individual or multiple-unit packaging of products such as beverage containers.

Claims

1. A light-shielding shrink film for packaging, comprising a light-shielding resin layer, a concealing resin layer provided to conceal the color of the light-shielding resin layer, and transparent resin layers provided as both outer layers, **characterized in that** the light-shielding shrink film for packaging has a thickness of 10 to 30 μm, and that the concealing resin layer is a resin composition containing a 25 to 70 weight% of white pigment and has a thickness of 2.4 to 8.0 μm.

2. The light-shielding shrink film for packaging of claim 1, wherein the shrink film is a laminate in order of transparent resin layer/concealing resin layer/light-shielding resin layer/concealing resin layer/transparent resin layer.

3. The light-shielding shrink film for packaging of claim 1, wherein the shrink film is a laminate in order of transparent resin layer/concealing resin layer/light-shielding resin layer/transparent resin layer.

4. The light-shielding shrink film for packaging of claim 1, wherein the shrink film comprises a white pigment-containing white resin layer, and is a laminate in order of transparent resin layer/concealing resin layer/light-shielding resin layer/white resin layer/transparent resin layer.

5. The light-shielding shrink film for packaging of any one of claims 1 to 4, wherein the transparent resin layer has a thickness of 1 μm or more.

6. The light-shielding shrink film for packaging of any one of claims 1 to 5, wherein the light-shielding resin layer has a thickness of 2 to 8 μm.

7. The light-shielding shrink film for packaging of any one of claims 1 to 6, wherein the white pigment is titanium dioxide.

8. The light-shielding shrink film for packaging of any one of claims 1 to 7, wherein the resin in the layers of the shrink film is olefinic resin.

9. The light-shielding shrink film for packaging of any one of claims 1 to 8, wherein at least one of the surfaces of the shrink film has a JIS Z8729 luminance (L*) of 70 or more.

10. A shrink package formed of the light-shielding shrink film for packaging of any one of claims 1 to 9.

11. The shrink package of claim 10, wherein an article is packaged in such a manner that the concealing resin layer is on the outer side of the light-shielding resin layer.

12. The shrink package of claim 10 or 11, wherein an outer surface of the shrink package has a JIS Z8729 luminance (L*) of 70 or more.

INTERNATIONAL SEARCH REPORT

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Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2009
Kokai Jitsuyo Shinan Koho	1971-2009	Toroku Jitsuyo Shinan Koho	1994-2009

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2004/094139 A1 (Fuji Seal, Inc.), 04 November, 2004 (04.11.04), Page 3, line 19 to page 4, line 21; page 6, lines 13 to 21; page 11, line 23 to page 12, line 1; page 14, lines 5 to 16; page 16, lines 19 to 21 & US 2006/0275592 A1 & EP 1616695 A1	1-12
Y	JP 2003-305811 A (Dainippon Printing Co., Ltd.), 28 October, 2003 (28.10.03), Par. No. [0030] (Family: none)	1-12

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

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INTERNATIONAL SEARCH REPORT

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	JP 2005-219396 A (Rengo Co., Ltd.), 18 August, 2005 (18.08.05), Claims; Par. No. [0015] (Family: none)	1-12
A	JP 2003-200965 A (Dainippon Printing Co., Ltd.), 15 July, 2003 (15.07.03), Claims (Family: none)	1-12
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Form PCT/ISA/210 (continuation of second sheet) (April 2007)

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- WO 200409413 A **[0005]**
- JP 2003305811 A **[0005]**
- JP 2004114515 A **[0005]**
- JP 2004114523 A **[0005]**

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(54) POLYESTER-BASED FILM, AND METHOD FOR RECYCLING POLYESTER-BASED CONTAINER USING SAME

(57) Embodiments relate to a polyester-based film and a process for regenerating a polyester-based container using the same, which not only solve the environmental problems by enhancing the recyclability of polyester-based containers but also are capable of enhancing the quality, yield, and productivity. When the polyester-based film is cut into a size of 1 cm in width and 1 cm in length, immersed in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1% by weight, and stirred for 15 minutes at 85°C at a speed of 240 m/minute, the average particle size of the component of the printing layer separated from the base layer satisfies 15 μm or more. Thus, it is possible to enhance the quality of the regenerated polyester-based chips produced from the polyester-based container provided with the polyester-based film.

EP 3 854 839 A1

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Description

Technical Field

[0001] Embodiments relate to a polyester-based film and a process for regenerating a polyester-based container using the same, which not only solve the environmental problems by enhancing the recyclability of polyester-based containers but also are capable of enhancing the quality, yield, and productivity.

Background Art

[0002] As concerns about environmental problems have increased in recent years, there is a demand for addressing the recycling issues of products fabricated using thermoplastic polymers. In particular, polyethylene terephthalate, a thermoplastic resin having excellent properties in terms of thermal resistivity, processability, transparency, and non-toxicity, has been widely used for producing a wide range of products such as films, fibers, bottles, containers, and the like, and efforts have been continued to enhance the regeneration rate thereof.

[0003] In general, a stretched film of polyolefin or the like is attached as a label to a container produced from PET. Thus, once a PET container recycled from the consumers has been washed and crushed, it is then subjected to liquid specific gravity separation, dehydration, drying, and/or wind specific gravity separation in order to remove a large amount of films contained in the crushed product and then to such an additional step as pelletization to obtain regenerated polyester-based chips. However, there has been a disadvantage in that the films are not completely removed even after the above steps, in particular, the regenerated polyester-based chips are colored due to the inks contained in the film, or the regenerated polyester-based chips are non-uniformly clumped due to the thermal characteristics of the film during the thermal treatment thereof.

[0004] Accordingly, a method of using a film made of a low specific gravity polymer such as polystyrene, polyethylene, polypropylene, and the like as a label has been proposed in order to readily carry out the specific gravity separation. However, the low specific gravity thereof cannot be effectively achieved due to the ink layer, which makes it difficult to completely separate and remove the films, and the problem that the residual ink colors the regenerated polyester-based chips cannot be solved.

Disclosure of Invention

Technical Problem

[0005] Accordingly, the embodiments aim to provide a polyester-based film and a process for regenerating a polyester-based container using the same, which are capable of preventing environmental pollution and enhancing the recyclability and quality in the regeneration process of containers.

Solution to Problem

[0006] The polyester-based film according to an embodiment comprises a base layer comprising a polyester-based resin; and a printing layer disposed on one side of the base layer, wherein when the film is cut into a size of 1 cm in width and 1 cm in length, immersed in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1%, and stirred for 15 minutes at 85°C at a speed of 240 m/minute, the average particle size of the component of the printing layer separated from the base layer is 15 μm or more.

[0007] The polyester-based film according to another embodiment comprises a base layer comprising a polyester-based resin; a printing layer opposite to the base layer; and a stripping promoting layer interposed between the base layer and the printing layer, wherein when the film is cut into a size of 1 cm in width and 1 cm in length, immersed in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1%, and stirred for 15 minutes at 85°C at a speed of 240 m/minute, the average particle size of the component of the printing layer separated from the base layer is 15 μm or more.

[0008] The process for regenerating a polyester-based container according to still another embodiment comprises providing a polyester-based container at least a portion of which is surrounded by the polyester-based film; crushing the polyester-based container provided with the film to obtain flakes; immersing the crushed flakes in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1% at 85°C, and thermally treating the immersed flakes to produce regenerated polyester-based chips, wherein when the flakes are thermally treated at a temperature of 200°C to 220°C for 60 minutes to 120 minutes, the clumping fraction is 5% or less.

[0009] The regenerated polyester-based chips according to still another embodiment are produced by the process for regenerating a polyester-based container.

Advantageous Effects of the Invention

[0010] When the polyester-based film according to the embodiment is immersed in an aqueous solution of sodium hydroxide under the specific conditions of temperature, concentration, and stirring speed, the printing layer thereof is not entirely dissolved in the aqueous solution of sodium hydroxide, while the average particle size of the component of the printing layer separated from the base layer is adjusted to a specific range. Thus, the component of the printing layer can be readily separated in the regeneration process of a polyester-based container comprising the film, thereby preventing environmental pollution.

[0011] In addition, the polyester-based film according to the embodiment enhances the recyclability of a polyester-based container comprising the film, thereby enhancing the quality, yield, and productivity of the regenerated polyester-based chips produced by the process for regenerating the polyester-based container using the film.

[0012] Further, the process for regenerating a polyester-based container according to the embodiment does not require a separate step of separating the polyester-based container and the film. Thus, it is economical since time and cost are saved.

Best Mode for Carrying out the Invention

[0013] Hereinafter, the present invention will be described in detail with reference to embodiments. The embodiments are not limited to those described below. Rather, they can be modified into various forms as long as the gist of the invention is not altered.

[0014] Throughout the present specification, when a part is referred to as "comprising" an element, it is understood that other elements may be comprised, rather than other elements are excluded, unless specifically stated otherwise.

[0015] All numbers and expressions related to the quantities of components, reaction conditions, and the like used herein are to be understood as being modified by the term "about," unless otherwise indicated.

[0016] Throughout the present specification, the terms first, second, and the like are used to describe various components. But the components should not be limited by the terms. The terms are used only for the purpose of distinguishing one component from another.

[0017] In the regeneration process of a container provided with a film as a label, it is important to effectively separate and remove the component of the printing layer, particularly ink, for enhancing the recyclability and quality of the container. A washing step with an aqueous solution of sodium hydroxide may be carried out as a method of removing the component of the printing layer. In the washing step, the component of the printing layer is almost dissolved in the aqueous solution of sodium hydroxide, or the average particle size thereof becomes very small, making its separation difficult.

[0018] Specifically, if the component of the printing layer is almost dissolved in an aqueous solution of sodium hydroxide in the washing step, it is difficult to separate the component of the printing layer dissolved in the aqueous solution of sodium hydroxide, which may contaminate the environment.

[0019] In addition, if the average particle size of the component of the printing layer is very small, e.g., less than 15 μm, the recyclability and quality of the container may be deteriorated, and additional costs may be incurred during the separation step from the aqueous solution of sodium hydroxide.

[0020] When the polyester-based film according to an embodiment is cut into a size of 1 cm in width and 1 cm in length, immersed in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1%, and stirred for 15 minutes at 85°C at a speed of 240 m/minute, the average particle size of the component of the printing layer separated from the base layer is adjusted to 15 μm or more.

[0021] Accordingly, in the regeneration process of a container provided with the film, the component of the printing layer is not dissolved in an aqueous solution of sodium hydroxide, and the component of the printing layer can be effectively separated, so that the recyclability and quality of the container can be enhanced, while environmental pollution is effectively prevented.

Polyester-based film

[0022] The polyester-based film according to an embodiment comprises a base layer comprising a polyester-based resin; and a printing layer disposed on one side of the base layer, wherein when the film is cut into a size of 1 cm in width and 1 cm in length, immersed in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1%, and stirred for 15 minutes at 85°C at a speed of 240 m/minute, the average particle size of the component of the printing layer separated from the base layer is 15 μm or more.

[0023] The polyester-based film according to another embodiment comprises a base layer comprising a polyester-based resin; a printing layer opposite to the base layer; and a stripping promoting layer interposed between the base layer and the printing layer, wherein when the film is cut into a size of 1 cm in width and 1 cm in length, immersed in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1%, and stirred for 15 minutes at 85°C at a speed of 240 m/minute, the average particle size of the component of the printing layer separated from the base layer is 15 μm or more.

Base layer

[0024] The polyester-based resin comprises a diol component and a dicarboxylic acid component.

[0025] Specifically, the diol component may comprise at least one selected from the group consisting of ethylene glycol, diethylene glycol, propanediol unsubstituted or substituted with an alkyl group, butanediol unsubstituted or substituted with an alkyl group, pentanediol unsubstituted or substituted with an alkyl group, hexanediol unsubstituted or substituted with an alkyl group, octanediol unsubstituted or substituted with an alkyl group, and a combination thereof.

[0026] For example, the diol component may comprise at least one selected from the group consisting of ethylene glycol, diethylene glycol, 1,3-propanediol, 1,2-octanediol, 1,3-octanediol, 2,3-butanediol, 1,3-butanediol, 1,4-butanediol, 1,5-pentanediol, neopentyl glycol, 2-butyl-2-ethyl-1,3-propanediol, 2,2-diethyl-1,5-pentanediol, 2,4-diethyl-1,5-pentanediol, 3-methyl-1,5-pentanediol, and 1,1-dimethyl-1,5-pentanediol.

[0027] More specifically, the diol component may comprise at least one selected from the group consisting of ethylene glycol, diethylene glycol, and neopentyl glycol.

[0028] The polyester-based resin may comprise neopentyl glycol in an amount of 1 to 35% by mole based on the total number of moles of the diol component. For example, the polyester-based resin may comprise neopentyl glycol in an amount of 3% by mole to 35% by mole, 5% by mole to 35% by mole, 7% by mole to 35% by mole, 7% by mole to 33% by mole, 10% by mole to 33% by mole, 15% by mole to 33% by mole, 17% by mole to 30% by mole, 20% by mole to 35% by mole, 20% by mole to 33% by mole, 21% by mole to 33% by mole, or 22% by mole to 30% by mole, based on the total number of moles of the diol component.

[0029] Since the content of neopentyl glycol satisfies the above range, the heat shrinkage rate in a first direction or in a second direction perpendicular to the first direction is readily adjusted when the film is thermally shrunk, so that it is possible to prevent wrinkles or deformation when the film is applied to a container.

[0030] In the present specification, the first direction may be the transverse direction (TD) or the longitudinal direction (MD), and the second direction perpendicular to the first direction may be the longitudinal direction (MD) or the transverse direction (TD). For example, the first direction may be the longitudinal direction (MD), and the second direction may be the transverse direction (TD) as the main shrinkage direction.

[0031] The polyester-based resin may comprise ethylene glycol in an amount of 55% by mole to 90% by mole and diethylene glycol in an amount of 1% by mole to 15% by mole, based on the total number of moles of the diol component. For example, the polyester-based resin may comprise ethylene glycol in an amount of 60% by mole to 90% by mole, 55% by mole to 85% by mole, 58% by mole to 80% by mole, 60% by mole to 78% by mole, 63% by mole to 78% by mole, 63% by mole to 75% by mole, or 65% by mole to 73% by mole and diethylene glycol in an amount of 1% by mole to 13% by mole, 1% by mole to 10% by mole, 3% by mole to 15% by mole, 3% by mole to 13% by mole, 4% by mole to 10% by mole, 4% by mole to 8% by mole, 5% by mole to 7% by mole, 1% by mole to 7% by mole, 2% by mole to 6% by mole, 3% by mole to 5.5% by mole, 3.5% by mole to 5.5% by mole, or 4% by mole to 5.5% by mole, based on the total number of moles of the diol component.

[0032] In addition, the molar ratio of ethylene glycol and diethylene glycol may be 5 to 60:1. For example, the molar ratio of ethylene glycol and diethylene glycol may be 7 to 55:1, 10 to 50:1, 13 to 46:1, 12 to 15:1, 13 to 14.7:1, 7.8 to 26:1, 7.8 to 23:1, 7.8 to 20:1, 8 to 18:1, 8 to 16:1, or 9 to 16:1. Since the molar ratio of ethylene glycol and diethylene glycol satisfies the above range, there is an advantageous effect on shrinkage uniformity and shrinkage stress, so that the component of the printing layer can be more readily removed in the subsequent regeneration process.

[0033] In addition, the polyester-based resin may further comprise a monohydric alcohol in addition to the diol component. For example, the monohydric alcohol may be methanol, ethanol, isopropyl alcohol, allyl alcohol, or benzyl alcohol. Specifically, the polyester-based resin may comprise a monohydric alcohol in an amount of 10 to 30% by mole, 13 to 25% by mole, or 15 to 22% by mole, based on the total number of moles of the diol component and the monohydric alcohol, but it is not limited thereto.

[0034] The dicarboxylic acid component may be selected from the group consisting of an aromatic dicarboxylic acid such as terephthalic acid, dimethylterephthalic acid, isophthalic acid, naphthalene dicarboxylic acid, and the like; an aliphatic dicarboxylic acid such as adipic acid, azelaic acid, sebacic acid, decanedicarboxylic acid, and the like; an alicyclic dicarboxylic acid; an ester thereof; and a combination thereof.

[0035] Specifically, the dicarboxylic acid component may comprise an aromatic dicarboxylic acid. For example, the dicarboxylic acid component may comprise terephthalic acid or dimethyl terephthalic acid in an amount of 80% by mole or more, 90% by mole or more, 95% by mole or more, or 99% by mole or more, based on the total number of moles of the dicarboxylic acid component.

[0036] The diol component and the dicarboxylic acid component are subjected to a transesterification reaction and then polymerization to thereby form a polyester-based resin.

[0037] Specifically, at least one catalyst selected from manganese acetate, calcium acetate, and zinc acetate may be used as a catalyst for the transesterification reaction. The content of the catalyst may be 0.02% by weight to 0.2% by weight, 0.02% by weight to 0.1% by weight, or 0.03% by weight to 0.08% by weight, based on the total weight of the dicarboxylic acid compound.

[0038] In addition, upon completion of the transesterification reaction, at least one additive selected from the group consisting of silica, potassium, and magnesium; a stabilizer such as trimethyl phosphate; a polymerization catalyst such as antimony trioxide and tetrabutylene titanate; and the like may be selectively added.

[0039] In addition, the thickness of the base layer may be 10 μm to 100 μm. For example, the thickness of the base layer may be 20 μm to 80 μm, 30 μm to 70 μm, 35 μm to 65 μm, 35 μm to 55 μm, 40 μm to 60 μm, or 35 μm to 45 μm. Since the thickness of the base layer satisfies the above range, it is possible to effectively prevent a deterioration in the physical properties of the film and the deformation of appearance such as curls or wrinkles when a printing layer is formed on one side of the base layer.

[0040] The haze of the base layer may be 10% or less. For example, it may be 9% or less, 8.5% or less, 8% or less, 7% or less, 6.5% or less, and it may be 3% to 10%, 4% to 9%, 4.5% to 8%, 4.5% to 7%, or 4.8% to 6.5%.

[0041] Since the haze of the base layer satisfies the above range, it is convenient to use the film comprising the base layer as a label. Specifically, if the haze is too low, the transparency may be too high to be suitable for use as a label on a container.

Printing layer

[0042] The polyester-based film according to an embodiment comprises a printing layer on one side of the base layer.

[0043] Specifically, the printing layer may be formed from a composition for a printing layer that comprises a first solvent, a first binder, and a first pigment.

[0044] The first solvent may comprise one or more selected from the group consisting of benzene, xylene, toluene, tetramethylbenzene, acetone, methyl ethyl ketone, methyl isobutyl ketone, cyclohexanone, methanol, ethanol, propanol, isopropyl alcohol, butyl alcohol, 2-methyl-2-propanol, octanol, allyl alcohol, benzyl alcohol, ethylene glycol, diethylene glycol, triethylene glycol, tetramethylene glycol, tetraethylene glycol, propylene glycol, dipropylene glycol, tripropylene glycol, hexylene glycol, and neopentyl glycol. Specifically, it may preferably be one or more selected from the group consisting of methanol, ethanol, propanol, isopropyl alcohol, butyl alcohol, 2-methyl-2-propanol, octanol, allyl alcohol, benzyl alcohol, ethylene glycol, diethylene glycol, triethylene glycol, tetramethylene glycol, tetraethylene glycol, propylene glycol, dipropylene glycol, tripropylene glycol, hexylene glycol, and neopentyl glycol.

[0045] In addition, the composition for a printing layer may comprise the first solvent in an amount of 1% by weight to 35% by weight based on the total weight of the composition for a printing layer. For example, the content of the first solvent may be 3% by weight to 35% by weight, 5% by weight to 35% by weight, 10% by weight to 33% by weight, 15% by weight to 32% by weight, 18% by weight to 32% by weight, 25% by weight to 32% by weight, 28% by weight to 32% by weight, 20% by weight to 35% by weight, or 20% by weight to 30% by weight, based on the total weight of the composition for a printing layer. Since the content of the first solvent satisfies the above range, when the film is cut into a size of 1 cm in width and 1 cm in length, immersed in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1%, and stirred for 15 minutes at 85°C at a speed of 240 m/minute, the average particle size of the component of the printing layer separated from the base layer can be adjusted to 15 μm or more.

[0046] The first binder may comprise at least one selected from the group consisting of a polyester-based resin, an acrylic-based resin, a urethane-based resin, a nitrocellulose-based resin, a chlorinated polypropylene-based resin, and a polyester urethane-based resin.

[0047] In addition, the composition for a printing layer may comprise the first binder in an amount of 25% by weight to 60% by weight based on the total weight of the composition for a printing layer. For example, the content of the first binder may be 27% by weight to 60% by weight, 25% by weight to 55% by weight, 25% by weight to 50% by weight, 28% by weight to 45% by weight, 28% by weight to 42% by weight, or 30% by weight to 40% by weight% by weight, based on the total weight of the composition for a printing layer. Since the content of the first binder satisfies the above range, when the film is cut into a size of 1 cm in width and 1 cm in length, immersed in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1%, and stirred for 15 minutes at 85°C at a speed of 240 m/minute, the average particle size of the component of the printing layer separated from the base layer can be adjusted to 15 μm or more.

[0048] The weight ratio of the first solvent and the first binder may be 1:0.5 to 2.5. For example, the weight ratio of the first solvent and the first binder may be 1:0.7 to 2.3, 1:0.9 to 2.2, 1:0.9 to 2.1, 1:1 to 2, 1:0.7 to 1.5, 1:0.7 to 1.3, or 1:0.9 to 1.2. Since the weight ratio of the first solvent and the first binder satisfies the above range, when the film is cut into a size of 1 cm in width and 1 cm in length, immersed in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1%, and stirred for 15 minutes at 85°C at a speed of 240 m/minute, the printing layer can be more effectively separated from the base layer while the average particle size of the component of the printing layer separated from the base layer can be adjusted to 15 μm or more.

[0049] The first pigment may be an insoluble azo-based such as barium sulfate, calcium carbonate, titanium oxide, yellow iron oxide, black iron, chromium yellow, chromium familion, cadmium yellow, cadmium red, royal blue, ultramarine, and organic pigments; soluble azo-based; phthalocyanine-based; kinakryton-based; polyazo-based, or a mixture thereof. Specifically, the first pigment may be one or more selected from the group consisting of carbon black, titanium oxide, insoluble azo-based, phthalocyanine-based, and polyazo-based.

[0050] In addition, the composition for a printing layer may comprise the first pigment in an amount of 5% by weight to 50% by weight based on the total weight of the composition for a printing layer. For example, the content of the first pigment may be 10% by weight to 50% by weight, 20% by weight to 45% by weight, 25% by weight to 45% by weight, 30% by weight to 45% by weight, or 35% by weight to 45% by weight, based on the total weight of the composition for a printing layer.

[0051] The printing layer may have a thickness of 0.1 μm to 100 μm. For example, the thickness of the printing layer may be 0.1 μm to 80 μm, 0.3 μm to 60 μm, 0.5 μm to 40 μm, 0.5 μm to 30 μm, 0.7 μm to 20 μm, 1 μm to 15 μm, 1.5 μm to 10 μm, 1.5 μm to 7 μm, 1.5 μm to 5 μm, or 1.5 μm to 3 μm. Since the thickness of the printing layer satisfies the above range, the resistance to scratch can be enhanced without deteriorating the color development of the printing layer.

[0052] The polyester-based film according to another embodiment comprises a printing layer at a position opposite to the base layer. Specifically, the polyester-based film according to another embodiment comprises a stripping promoting layer, and the printing layer may be formed on one side of the stripping promoting layer, wherein the printing layer, the stripping promoting layer, and the base layer may be positioned in order.

[0053] The printing layer formed on one side of the stripping promoting layer may be formed from the composition for a printing layer that comprises a first solvent, a first binder, and a first pigment.

[0054] The first solvent of the printing layer formed on one side of the stripping promoting layer may be one or more selected from the group consisting of benzene, xylene, toluene, tetramethylbenzene, acetone, methyl ethyl ketone, methyl isobutyl ketone, cyclohexanone, methanol, ethanol, propanol, isopropyl alcohol, butyl alcohol, 2-methyl-2-propanol, octanol, allyl alcohol, benzyl alcohol, ethylene glycol, diethylene glycol, triethylene glycol, tetramethylene glycol, tetraethylene glycol, propylene glycol, dipropylene glycol, tripropylene glycol, hexylene glycol, and neopentyl glycol.

[0055] Specifically, in the case of benzene, xylene, toluene, tetramethylbenzene, acetone, methyl ethyl ketone, methyl isobutyl ketone, or cyclohexanone used in the conventional printing layer, it is almost dissolved in an aqueous solution of sodium hydroxide during the washing step using the aqueous solution of sodium hydroxide, or the average particle size is very small, making its separation difficult.

[0056] However, in the case of a polyester film comprising a stripping promoting layer according to an embodiment, even if the printing layer comprises benzene, xylene, toluene, tetramethylbenzene, acetone, methyl ethyl ketone, methyl isobutyl ketone, or cyclohexanone, the component of the printing layer can be effectively separated while the component of the printing layer is not dissolved in an aqueous solution of sodium hydroxide.

Stripping promoting layer

[0057] The film according to another embodiment comprises a stripping promoting layer on one side of the base layer. Specifically, the film comprises a stripping promoting layer interposed between the base layer and the printing layer.

[0058] If the film comprises a stripping promoting layer interposed between the base layer and the printing layer, when the film is cut into a size of 1 cm in width and 1 cm in length, immersed in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1%, and stirred for 15 minutes at 85°C at a speed of 240 m/minute, the average particle size of the component of the printing layer separated from the base layer can be adjusted to 15 μm or more. In addition, the separation of the component of the printing layer can be more readily performed.

[0059] The stripping promoting layer may be formed from a composition for a stripping promoting layer that comprises a second solvent and a second binder.

[0060] The second solvent may comprise one or more selected from the group consisting of methanol, ethanol, propanol, isopropyl alcohol, butyl alcohol, 2-methyl-2-propanol, octanol, allyl alcohol, benzyl alcohol, ethylene glycol, diethylene glycol, triethylene glycol, tetramethylene glycol, tetraethylene glycol, propylene glycol, dipropylene glycol, tripropylene glycol, hexylene glycol, and neopentyl glycol.

[0061] In addition, the composition for a stripping promoting layer may comprise the second solvent in an amount of 15% by weight to 40% by weight based on the total weight of the composition for a stripping promoting layer. For example, the content of the second solvent may be 17% by weight to 40% by weight, 15% by weight to 38% by weight, 17% by weight to 38% by weight, or 20% by weight to 35% by weight, based on the total weight of the composition for a stripping promoting layer. Since the content of the second solvent satisfies the above range, when the film is cut into a size of 1 cm in width and 1 cm in length, immersed in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1%, and stirred for 15 minutes at 85°C at a speed of 240 m/minute, the component of the printing layer can be more readily separated from the base layer, and the average particle size of the component of the printing layer separated from the base layer can be adjusted to 15 μm or more.

[0062] The second binder may comprise at least one selected from the group consisting of a polyester-based resin, an acrylic-based resin, a polyurethane-based resin, an acrylic urethane-based resin, a nitrocellulose-based resin, a chlorinated polypropylene-based resin, and a polyester urethane-based resin.

[0063] In addition, the composition for a stripping promoting layer may comprise the second binder in an amount of 10% by weight to 55% by weight based on the total weight of the composition for a stripping promoting layer. For example, the content of the second binder may be 15% by weight to 50% by weight, 15% by weight to 45% by weight, 20% by weight to 43% by weight, or 25% by weight to 40% by weight, based on the total weight of the composition for a stripping promoting layer. Since the content of the second binder satisfies the above range, when the film is cut into a size of 1 cm in width and 1 cm in length, immersed in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1%, and stirred for 15 minutes at 85°C at a speed of 240 m/minute, the component of the printing layer can be more readily separated from the base layer, and the average particle size of the component of the printing layer separated from the base layer can be adjusted to 15 μm or more.

[0064] The weight ratio of the second solvent and the second binder may be 1:0.5 to 3. For example, the weight ratio of the second solvent and the second binder may be 1:0.5 to 2.7, 1:0.5 to 2.5, 1:0.6 to 2.3, or 1:0.7 to 2. Since the weight ratio of the second solvent and the second binder satisfies the above range, when the film is cut into a size of 1 cm in width and 1 cm in length, immersed in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1%, and stirred for 15 minutes at 85°C at a speed of 240 m/minute, the component of the printing layer can be more readily separated from the base layer, and the average particle size of the component of the printing layer separated from the base layer can be adjusted to 15 μm or more.

[0065] In addition, the composition for a stripping promoting layer may further comprise a second pigment. Specifically, the second pigment may be an insoluble azo-based such as barium sulfate, calcium carbonate, titanium oxide, yellow iron oxide, black iron, chromium yellow, chromium familion, cadmium yellow, cadmium red, royal blue, ultramarine, and organic pigments; soluble azo-based; phthalocyanine-based; kinakryton-based; polyazo-based, or a mixture thereof. Specifically, the second pigment may be one or more selected from the group consisting of carbon black, titanium oxide, insoluble azo-based, phthalocyanine-based, and polyazo-based.

[0066] The composition for a stripping promoting layer may comprise the second pigment in an amount of 5% by weight to 50% by weight based on the total weight of the composition for a stripping promoting layer. For example, the content of the second pigment may be 3% by weight to 50% by weight, 5% by weight to 50% by weight, 10% by weight to 50% by weight, 20% by weight to 45% by weight, 25% by weight to 45% by weight, 30% by weight to 45% by weight, or 35% by weight to 45% by weight, based on the total weight of the composition for a stripping promoting layer.

[0067] The stripping promoting layer may have a thickness of 10 μm to 200 μm. For example, the thickness of the stripping promoting layer may be 15 nm to 180 nm, 20 nm to 150 nm, 40 nm to 120 nm, 60 nm to 110 nm, 80 nm to 110 nm, 20 nm to 80 nm, 30 nm to 60 nm, or 40 nm to 50 nm. Since the thickness of the stripping promoting layer satisfies the above range, when the film is cut into a size of 1 cm in width and 1 cm in length, immersed in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1%, and stirred for 15 minutes at 85°C at a speed of 240 m/minute, the component of the printing layer can be more readily separated from the base layer.

[0068] When the film is cut into a size of 1 cm in width and 1 cm in length, immersed in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1%, and stirred for 15 minutes at 85°C at a speed of 240 m/minute, the average particle size of the component of the printing layer separated from the base layer may be 15 μm or more. For example, the average particle size of the component of the printing layer separated from the base layer may be 20 μm or more, 23 μm or more, 25 μm or more, and it may be 15 μm to 1,000 μm, 15 μm to 100 μm, 15 μm to 80 μm, 20 μm to 100 μm, 20 μm to 80 μm, 25 μm to 75 μm, 20 μm to 1,000 μm, 20 μm to 900 μm, 25 μm to 800 μm, 25 μm to 750 μm, 50 μm to 1,000 μm, 65 μm to 800 μm, 500 μm to 1,000 μm, or 600 μm to 800 μm.

[0069] Since the average particle size of the component of the printing layer separated from the base layer satisfies the above range, the component of the printing layer can be effectively separated with the effect of cost reduction. Specifically, if the average particle size of the component of the printing layer separated from the base layer is less than the above range, it is not easy to separate fine particles, resulting in an increase in the cost of replacing the filter. If the average particle size of the component of the printing layer separated from the base layer exceeds the above range, the quality of the regenerated polyester-based chips produced in the recycling process of containers may be deteriorated.

[0070] The total thickness of the film may be 10 μm to 200 μm. For example, the total thickness of the film may be 10 μm to 150 μm, 30 μm to 160 μm, 60 μm to 120 μm, 60 μm to 140 μm, 90 μm to 110 μm, 80 μm to 90 μm, 20 μm to 130 μm, 25 μm to 100 μm, 30 μm to 80 μm, 35 μm to 60 μm, or 35 μm to 45 μm.

[0071] The film may have a light transmittance of 90% or more at a wavelength of 550 nm. Specifically, the light transmittance of the film measured at a wavelength of 550 nm before and after immersion in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1% at 85°C may be 90.5% or more, 91% or more, 92% or more, or 93% or more, respectively.

[0072] In addition, the change in light transmittance of the film before and after immersion in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1% at 85°C may be 0.7% or less. For example, the change in light transmittance of the film before and after the immersion may be 0.6% or less or 0.5% or less.

[0073] The change in light transmittance refers to an absolute value of the difference between the light transmittance of the film measured at a wavelength of 550 nm before the immersion and the light transmittance of the film measured at a wavelength of 550 nm after the immersion.

[0074] In addition, the change (ΔL) in Col-L may be 0.7 or less, the change (Δa) in Col-a may be 0.5 or less, and the change (Δb) in Col-b may be 0.5 or less, before and after immersion of the film in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1% at 85°C. For example, the change (ΔL) in Col-L may be 0.65 or less, 0.6 or less, 0.55 or less, or 0.5 or less, the change (Δa) in Col-a may be 0.3 or less, 0.1 or less, 0.08 or less, 0.06 or less, or 0.05 or less, and the change (Δb) in Col-b may be 0.3 or less, 0.1 or less, 0.08 or less, or 0.07 or less, before and after the immersion.

[0075] The change (ΔL) in Col-L refers to an absolute value of the difference between the Col-L value before the immersion and the Col-L value after the immersion, the change (Δa) in Col-a refers to an absolute value of the difference between the Col-a value before the immersion and the Col-a value after the immersion, and the change (Δb) in Col-b refers to an absolute value of the difference between the Col-b value before the immersion and the Col-b value after the immersion.

[0076] Since the change (ΔL) in Col-L, the change (Δa) in Col-a, and the change (Δb) in Col-b, before and after the immersion of the film, satisfy the above ranges, the average particle size of the component of the printing layer separated from the base layer satisfies 15 μm or more while there is little change in the physical properties such as light transmittance and color change even before and after immersion, resulting in excellent quality. Specifically, it is possible to provide regenerated polyester-based chips having excellent quality in the regeneration process of a container provided with the film.

[0077] Col-L, Col-a, and Col-b are color coordinates established by the Commission International d'Eclairage (CIE), where color is represented by L (brightness), a (green to red complementary color), and b (yellow to blue complementary color). They can be measured using UltraScan PRO (manufacturer: Hunterlab), but it is not limited thereto.

[0078] In addition, the change in the haze of the film before and after immersion in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1% may be 0.5% or less. Specifically, the haze of the film refers to the haze of the base layer. Since the component of the printing layer is removed from the film after the immersion, it is possible to measure the haze, and the change in haze may be 0.4% or less, 0.35% or less, or 0.3% or less. The change in haze refers to an absolute value of the difference between the haze before the immersion and the haze after the immersion. If the component of the printing layer is not removed, the haze cannot be measured for the film comprising the printing layer.

[0079] Since the change in haze satisfies the above range, there is little change in the physical properties such as haze even before and after immersion. Thus, in the film according to an embodiment, the average particle size of the component of the printing layer separated from the base layer satisfies 15 μm or more while there is little change in the physical properties such as haze even before and after the immersion, resulting in excellent quality. Specifically, it is possible to provide regenerated polyester-based chips having excellent quality in the regeneration process of a container provided with the film.

[0080] In addition, the film may have a heat shrinkage rate of 1% to 55% in a first direction or in a second direction upon thermal treatment at a temperature of 70°C for 10 seconds. For example, the film may have a heat shrinkage rate of 1% to 50%, 3% to 50%, 5% to 50%, 10% to 50%, 20% to 45%, or 25% to 40%, in a first direction or in a second direction upon thermal treatment at a temperature of 70°C for 10 seconds.

[0081] The film may have a heat shrinkage rate of 30% or more in a first direction or in a second direction upon thermal treatment at a temperature of 80°C for 10 seconds. For example, the film may have a heat shrinkage rate of 35% or more, 40% or more, 45% or more, 50% or more, 30% to 85%, 40% to 80%, or 50% to 80%, in a first direction or in a second direction upon thermal treatment at a temperature of 80°C for 10 seconds.

[0082] In addition, the film may have a heat shrinkage rate of 50% or more in a first direction or in a second direction upon thermal treatment at a temperature of 90°C for 10 seconds. For example, the film may have a heat shrinkage rate of 55% or more, 60% or more, 70% or more, 50% to 90%, 60% to 85%, 70% to 85%, or 70% to 80%, in a first direction or in a second direction upon thermal treatment at a temperature of 90°C for 10 seconds.

[0083] The film may have a heat shrinkage rate of 30% or more in a first direction or in a second direction upon thermal treatment at a temperature of 100°C for 10 seconds. For example, the film may have a heat shrinkage rate of 35% or more, 40% or more, 50% or more, 30% to 90%, 30% to 80%, 40% to 80%, 45% to 80%, or 50% to 80%, in a first direction or in a second direction upon thermal treatment at a temperature of 100°C for 10 seconds.

[0084] Since the heat shrinkage rates at 70°C, 80°C, 90°C, and 100°C satisfy the above ranges, it is convenient to conduct labeling in the process in which the film surrounds at least a portion of a container.

[0085] In addition, the film may have a glass transition temperature (Tg) of 60°C or higher as measured by differential scanning calorimetry. For example, the film may have a glass transition temperature of 60°C or higher, 65°C or higher, 70°C to less than 80°C, or 70°C to 75°C, as measured by differential scanning calorimetry.

[0086] The film may have a melting point (Tm) of 170°C or higher as measured by differential scanning calorimetry. For example, the film may have a melting point of 170°C or higher, 175°C or higher, specifically 170°C to 230°C, 170°C to 200°C, or 175°C to 200°C, as measured by differential scanning calorimetry.

[0087] Since the glass transition temperature and the melting point of the film satisfy the above ranges, the clumping phenomenon that may occur in the regeneration process can be reduced. Specifically, the flakes may form aggregates during the thermal treatment in the process of regenerating a container. This clumping phenomenon may deteriorate the quality of the regenerated polyester-based chips thus produced, thereby impairing the recyclability of the containers.

[0088] However, since the glass transition temperature and the melting point of the film according to an embodiment satisfy the above ranges, it is possible to reduce the clumping phenomenon that may occur in the regeneration process. Thus, it is possible to enhance the recyclability of containers, thereby maximizing the quality and productivity of the regenerated polyester-based chips thus produced.

[0089] In addition, the crystallization temperature of the film is not measured or is 70°C to 130°C, as measured by differential scanning calorimetry. For example, the crystallization temperature (Tc) of the film is not measured or may be 70°C to 120°C, 75°C to 110°C, or 80°C to 110°C, as measured by differential scanning calorimetry.

[0090] The heat of crystallization of the film may be 0.01 J/g to 50 J/g as measured at the crystallization temperature (Tc). For example, the heat of crystallization of the film may be 0.01 J/g to 40 J/g, 0.05 J/g to 30 J/g, 0.1 J/g to 20 J/g, 0.1 J/g to 10 J/g, 0.1 J/g to 8 J/g, or 0.1 J/g to 5 J/g, as measured at the crystallization temperature (Tc).

[0091] Since the crystallization temperature and the heat of crystallization satisfy the above ranges, it is possible to reduce the clumping phenomenon that may occur in the regeneration process. Thus, it is possible to enhance the recyclability of containers, thereby maximizing the quality and productivity of the regenerated polyester-based chips thus produced.

[0092] Specifically, if the film has a melting point (Tm) of 170°C or higher and a crystallization temperature (Tc) of 70°C to 130°C as measured by differential scanning calorimeter, the effect of reducing the clumping phenomenon can be maximized.

Process for preparing a polyester-based film

[0093] The process for preparing a polyester-based film according to an embodiment comprises forming a base layer from a composition for a base layer comprising a polyester-based resin; and forming a printing layer on one side of the base layer from a composition for a printing layer.

[0094] The process for preparing a polyester-based film according to another embodiment comprises forming a base layer from a composition for a base layer comprising a polyester-based resin; forming a stripping promoting layer on one side of the base layer from a composition for a stripping promoting layer; and forming a printing layer on one side of the base layer from a composition for a printing layer.

Base layer

[0095] The base layer may be formed from a composition for a base layer comprising a polyester-based resin. Details on the polyester-based resin are as described above.

[0096] Specifically, the polyester-based resin may be melt-extruded at 260°C to 300°C or 270°C to 290°C through a T-die and then cooled to obtain an unstretched sheet. The unstretched sheet is passed through a chamber to be preheated while it is conveyed at a speed of 10 m/minute to 110 m/minute or 20 m/minute to 90 m/minute and then stretched to obtain a stretched sheet, which is heat-set to prepare a base layer.

[0097] The preheating may be carried out at 90°C to 120°C for 0.01 to 1 minute. For example, the preheating temperature (T1) may be 95°C to 115°C or 97°C to 113°C, and the preheating time may be 0.05 minute to 0.5 minute or 0.08 minute to 0.2 minute.

[0098] In addition, the stretching may be uniaxial stretching or biaxial stretching. Specifically, the stretching may be uniaxial stretching carried out in a second direction, or biaxial stretching carried out in a first direction and then in a second direction perpendicular to the first direction. For example, if the stretching is uniaxial stretching, the second direction may be the transverse direction (TD).

[0099] Specifically, if the stretching is uniaxial stretching, the stretching may be carried out at a temperature lower than the preheating temperature (T1) by at least 20°C in a second direction at a stretching ratio of 3 times to 5.5 times. For example, the stretching may be carried out at a stretching temperature of 60°C to 90°C, 70°C to 90°C, or 70°C to 85°C in a second direction at a stretching ratio of 2.5 times to 5.5 times, 2.5 times to 5 times, or 3.5 times to 5 times.

[0100] Alternatively, if the stretching is biaxial stretching, the stretching may be carried out at a temperature lower than the preheating temperature (T1) by at least 20°C in a first direction at a stretching ratio of 2.5 times to 5 times and then in a second direction at a stretching ratio of 3 times to 5 times. For example, the stretching may be carried out at a stretching temperature of 60°C to 90°C, 70°C to 90°C, or 70°C to 85°C in a first direction at a stretching ratio of 2.5 times to 5 times, 2.5 times to 4 times, or 3.5 times to 5 times and then in a second direction at a stretching ratio of 2.5 times to 5 times, 2.5 times to 4 times, or 3.5 times to 5 times.

[0101] In addition, a coating step may be further carried out before the uniaxial stretching in the second direction or before stretching in the second direction after stretching in the first direction. Specifically, a coating step may be further carried out for forming a promoting layer or the like capable of imparting functionality such as antistatic or the like to the film. The coating step may be carried out by spin coating or in-line coating, but it is not limited thereto.

[0102] The heat setting may be annealing and carried out at 70°C to 95°C for 0.01 minute to 1 minute. For example, the heat setting temperature (T2) may be 75°C to 95°C, 75°C to 93°C, 80°C to 93°C, or 85°C to 93°C, and the heat setting time may be 0.05 minute to 0.5 minute or 0.08 minute to 0.2 minute.

[0103] The preheating temperature (T1) - heat setting temperature (T2) may be 10°C to 40°C. Specifically, the stretching temperature may be lower than the preheating temperature (T1) by 10°C or more, 15°C or more, or 20°C or more, and the heat setting temperature (T2) may be higher than the stretching temperature by 5°C or more or 10°C or more. Since the preheating temperature, stretching temperature, and heat setting temperature satisfy the above ranges, the heat shrinkage rates in the first direction and in the second direction can be effectively controlled.

Stripping promoting layer

[0104] The stripping promoting layer may be formed by coating a composition for a stripping promoting layer on one side of the base layer. Specifically, it may be formed by carrying out the in-line or off-line coating of a composition for a stripping promoting layer on one side of the base layer, but it is not limited thereto.

[0105] Details on the composition for a stripping promoting layer are as described above.

Printing layer

[0106] The printing layer may be formed from a composition for a printing layer using a printer. Specifically, the base layer or the base layer having a stripping promoting layer formed on one side thereof is put into a printer to print the composition for a printing layer on one side of the stripping promoting layer, thereby forming a printing layer.

[0107] Details on the composition for a printing layer are as described above.

Process for regenerating a polyester-based container

[0108] The process for regenerating a polyester-based container according to another embodiment comprises providing a polyester-based container at least a portion of which is surrounded by the polyester-based film; crushing the polyester-based container provided with the film to obtain flakes; immersing the crushed flakes in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1% at 85°C, and thermally treating the immersed flakes to produce regenerated polyester-based chips, wherein when the flakes are thermally treated at a temperature of 200°C to 220°C for 60 minutes to 120 minutes, the clumping fraction is 5% or less.

[0109] In order to regenerate a polyester-based container according to an embodiment, a polyester-based container at least a portion of which is surrounded by the polyester-based film is prepared.

[0110] Conventionally adopted was a process, which comprises washing recycled waste products in which containers, metals, glass, and plastics may be intermingled to classify polyester-based containers and removing the films or like wrapping the containers in order to enhance the recyclability and quality of the containers. The removal step has been carried out by mechanically tearing or cutting the films or by such an additional step as liquid specific gravity separation, dehydration, drying, wind specific gravity separation, or pelletization.

[0111] However, it was difficult to completely remove the films in the above removal step. In particular, it was difficult to enhance the quality of the regenerated polyester-based chips thus produced due to the residual ink that had been formed on the films.

[0112] In the process for regenerating a polyester-based container according to an embodiment, it is possible to produce regenerated polyester-based chips without an additional step of removing the film surrounding the polyester-based container, whereby the cost is saved. In addition, in the film according to an embodiment, the component of the printing layer is readily separated, and all of them are not dissolved in an aqueous solution of sodium hydroxide in the washing step, resulting in an excellent effect of preventing environmental pollution.

[0113] In the polyester-based container, the polyester-based film is provided on the outer surface of the container. Specifically, the outer surface of the polyester-based container is covered with the polyester-based film, and the film may be shrunk by steam or hot air to surround at least a portion of the outer surface of the polyester-based container. For example, the polyester-based film, as a heat shrinkable film, may be a label of the polyester-based container, but it is not limited thereto.

[0114] Details on the polyester-based film are as described above.

[0115] The polyester-based container may comprise a polyester-based resin in an amount of at least 90% by weight based on the total weight of the polyester-based container. For example, the polyester-based container may be a container that comprises polyethylene terephthalate (PET) and may comprise polyethylene terephthalate in an amount of 90% by weight or more, 95% by weight or more, or 99% by weight or more, based on the total weight of the polyester-based container, but it is not limited thereto.

[0116] Thereafter, the polyester-based container provided with the film is crushed to obtain flakes.

[0117] Specifically, at least a portion of the outer surface of the polyester-based container is surrounded by the film, and the container and the film are crushed together to obtain flakes without a step of separating the container and the film.

[0118] That is, the flakes comprise first flakes obtained by crushing the polyester-based container and second flakes obtained by crushing the film.

[0119] The particle size of the first flakes may be 0.1 mm to 25 mm, and the particle size of the second flakes may be 0.1 mm to 25 mm. For example, the particle size of the first flakes may be 0.3 mm to 23 mm, 0.5 mm to 20 mm, 1 mm to 20 mm, 0.5 mm to 15 mm, 0.5 mm to 13 mm, 1 mm to 18 mm, 1 mm to 15 mm, 1 mm to 13 mm, or 2 mm to 10 mm, and the particle size of the second flakes may be 0.3 mm to 23 mm, 0.5 mm to 20 mm, 1 mm to 20 mm, 0.5 mm to 15 mm, 0.5 mm to 13 mm, 1 mm to 18 mm, 1 mm to 15 mm, 1 mm to 13 mm, or 2 mm to 10 mm, but they are not limited thereto.

[0120] Thereafter, the crushed flakes are immersed in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1% at 85°C.

[0121] Specifically, the crushed flakes are immersed in an aqueous solution of sodium hydroxide having a concentration of 1% at 85°C for 5 minutes to 30 minutes to be washed. For example, the first flakes and second flakes may be immersed in an aqueous solution of sodium hydroxide having a concentration of 1% at 85°C for 5 minutes to 25 minutes or 10 minutes to 20 minutes to be washed.

[0122] As the washing step is carried out, it is possible to remove impurities that may remain in the crushed flakes, as well as to effectively remove the component of the printing layer. Thus, it is possible to enhance the quality and purity of the regenerated polyester-based chips thus produced, thereby maximizing the recyclability of containers.

[0123] As described above, when the film is cut into a size of 1 cm in width and 1 cm in length, immersed in an aqueous solution of sodium hydroxide having a concentration of 1%, and stirred for 15 minutes at 85°C at a speed of 240 m/minute, the average particle size of the component of the printing layer separated from the base layer is 15 μm or more.

[0124] Thus, it is possible to effectively separate and remove the component of the printing layer remaining in the crushed flakes, particularly the second flakes, from the second flakes through the washing step. In addition, since the component of the printing layer has an average particle size of 15 μm or more while it is not dissolved in an aqueous solution of sodium hydroxide, it is possible to effectively remove the component, particularly the ink component, of the printing layer, thereby enhancing the quality and purity of the regenerated polyester-based chips thus produced with an excellent effect of environmental protection.

[0125] Specifically, the component of the printing layer having an average particle size of 15 μm or more can be separated and removed from the aqueous solution of sodium hydroxide by using a filter having a pore size of 15 μm or a filter of 0.1 mm to less than 25 mm, which is smaller than the size of the flakes, but it is not limited thereto.

[0126] In addition, if the washing step in which the film is immersed in an aqueous solution of sodium hydroxide having a concentration of 1% at 85°C for 5 minutes to 30 minutes is a first washing step, a second washing step may be further carried out after the first washing step.

[0127] Specifically, the second washing step may be carried out with water at room temperature and/or an aqueous solution of sodium hydroxide having a concentration of 0.5% to 3% at 80°C to 97°C for 5 minutes to 30 minutes.

[0128] More specifically, if the second washing step is carried out with an aqueous solution of sodium hydroxide having a concentration of 0.5% to 3%, it is possible to more effectively remove impurities remaining in the crushed flakes. If the second washing step is carried out with water at room temperature, it is possible to remove the residual aqueous solution of sodium hydroxide. For example, a second washing step may be carried out with water at room temperature after the first washing step. Alternatively, washing with an aqueous solution of sodium hydroxide having a concentration of 0.5% to 3% is carried out after the first washing step, followed by a second washing step with water at room temperature.

[0129] In addition, after the washing step, a step of drying the washed flakes at 60°C to 175°C for 10 minutes to 30 minutes may be further carried out. For example, the drying step may be carried out at 65°C to 175°C, 70°C to 170°C, 90°C to 165°C, 100°C to 165°C, or 120°C to 165°C for 15 minutes to 85 minutes, 20 minutes to 70 minutes, 15 minutes to 30 minutes, or 50 minutes to 70 minutes.

[0130] The washing and drying steps may be carried out once to five times repeatedly. For example, impurities remaining in the flakes can be effectively removed by repeatedly carrying out the washing and drying steps two to five times or three to five times in order.

[0131] Finally, the immersed flakes are thermally treated to produce regenerated polyester-based chips.

[0132] The thermal treatment may be carried out at 200°C to 220°C for 60 minutes to 120 minutes. For example, the thermal treatment may be carried out at 200°C to 215°C or 205°C to 220°C for 70 minutes to 120 minutes or 80 minutes to 120 minutes.

[0133] In addition, when the flakes are thermally treated at a temperature of 200°C to 220°C for 60 minutes to 120 minutes, the clumping fraction may be 5% or less. For example, when the flakes are thermally treated at 220°C for 60 minutes or at 210°C for 90 minutes, the clumping fraction may be 4% or less, 3% or less, 2.5% or less, 2% or less, 1% or less, or 0.8% or less.

[0134] Clumping refers to an aggregate that may be formed from the flakes. The size of the aggregate may be, for example, at least three times the size of the flake particles. The clumping fraction refers to the fraction of the aggregates based on the total weight of the flakes. For example, the flakes may be passed through a sieve and thermally treated. At that time, aggregates may be formed as the flakes are clumped. The aggregates may be passed through a sieve again to be separated. The weight of the aggregates thus collected is measured to calculate the weight ratio of the aggregates based on the total weight of the thermally treated flakes as the clumping fraction.

[0135] Thus, the higher the value of the crumbling fraction is, the more the first flakes and the second flakes are entangled together to lower the quality of the regenerated polyester-based chips. However, the second flakes are obtained by crushing the polyester-based film according to an embodiment, thereby effectively reducing or preventing the formation of aggregates and enhancing the quality of the regenerated polyester-based chips thus produced.

[0136] Regenerated polyester-based chips may be obtained after the thermal treatment step. Specifically, the regenerated polyester-based chips that comprise the first flakes and the second flakes may be obtained after the thermal treatment step. For example, the flakes may be melt-extruded and cut to obtain regenerated polyester-based chips, but it is not limited thereto.

Regenerated polyester-based chips

[0137] The regenerated polyester-based chips according to still another embodiment are produced by the process for regenerating a polyester-based container.

[0138] Specifically, the regenerated polyester-based chips may comprise first flakes comprising polyethylene terephthalate and second flakes comprising a polyester-based resin.

[0139] The regenerated polyester-based chips may have an intrinsic viscosity (IV) of 0.60 dl/g or more. For example, the regenerated polyester-based chips may have an intrinsic viscosity (IV) of 0.63 dl/g or more, 0.65 dl/g or more, 0.70 dl/g or more, 0.75 dl/g or more, 0.60 dl/g to 3.00 dl/g, 0.60 dl/g to 2.0 dl/g, or 0.65 dl/g to 1.0 dl/g.

[0140] In addition, the regenerated polyester-based chips may comprise polyethylene terephthalate in an amount of 70% by weight to 99% by weight and a polyester-based resin in an amount of 1% by weight to 30% by weight, based on the total weight of regenerated polyester-based chips. For example, the regenerated polyester-based chips may comprise polyethylene terephthalate in an amount of 80% by weight to 99% by weight, 90% by weight to 99% by weight, or 95% by weight to 99% by weight and a polyester-based resin in an amount of 1% by weight to 20% by weight, 1% by weight to 10% by weight, or 1% by weight to 5% by weight, based on the total weight of the regenerated polyester-based chips.

Mode for the Invention

[0141] Hereinafter, the present invention will be described in more detail with reference to the following examples. However, these examples are set forth to illustrate the present invention, and the scope of the present invention is not limited thereto.

<Example A>

Preparation of a polyester-based film

Preparation Example 1-1

[0142] A stainless steel autoclave equipped with a stirrer, a thermometer, and a partial reflux condenser was charged with 100% by mole of terephthalic acid (TPA) as a dicarboxylic acid component and 78% by mole of ethylene glycol (EG), 17% by mole of neopentyl glycol (NPG), and 5% by mole of diethylene glycol (DEG) as a diol component. Then, 0.05% by mole (based on the acid component) of zinc acetate as a transesterification catalyst was added thereto. The transesterification reaction was carried out while methanol was being distilled off. Thereafter, 0.025% by mole (based on the acid component) of antimony trioxide as a polycondensation catalyst was added, and the polycondensation reaction was carried out under a reduced pressure of 26.6 Pa (0.2 Torr) at 280°C to obtain a polyester-based resin.

Preparation Examples 1-2 to 1-6

[0143] Polyester-based resins were prepared in the same manner as in Preparation Example 1-1, except that the components and contents were changed as shown in Table 1 below.

[Table 1]

	Prep. Ex. 1-1	Prep. Ex. 1-2	Prep. Ex. 1-3	Prep. Ex. 1-4	Prep. Ex. 1-5	Prep. Ex. 1-6
TPA (% by mole)	100	100	100	100	100	100
EG (% by mole)	78	70	63	38	68.5	68
NPG (% by mole)	17	24	30	57	-	-
CHDM (% by mole)	-	-	-	-	30	22
DEG (% by mole)	5	6	7	5	1.5	10
* CHDM: cyclohexanedimethanol						

Preparation of a composition for a printing layer

Preparation Example 2-1

[0144] 25% by weight of ethanol, 35% by weight of a polyester-based binder (BNPE-100, manufacturer: BN Chemical), and 40% by weight of a Blue pigment (First Blue 1530, manufacturer: First Color) were mixed and stirred to prepare a composition for a printing layer.

Preparation Examples 2-2 to 2-6

[0145] Compositions for a printing layer were prepared in the same manner as in Preparation Example 2-1, except that the components and contents were changed as shown in Table 2 below.

[Table 2]

	Prep. Ex. 2-1	Prep. Ex. 2-2	Prep. Ex. 2-3	Prep. Ex. 2-4	Prep. Ex. 2-5	Prep. Ex. 2-6
Alcohol	Ethanol 25% by weight	Ethanol 30% by weight	Ethanol 20% by weight	Toluene 30% by weight	Ethanol 45% by weight	Ethanol 40% by weight
Binder	Polyester-based 35% by weight	Acrylic-based 30% by weight	Polyurethane-based 40% by weight	Polypropylen e-based 30% by weight	Polyester-based 15% by weight	Acrylic-based 20% by weight
Pigment	Blue 40% by weight	Green 40% by weight	Yellow 40% by weight	Blue 40% by weight	Green 40% by weight	Yellow 40% by weight
* Acrylic-based binder (509, manufacturer: Daeyang Chemical) * Polyurethane-based binder (GR-103F, manufacturer: Base Korea) * Polypropylene-based binder (BINDER-I, manufacturer: Hyundai Chemical) * Green pigment (F3G, manufacturer: Dongyang Chemical) * Yellow pigment (FR, manufacturer: Dongyang Chemical)						

Preparation of a polyester-based film

Preparation Example 3-1

[0146] The polyester-based resin of Preparation Example 1-1 was fed to an extruder and then melt-extruded at 280°C through a T-die, which was cooled to obtain an unstretched sheet. Then, the unstretched sheet was preheated at 105°C for 0.1 minute while it was transferred at a speed of 30 m/minute. Thereafter, it was stretched in the transverse direction at 85°C at a stretching ratio of 4.0 times to 4.7 times. Thereafter, it was heat set at 90°C for 0.1 minute to prepare a base layer having a thickness of 40 μm.

[0147] Thereafter, the base layer was put into a printer, and one side of the base layer was printed with the composition for a printing layer of Preparation Example 2-1 to prepare a polyester-based film having a total thickness of 42 μm in which a printing layer having a thickness of 2 μm was formed.

Preparation Examples 3-2 to 3-6

[0148] Polyester-based films were prepared in the same manner as in Preparation Example 3-1, except that the polyester-based resins of Preparation Examples 1-2 to 1-6 were each used instead of the polyester-based resin of Preparation Example 1-1, and the compositions for a printing layer of Preparation Examples 2-2 to 2-6 were each used instead of the composition for a printing layer of Preparation Example 2-1, as shown in Table 3 below.

Preparation of regenerated polyester-based chips

Example 1

[0149] A part of the outer surface of a polyethylene terephthalate container (PET container, 30 g) was wrapped with the polyester-based film (1 g) of Preparation Example 3-1. The film was shrunk in hot air at a temperature of 90°C to prepare a polyester-based container in which the film surrounded a part of the outer surface.

[0150] Thereafter, the container provided with the film was crushed with a crusher to obtain flakes. The crushed flakes were immersed in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1% at 85°C and washed for 15 minutes at a stirring speed of 240 m/minute.

[0151] Thereafter, the flakes were washed once more with water at room temperature to remove the residual aqueous solution of sodium hydroxide and then filtered through a sieve having a pore size of 15 μm. Thereafter, they were dried at 160°C for 1 hour and then thermally treated at 210°C for 90 minutes to produce regenerated polyester-based chips.

Examples 2 and 3 and Comparative Examples 1 to 3

[0152] Regenerated polyester-based chips were prepared in the same manner as in Example 1, except that the polyester-based films of Preparation Examples 3-2 to 3-6 were each used instead of the polyester-based film of Preparation Example 3-1.

<Evaluation Example>

Evaluation Example 1-1: Average particle size

[0153] A stirrer was charged with an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1%, which was heated to 85°C. The film was cut into 1 cm in width and 1 cm in length and added thereto. After it was stirred for 15 minutes at a stirring speed of 240 m/minute, the average particle size of the component of the printing layer thus separated was measured using MICROTRAC S-3500 (manufacturer: Dream Corporation).

Evaluation Example 1-2: Light transmittance and color

[0154] The film was cut into 1 cm in width and 1 cm in length and immersed in an aqueous solution of sodium hydroxide having a concentration of 1% at 85°C. It was measured for the light transmittance at 550 nm, Col-L, Col-a, and Col-b before and after the immersion using UltraScan PRO (manufacturer: Hunterlab).

Evaluation Example 1-3: Clumping fraction

[0155] The flakes prepared above were passed through a 0.625"-sieve. 1 kg of the flakes thus sieved was exposed in an oven at 210°C for 90 minutes. The flakes were cooled to room temperature and passed through a 0.625"-sieve. The weight of the aggregates thus filtered out was measured and calculated as a percentage of the total weight of the flakes.

[Table 3]

		Ex. 1	Ex. 2	Ex. 3	C. Ex. 1	C. Ex. 2	C. Ex. 3
Film	Base layer	Prep. Ex. 1-1	Prep. Ex. 1-2	Prep. Ex. 1-3	Prep. Ex. 1-4	Prep. Ex. 1-5	Prep. Ex. 1-6

(continued)

	Printing layer	Prep. Ex. 2-1	Prep. Ex. 2-2	Prep. Ex. 2-3	Prep. Ex. 2-4	Prep. Ex. 2-5	Prep. Ex. 2-6
Before immersion	Light transmittance	94.5	95.0	92.0	93.0	94.0	94.0
	Col-L	91.5	92.2	92.3	95.8	96.0	94.0
	Col-a	-1.37	-1.32	-1.33	0.02	0.06	0.03
	Col-b	1.97	1.90	1.85	0.60	0.48	0.40
After immersion	Light transmittance	94.4	94.5	91.8	93.0	85.0	93.9
	Col-L	91.0	92.0	92.0	95.8	87.0	93.9
	Col-a	-1.32	-1.34	-1.35	0.02	-1.10	0.03
	Col-b	1.90	1.89	1.86	0.60	-0.10	0.39
Average particle size of the printing layer component (μm)		70	25	75	#	5	14
Clumping fraction (%)		0.7	1	1.8	5.4	23	22.5
#: Since the component of the printing layer was completely dissolved in the aqueous solution of sodium hydroxide, the particle size thereof could not be measured.							

[0156] As shown in Table 3 above, the regenerated polyester-based chips of Examples 1 to 3 prepared by the polyester-based films of Preparation Examples 3-1 to 3-3 and the process for regenerating a polyester-based container using the same had excellent quality as compared with Comparative Examples 1 to 3.

[0157] Specifically, as the polyester-based films of Preparation Examples 3-1 to 3-3 comprised the printing layers of Preparation Examples 2-1 to 2-3, there was almost no change in the light transmittance and color before and after immersion in an aqueous solution of sodium hydroxide having a concentration of 1% at a temperature of 85°C, and the average particle size of the component of the printing layer separated in the regeneration process was 15 μm or more. As a result, the regenerated polyester-based chips produced according to the process for regenerating a polyester-based container comprising the same were excellent in quality. In addition, since the component of the printing layer was not dissolved in the aqueous solution of sodium hydroxide, the effect of preventing environmental pollution was excellent as well.

[0158] In contrast, the regenerated polyester-based chips of Comparative Examples 1 to 3 had a high clumping fraction, resulting in poor quality and low recyclability. Since the component of the printing layer was completely dissolved in the aqueous solution of sodium hydroxide or the average particle size thereof was less than 15 μm, it was not readily separated, resulting in a problem of environmental pollution.

<Example B>

Preparation of a polyester-based film

Preparation Example 4-1

[0159] A stainless steel autoclave equipped with a stirrer, a thermometer, and a partial reflux condenser was charged with 100% by mole of terephthalic acid (TPA) as a dicarboxylic acid component and 65% by mole of ethylene glycol (EG), 30% by mole of neopentyl glycol (CHDM), and 5% by mole of diethylene glycol (DEG) as a diol component. 0.05% by mole (based on the acid component) of zinc acetate as a transesterification catalyst was added thereto. The transesterification reaction was carried out while methanol was being distilled off. Thereafter, 0.025% by mole (based on the acid component) of antimony trioxide as a polycondensation catalyst was added, and the polycondensation reaction was carried out under a reduced pressure of 26.6 Pa (0.2 Torr) at 280°C to obtain a polyester-based resin.

Preparation Examples 4-2 to 4-6

[0160] Polyester-based resins were prepared in the same manner as in Preparation Example 4-1, except that the components and contents were changed as shown in Table 4 below.

[Table 4]

	Prep. Ex. 4-1	Prep. Ex. 4-2	Prep. Ex. 4-3	Prep. Ex. 4-4	Prep. Ex. 4-5	Prep. Ex. 4-6
TPA (% by mole)	100	100	100	100	100	100
EG (% by mole)	65	71	73	75	78	68.5
NPG (% by mole)	30	24	22	20	17	-
CHDM (% by mole)	-	-	-	-	-	30
DEG (% by mole)	5	5	5	5	5	1.5

Preparation of a composition for a stripping promoting layer

Preparation Example 5-1

[0161] 25% by weight of ethanol, 35% by weight of a polyester-based binder (BNPE-100, manufacturer: BN Chemical), and 40% by weight of a Blue pigment (FR, manufacturer: Dongyang Chemical) were mixed and stirred to prepare a composition for a stripping promoting layer.

Preparation Examples 5-2 to 5-6

[0162] Compositions for a stripping promoting layer were prepared in the same manner as in Preparation Example 5-1, except that the components and contents were changed as shown in Table 5 below.

[Table 5]

	Second solvent	Second binder	Second pigment
Prep. Ex. 5-1	25% by weight of ethanol	35% by weight of polyester-based	40% by weight of Blue
Prep. Ex. 5-2	30% by weight of ethanol	30% by weight of acrylic-based	40% by weight of Blue
Prep. Ex. 5-3	20% by weight of ethanol	40% by weight of polyurethane-based	40% by weight of Yellow
Prep. Ex. 5-4	35% by weight of ethanol	25% by weight of acrylic urethane-based	40% by weight of Yellow
* Acrylic-based (509, manufacturer: Daeyang Chemical) * Polyurethane-based (GR-103F, manufacturer: Base Korea) * Acrylic urethane-based (Binder PT-104, manufacturer: Hyundai Chemical)			

Preparation of a composition for a printing layer

Preparation Example 6-1

[0163] 30% by weight of toluene, 30% by weight of a polypropylene-based binder (BINDER-I, manufacturer: Hyundai Chemical), and 40% by weight of a Blue pigment (First Blue 1530, manufacturer: First Color) were mixed and stirred to prepare a composition for a printing layer.

Preparation Example 6-2

[0164] Compositions for a printing layer were prepared in the same manner as in Preparation Example 6-1, except that a Yellow pigment was used instead of a Blue pigment.

[Table 6]

	First solvent	First binder	First pigment
Prep. Ex. 6-1	30% by weight of toluene	30% by weight of propylene-based	40% by weight of Blue
Prep. Ex. 6-2	30% by weight of toluene	30% by weight of propylene-based	40% by weight of Yellow
* Yellow pigment (FR, manufacturer: Dongyang Chemical)			

Preparation of a polyester-based film

Preparation Example 7-1

[0165] The polyester-based resin of Preparation Example 4-1 was fed to an extruder and then melt-extruded at 280°C through a T-die, which was cooled to obtain an unstretched sheet. Then, the unstretched sheet was preheated at 105°C for 0.1 minute while it was transferred at a speed of 30 m/minute. Thereafter, it was stretched in the transverse direction at 85°C at a stretching ratio of 4.0 times to 4.7 times and heat set at 90°C for 0.1 minute to prepare a base layer having a thickness of 40 μm.

[0166] Thereafter, the composition for a stripping promoting layer of Preparation Example 5-1 was coated on one side of the base layer by the in-line or off-line coating to form a stripping promoting layer having a thickness of 100 nm. Thereafter, the base layer provided with a stripping promoting layer on one side thereof was put into a printer, and one side of the stripping promoting layer was printed with the composition for a printing layer of Preparation Example 6-1 to prepare a polyester-based film having a total thickness of 42.1 μm in which a printing layer having a thickness of 2 μm was formed.

Preparation Examples 7-2 to 7-6

[0167] Polyester-based films were prepared in the same manner as in Preparation Example 7-1, except that the polyester-based resins of Preparation Examples 4-2 to 4-6 were each used instead of the polyester-based resin of Preparation Example 4-1, the compositions for a stripping promoting layer of Preparation Examples 5-2 to 5-4 were each used instead of the composition for a stripping promoting layer of Preparation Example 5-1, and the composition for a printing layer of Preparation Example 6-1 or 6-2 was used, as shown in Table 7 below. Here, in the polyester-based films of Preparation Examples 7-5 and 7-6, a stripping promoting layer was not formed.

Preparation of regenerated polyester-based chips

Example 4

[0168] A part of the outer surface of a polyethylene terephthalate container (PET container, 30 g) was wrapped with the polyester-based film (1 g) of Preparation Example 7-1. The film was shrunk in hot air at a temperature of 90°C to prepare a polyester-based container in which the film surrounded a part of the outer surface.

[0169] Thereafter, the container provided with the film was crushed with a crusher to obtain flakes. The crushed flakes were immersed in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1% at 85°C and washed for 15 minutes at a stirring speed of 240 m/minute.

[0170] Thereafter, the flakes were washed once more with water at room temperature to remove the residual aqueous solution of sodium hydroxide and then filtered through a sieve having a pore size of 15 μm. Thereafter, they were dried at 160°C for 1 hour and then thermally treated at 210°C for 90 minutes to produce regenerated polyester-based chips.

Examples 5 and 6 and Comparative Examples 4 to 6

[0171] Regenerated polyester-based chips were prepared in the same manner as in Example 4, except that the polyester-based films of Preparation Examples 7-2 to 7-6 were each used instead of the polyester-based film of Preparation Example 7-1.

<Evaluation Example>

Evaluation Example 2-1: Average particle size

[0172] A stirrer was charged with an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1%, which was heated to 85°C. The film was cut into 1 cm in width and 1 cm in length and added thereto. After it was stirred for 15 minutes at a stirring speed of 240 m/minute, the average particle size of the component of the printing layer thus separated was measured using MICROTRAC S-3500 (manufacturer: Dream Corporation).

Evaluation Example 2-2: Haze

[0173] The film was cut into 1 cm in width and 1 cm in length and immersed in an aqueous solution of sodium hydroxide having a concentration of 1% at 85°C. It was measured for the haze before and after the immersion using a haze meter NDH-5000W manufactured by Nippon Denshoku Industries Co., Ltd.

Evaluation Example 2-3: Clumping fraction

[0174] The flakes prepared above were passed through a 0.625"-sieve. 1 kg of the flakes thus sieved was exposed in an oven at 210°C for 90 minutes. The flakes were cooled to room temperature and passed through a 0.625"-sieve. The weight of the aggregates thus filtered out was measured and calculated as a percentage of the total weight of the flakes.

[Table 7]

		Ex. 4	Ex. 5	Ex. 6	C. Ex. 4	C. Ex. 5	C. Ex. 6
Film	Base layer	Prep. Ex. 4-1	Prep. Ex. 4-2	Prep. Ex. 4-3	Prep. Ex. 4-4	Prep. Ex. 4-5	Prep. Ex. 4-6
	Stripping promoting layer	Prep. Ex. 5-2	Prep. Ex. 5-3	Prep. Ex. 5-4	-	-	Prep. Ex. 5-1
	Printing layer	Prep. Ex. 6-1	Prep. Ex. 6-1	Prep. Ex. 6-1	Prep. Ex. 6-2	Prep. Ex. 6-2	Prep. Ex. 6-1
Average particle size of the printing layer component (μm)		25	750	18	#	#	74
Haze (%)	Before immersion	4.8	6.2	5.6	4.5	4.5	3.9
	After immersion	4.8	6.4	5.3	-	-	4.1
Clumping fraction (%)		4.9	3.4	2.9	1.5	0.9	26
#: Since the component of the printing layer was completely dissolved in the aqueous solution of sodium hydroxide, the particle size thereof could not be measured.							

[0175] As shown in Table 7 above, the regenerated polyester-based chips of Examples 4 to 6 prepared by the polyester-based films of Preparation Examples 4-1 to 4-3 and the process for regenerating a polyester-based container using the same had excellent quality as compared with Comparative Examples 4 to 6.

[0176] Specifically, as the polyester-based films of Preparation Examples 7-1 to 7-3 comprised the stripping promoting layer, there was almost no change in the haze before and after immersion in an aqueous solution of sodium hydroxide having a concentration of 1% at a temperature of 85°C, and the average particle size of the component of the printing layer separated in the regeneration process was 15 μm or more. As a result, the regenerated polyester-based chips produced according to the process for regenerating a polyester-based container comprising the same were excellent in quality. In addition, since the component of the printing layer was not dissolved in the aqueous solution of sodium hydroxide, the effect of preventing environmental pollution was excellent as well.

[0177] In contrast, since the component of the printing layer was completely dissolved in the aqueous solution of sodium hydroxide in the regenerated polyester-based chips of Comparative Examples 4 to 6, there was a problem of environmental pollution. Specifically, the haze of the regenerated polyester-based chips of Comparative Examples 4 to 6 was not measured, indicating that the component of the printing layer was not removed, although they had a relatively low clumping fraction. Although the average particle size of the component of the printing layer thus separated was 15 μm or more, the regenerated polyester-based chips of Comparative Examples 6 had a very high clumping fraction, resulting in poor quality and low recyclability.

Claims

1. A polyester-based film, which comprises a base layer comprising a polyester-based resin; and a printing layer disposed on one side of the base layer,
   wherein when the film is cut into a size of 1 cm in width and 1 cm in length, immersed in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1%, and stirred for 15 minutes at 85°C at a speed of 240 m/minute, the average particle size of the component of the printing layer separated from the base layer is 15 μm or more.

2. The polyester-based film of claim 1, wherein the printing layer is formed from a composition for a printing layer that comprises a first solvent, a first binder, and a first pigment, and the weight ratio of the first solvent and the first binder is 1:0.5 to 2.5.

3. The polyester-based film of claim 2, wherein the first solvent comprises one or more selected from the group consisting of benzene, xylene, toluene, tetramethylbenzene, acetone, methyl ethyl ketone, methyl isobutyl ketone, cyclohexanone, methanol, ethanol, propanol, isopropyl alcohol, butyl alcohol, 2-methyl-2-propanol, octanol, allyl alcohol, benzyl alcohol, ethylene glycol, diethylene glycol, triethylene glycol, tetramethylene glycol, tetraethylene glycol, propylene glycol, dipropylene glycol, tripropylene glycol, hexylene glycol, and neopentyl glycol.

4. The polyester-based film of claim 2, wherein the composition for a printing layer comprises the first solvent in an amount of 1% by weight to 35% by weight, the first binder in an amount of 25% by weight to 60% by weight, and the first pigment in an amount of 5% by weight to 50% by weight, based on the total weight of the composition for a printing layer.

5. The polyester-based film of claim 1, wherein the polyester-based resin comprises a diol component and a dicarboxylic acid component,
   the diol component comprises at least one selected from the group consisting of ethylene glycol, diethylene glycol, and neopentyl glycol, and
   the polyester-based resin comprises neopentyl glycol in an amount of 1% by mole to 35% by mole based on the total number of moles of the diol component.

6. The polyester-based film of claim 5, wherein the polyester-based resin comprises ethylene glycol in an amount of 55% by mole to 90% by mole and diethylene glycol in an amount of 1% by mole to 15% by mole, based on the total number of moles of the diol component, and the molar ratio of ethylene glycol and diethylene glycol is 5 to 60:1.

7. The polyester-based film of claim 1, which has a light transmittance of 90% or more at a wavelength of 550 nm,
   a change in light transmittance of 0.7% or less before and after the immersion, and
   a change (ΔL) in Col-L of 0.7 or less, a change (Δa) in Col-a of 0.5 or less, and a change (Δb) in Col-b of 0.5 or less, before and after the immersion.

8. A polyester-based film, which comprises a base layer comprising a polyester-based resin; a printing layer opposite to the base layer; and a stripping promoting layer interposed between the base layer and the printing layer,
   wherein when the film is cut into a size of 1 cm in width and 1 cm in length, immersed in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1%, and stirred for 15 minutes at 85°C at a speed of 240 m/minute, the average particle size of the component of the printing layer separated from the base layer is 15 μm or more.

9. The polyester-based film of claim 8, wherein the stripping promoting layer is formed from a composition for a stripping promoting layer that comprises a second solvent, a second binder, and a second pigment, and the weight ratio of the second solvent and the second binder is 1:0.5 to 3.

10. The polyester-based film of claim 8, wherein the second solvent comprises one or more selected from the group consisting of methanol, ethanol, propanol, isopropyl alcohol, butyl alcohol, 2-methyl-2-propanol, octanol, allyl alcohol, benzyl alcohol, ethylene glycol, diethylene glycol, triethylene glycol, tetramethylene glycol, tetraethylene glycol,

propylene glycol, dipropylene glycol, tripropylene glycol, hexylene glycol, and neopentyl glycol.

11. The polyester-based film of claim 8, wherein the composition for a stripping promoting layer comprises the second solvent in an amount of 15% by weight to 40% by weight, the second binder in an amount of 10% by weight to 55% by weight, and the second pigment in an amount of 5% by weight to 50% by weight, based on the total weight of the composition for a stripping promoting layer.

12. The polyester-based film of claim 8, wherein the thickness of the base layer is 10 μm to 100 μm,
the thickness of the stripping promoting layer is 10 μm to 200 μm, and
the thickness of the printing layer is 0.1 μm to 100 μm.

13. The polyester-based film of claim 8, which has a change in haze of 0.5% or less before and after immersion in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1% at 85°C.

14. A process for regenerating a polyester-based container, which comprises:

providing a polyester-based container at least a portion of which is surrounded by the polyester-based film according to claim 1;
crushing the polyester-based container provided with the film to obtain flakes;
immersing the crushed flakes in an aqueous solution of sodium hydroxide (NaOH) having a concentration of 1% at 85°C; and
thermally treating the immersed flakes to produce regenerated polyester-based chips,
wherein when the flakes are thermally treated at a temperature of 200°C to 220°C for 60 minutes to 120 minutes, the clumping fraction is 5% or less.

15. Regenerated polyester chips prepared according to the regeneration process of claim 14.

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

C08J 7/04(2006.01)i; **C08J 5/18**(2006.01)i; **C08L 67/02**(2006.01)i; **C08G 63/181**(2006.01)i; **B29B 17/02**(2006.01)i; **B29B 17/04**(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C08J 7/04(2006.01); B07B 7/00(2006.01); B29C 55/14(2006.01); B32B 27/36(2006.01); B65D 1/09(2006.01); B65D 25/20(2006.01); C08J 5/18(2006.01); C08L 67/00(2006.01); G09F 3/02(2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models: IPC as above
Japanese utility models and applications for utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal) & keywords: 폴리에스테르계 필름(polyester film), 용기(container), 재생(recycle), 테레프탈산(terephthalic acid), 에틸렌글리콜(ethylene glycol), 네오펜틸글리콜(neopentyl glycol), 폴리에스테르 칩(polyester chip)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2001-058622 A (TOYOBO CO., LTD.) 06 March 2001 (2001-03-06) See claim 1; and paragraphs [0038]-[0085].	1-4,8-12
Y		5-7,13-15
Y	KR 10-0981129 B1 (SKC CO., LTD.) 10 September 2010 (2010-09-10) See claim 2; and paragraphs [0020]-[0022].	5-7,13-15
A	JP 2003-122256 A (TOYOBO CO., LTD.) 25 April 2003 (2003-04-25) See paragraphs [0043]-[0064].	1-15
A	KR 10-2007-0007058 A (TOYO BOSEKI KABUSHIKI KAISHA) 12 January 2007 (2007-01-12) See claims 1-7.	1-15
A	JP 2014-065282 A (TOYOBO CO., LTD.) 17 April 2014 (2014-04-17) See paragraphs [0023]-[0034], [0103] and [0104].	1-15

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search **29 January 2021**	Date of mailing of the international search report **01 February 2021**
Name and mailing address of the ISA/KR **Korean Intellectual Property Office** **Government Complex-Daejeon Building 4, 189 Cheongsa-ro, Seo-gu, Daejeon 35208** Facsimile No. **+82-42-481-8578**	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2019)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 2001-058622 A	06 March 2001	JP 3932009 B2	20 June 2007
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		US 7344765 B2	18 March 2008
		WO 2005-063485 A1	14 July 2005
JP 2014-065282 A	17 April 2014	JP 6036099 B2	30 November 2016

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(54) Title: SHRINK WRAP LABEL COATING TO FACILITATE RECYCLING

(57) Abstract: The present invention discloses a method of enabling the easy separation of labels, including wrap around labels and sleeve labels, particularly shrink sleeve labels, from containers during recycling through the use of a specially formulated coating to be applied in the seam area. The coatings ensure proper bonding, and shrink properties, of the labels, and have been designed to help de-bonding of the seam in a hot caustic wash step, or a solvent wash step. The method does not rely on floatation separation and therefore may be applied to any container / label material combination regardless of their specific gravity differences.

SHRINK WRAP LABEL COATING TO FACILITATE RECYCLING

CROSS REFERENCE TO RELATED APPLICATIONS

[001] This application claims priority to U.S. Provisional Application Serial No. 61/868,261, filed August 21, 2013, which is hereby incorporated herein in its entirety.

FIELD OF THE INVENTION

[002] The present invention is in the field of materials and processes to enable the facile recycling of plastic containers. The present invention provides a coating to apply to labels, including wrap around and sleeve labels, particularly shrink wrap labels, for plastic containers to promote good bonding at the seam, with subsequent ease of recycling. The coatings of the invention are particularly useful for use on labels comprising polyethylene terephthalate (PET), glycol-modified PET (PET-G), polyolefins, cyclic polyolefins (COC) and alpha-polyolefins such as oriented polypropylene (OPP), oriented polystyrene (OPS) and polyethylene (PE), or polyvinyl chloride (PVC). Label substrates may be monolithic or multilayer and comprise one or more polymer layers typically produced via a co-extrusion process. The materials and processes of the invention enable good sealing, resistance to shrinking, and resistance to cold water, of the label applied to the container, while allowing efficient de-seaming and removal of the label during the recycling process.

BACKGROUND

[003] Recycling of plastic containers has become increasingly more popular over the last several years. However, while the plastic containers are recyclable, the materials used to make the shrink wrap labels applied to the containers are often not recyclable. Therefore, it is necessary to remove the shrink wrap label from a plastic container, or separate the label material from the container material, to allow recycling of the plastic container. When the labels are not easily separable from the containers, many containers are not recycled that otherwise would be, and recycling yields are reduced. Thus, there is a need to produce easily separable labels to increase the efficiency of recycling.

[004] The Association of Plastics Recyclers, guidelines from brand owners, and publications of the National Association for PET Container Resources (NAPCOR), are all pointing to the issue created by full body sleeve labels in the recycling system. The sleeves tend to obscure the automated detection systems during the sorting process. As a result, PET recycling facilities have seen decreasing yields as sleeved bottles tend to end up being separated from clear PET containers and discarded.

[005] To alleviate the problems with sorting, recyclers and brand owners tend to recommend paper labels, or partial sleeves made with low density thermoplastic materials, such as polyolefins. However, such materials do not have the desirable shrink properties or printability of higher density substrates such as PET-G.

[006] Moreover, there are currently certain restrictions when applying shrink wrap labels wherein the labels must be sealed at a seam to ensure a strong bond at the seam. For example, it is necessary to avoid printing in the margins of a shrink wrap structure prior to adhering or solvent-welding them together. In addition, it is necessary to clean or wipe the margins of the shrink wrap structure in the area to be seamed prior to adhering or solvent-welding them together.

[007] Shrink sleeve separation from PET containers is typically achieved in the sink/floatation tanks as part of the overall PET recycling process, starting from bales of PET containers and ending with clear recycled PET (R-PET) flakes to be re-used for container making. Several film/resin suppliers, including Exxon, Toppas, and Cryovac, or converters such as Fujiseal, have introduced low density films or co-extruded film structures with low density (below 1.0 or at least below 1.05), to address the shrink sleeve separation issue. Such films are generally based on mono- or multi-layer structures including polymers built around a low density core, such as polyolefins, or micro-voided/cavitated polymer, optionally wrapped by a PET-G skin, and, if needed, a tie layer between the core and the PET-G. The overall density of the film is designed to make it floatable in the sink/floatation tank. However, if the density prior to printing is not low enough, it is possible for the printed sleeve to become too dense, and therefore unable to be separated from the standard PET to be recycled.

[008] PET-G is the preferred material for shrink wrap labels. However, PET-G has a higher density (about 1.3), which hinders separation in the sink/floatation tanks. The density of PET-G may be reduced if voids are created in the extruded film. Incorporation of a blowing agent into a coating offers the advantage that the overall label structure can be significantly reduced in density after activation of the blowing agent by various means, and separated from the container by floatation in a suitable liquid. In principle, this will work both for an entire label, and a ground up mixture of label and container. A coating will show an advantage over an ink for two reasons. First, coating of the entire label means that the blowing agent will be evenly distributed over the label, so that no one area has a higher concentration of blowing agent. Conversely, when the blowing agent is incorporated into the ink printed only in selected areas, those areas will have a higher concentration of blowing agent. Because the blowing agent in a coating is more evenly distributed, it means that a smaller particle size and/or lower coat weight of blowing agent can be used, while still achieving the desired level of density reduction. This, in turn, means that a higher level of transparency, gloss, and slip can be maintained in the overall shrink label structure.

[009] Second, a 100%, even, coating of an entire label will give a consistent level of density reduction between different label designs, compared to an ink which may be printed at a wide range of percentage coverages. This simplifies and standardizes the recycling process.

[0010] Additionally, a micro-voided or cavitated film is opaque white, while a foamable coating approach may provide transparency or translucency. Blowing agents that generate a gas on exposure to heat, pH change, photonic radiation and/or thermal energy may comprise any of the types that are well-known to those of skill in the art (see, for example, http://en.wikipedia.org/wiki/Blowing_agent and http://www.eiwa-chem.co.jp/en/product/types.html). Blowing agents may also include metal carbonates and bicarbonates, azides, azodicarbonamide, and diazonium salts.

[0011] In addition, it is well known to those of skill in the art that inks can bleed through from their desired location, either into an undesired location on a printed article, or even onto the body parts of someone holding that article (which may be aided by a body fluid such as sweat or saliva). An appropriate coating may alleviate the problem of bleeding.

[0012] A coating that is a gas barrier may also be advantageous. Gas barrier coatings are known in the art. However, there are no known coatings that are gas barriers combined with the ability to work as "de-seamable" coatings to improve recycling.

[0013] Thus, there is currently no practical or economical solution built around printable materials to address the shrink sleeve issue in the PET recycling process. Manufacturers either must use less-preferred substrates that are less dense than PET-G, or move to more complex, and likely more expensive, floatable film structures. Therefore, there is a need to provide a method to produce labels that have good bond strength at the seams, while still being easily separable from the plastic container during the recycling process.

SUMMARY OF THE INVENTION

[0014] The present invention provides novel coatings for labels, including wrap around and sleeve labels, particularly shrink wrap labels, for containers. As used herein, the terms "coating," "coatings," "coating of the invention," or "coatings of the invention" mean liquid compositions that can be deposited on a substrate in various ways, including, but not limited to, printing (such as, but not limited to, analog or digital, inkjet, offset, flexographic, lithographic, gravure, screen printing), roll coating, spray coating, die coating, use of a liquid dosing system such as needle or wick deposition currently done for in-line seaming of shrink sleeve film, and the like. Also provided are methods and processes for application and use of the coatings of the invention. The coatings of the invention promote good bonding at the seam, with subsequent ease of removal for recycling of the containers. The coatings of the invention are useful for coating labels, including wrap around and sleeve labels, particularly shrink wrap labels, to be applied to plastic containers. The coatings of the invention are particularly useful for use on labels comprising PET, PET-G, polyolefins, cyclic polyolefins (COC) and alpha-polyolefins such as OPP and polyethylene (PE), OPS or PVC. Coatings of the invention enable good sealing, resistance to shrinking, and resistance to cold water, of the label applied to the container, while allowing efficient de-seaming and removal of the label during the recycling process.

[0015] In one aspect, the present invention provides a method comprising applying a coating composition to a label substrate wherein:

a) the label substrate is applied to a plastic article; and
b) the coating enables removal of the sleeve label during recycling.

[0016] In one aspect, the present invention provides novel coating compositions to produce de-seamable labels wherein:

a) the coating produces a bond strength of coating to substrate after seaming to the substrate, that is the greater 5 N/in or the tensile strength of the substrate;
b) the coating produces a bond that is suitable for hot shrinking around a container or article; and
c) the coating is delaminated when placed into a hot caustic environment.

[0017] In certain embodiments, the coating composition produces a bond strength of greater than 9 N/in of coating to substrate after seaming to substrate.

[0018] In another embodiment, the coating composition produces a bond strength of greater than 30 N/in of coating to substrate after seaming to substrate.

[0019] In one aspect, the present invention provides novel coating compositions as described above, comprising:

a) at least one first resin with a Tg above about 25 °C, and preferably above about 50°C;
b) at least one second resin hydrolysable or solutionable under the conditions of recycling; and

wherein the first and second resin may be the same or different.

[0020] In one embodiment, the coating forms a strong bond with the substrate via either a solvent or heat sealing process.

[0021] In one embodiment, the coating itself functions as a seaming material, so that no additional solvent or heat sealing process is necessary, and replaces the traditional seaming solvent.

[0022] In another embodiment, the coating compositions comprise at least one resin with a Tg above about 25 °C, and preferably above 50°C, selected from the group consisting of polyesters, nitrocelluloses, acrylics, styrenics, shellacs, and polyurethanes.

[0023] In certain embodiments, the coating compositions further comprise at least one second resin which is at least partially solutioned or hydrolysed in an aqueous medium at a pH of 12 or greater.

[0024] In another embodiment, the second resin is selected from the group consisting of polyhydroxycarboxylic acids, sulfopolyesters, acrylics, polymers containing sulfonamide functionality, and polymers with a hydroxyl level of about 50 or greater.

[0025] In one embodiment, the acid value of the coating composition based on dry film is greater than 20.

[0026] In a certain aspect, the present invention provides a shrink sleeve label film substrate coated with the coating of the invention.

[0027] In one embodiment, the entire shrink sleeve label film substrate is coated with the coating.

[0028] In another embodiment, the substrate is partly coated with the coating composition.

[0029] In another embodiment, the coating has been applied to the substrate as a pattern to create a partial coverage in the seam area.

[0030] In certain embodiments, the shrink sleeve label substrate is coated in at least the seaming area with a coating of the invention.

[0031] In certain embodiments, the present invention provides a shrink sleeve label substrate coated in at least the seaming area with two outer layers of coatings of the invention, wherein the combination is a coating system that is at least partially hydrolysable or solutionable under the conditions of recycling, comprising:

a) a first coating layer in contact with the sleeve film substrate comprising at least one resin with a Tg above 25°C, and preferably above about 50 °C; and
b) a second coating layer applied over the first coating layer;

[0032] In one embodiment, the first coating layer is further in contact with the inks printed on the substrate.

[0033] In one embodiment, the second coating layer is further in contact with the inks printed on the substrate.

[0034] In another embodiment, both the first coating layer and the second coating layer are further in contact with the inks printed on the substrate.

[0035] In one embodiment, the two coating layers provide a coating system that is at least partially hydrolysable or solutionable under the conditions of recycling.

[0036] In a certain aspect, the present invention provides an article comprising a sleeve label as described above.

[0037] In one aspect, the present invention provides a novel method to produce sleeves for labeling plastic containers that can be removed from the container during a hot caustic wash step in the recycling process.

[0038] In another aspect, the present invention provides a novel method to produce sleeves for labeling plastic containers that can be removed from the container during a solvent wash step in the recycling process.

[0039] In one embodiment, the method to produce sleeves for labeling plastic containers that can be removed from the container during a hot caustic wash step or solvent wash step in the recycling process, comprises applying a coating of the invention to the sleeve label substrate.

[0040] In certain embodiments, the sleeves are removed by de-seaming from the container.

[0041] In one aspect, the present invention provides an article wrapped with a sleeve label applied as described above.

[0042] In one embodiment, the label separates from the article when the article is placed into a hot caustic wash.

[0043] In another embodiment, the label is comprised of a seamed substrate.

[0044] In another embodiment, the seamed substrate is a plastic substrate.

[0045] In certain embodiments, the label separates in less than 5 minutes at 65°C.

[0046] In another embodiment, the label separates in less than 3.5 minutes at 65°C.

[0047] In another embodiment, the label separates in less than 2 minutes at 75°C.

[0048] In another embodiment, the label separates in less than 1 minute at 85°C.

[0049] In certain embodiments, the sleeve label on which a coating of the invention has been applied can be de-seamed with a solvent. Suitable solvents include, but are not limited to, acetates, such as methyl acetate, ethyl acetate, and the like.

[0050] In one embodiment, the label is a full wrap label.

[0051] In another embodiment, the label is a partial wrap label.

[0052] In certain embodiments, the label is a shrink wrap label.

[0053] In certain embodiments, a coating composition that is not a hot melt glue or a water soluble adhesive composition is applied to the label.

[0054] In certain embodiments, the coating composition comprises the coating composition described above.

[0055] In one embodiment, the article is a plastic article.

[0056] In certain embodiments, the coatings of the invention can be adjusted to have a higher content of solids, to provide coatings suitable for seaming of in-line wrap around labels that are placed and seamed directly onto the containers. In some embodiments, the label film is coated in the target area with a coating of the invention, wrapped around a container, and heat-sealed onto the container. Labels so applied will de-seam from the containers when the containers are placed in a hot caustic bath. By seaming the labels directly onto the containers, an additional shrink step would not be necessary. Compared to containers affixed with a label seamed with hot melt glue, the containers of these embodiments would have higher heat resistance, which is an advantage for hot filling of containers. Compared to wrap around labeled containers seamed with water-based adhesives, the containers seamed according to these embodiments would have improved resistance to a water bath (such as when beverage containers are immersed in cold water for extended periods of time).

DETAILED DESCRIPTION OF THE INVENTION

[0057] The present invention provides novel coatings for labels, including wrap around and sleeve labels, particularly shrink wrap labels, for containers. The coatings of the invention promote good bonding at the seam, with subsequent ease of removal for recycling of the containers. The coatings of the invention are useful for coating labels, including wrap around and sleeve labels, particularly shrink wrap labels, to be applied to plastic containers. The coatings of the invention are particularly useful for use on labels comprising PET, PET-G, polyolefins, cyclic polyolefins (COC) and alpha-polyolefins such as OPP and polyethylene (PE), OPS or PVC. Coatings of the invention enable good sealing, resistance to shrinking, and resistance to cold water, of the label applied to the container, while allowing efficient de-seaming and removal of the label during the recycling process.

[0058] The present invention provides a way to easily separate sleeve labels from containers, such as PET bottles, during recycling, without adding special manual or mechanical removal equipment, and while maintaining sufficient bond properties within the sleeve to allow it to perform as a standard sleeve. Moreover, the coatings and methods of the present invention are not substrate limited. That is, the coatings and methods of the invention work with low or high density substrates such as polyolefins or PET-G. Additionally, the coatings of the invention may help protect the ink layers and minimize or eliminate the ink bleeding into the water/caustic used for recycling.

[0059] Another optional benefit of the invention is that, contrary to what is currently done to achieve good bonds, the sleeves may now be printed with graphics that include the seaming area. Using the methods currently used in the industry, precisely positioning the unprinted seam with regard to the graphics creates additional challenges for the label converters from printing through splitting and cutting. The coatings of this invention are designed to provide good bonds between the coating and the substrate (such as PET-G) even when there is printing in the seam.

[0060] The present invention relates to novel coating compositions for use with labels, including wrap around and sleeve labels, particularly shrink sleeve labels, that will allow for an easy separation of the label from the container during recycling, and, in particular, during the hot caustic wash step, or a solvent wash step. The method of separating the label from the container comprises applying a bondable, caustic de-seamable, coating layer of the invention in the seam area.

[0061] Although prior art teaches that sleeve labels must be printed such that the seam area remains free of ink or coating to ensure good solvent bondability, the coatings of the invention were developed to provide good bond strength for solvent seamed sleeves. In certain embodiments, the coatings of the invention were developed to themselves function as a seaming material, eliminating the need for the additional step of applying a separate seaming solvent, and replace the traditional seaming solvent, to form the seam of the sleeve label.

[0062] Good bonds are defined by the bond strength values measured by pulling perpendicularly to the seam direction and measuring the force necessary to separate the seam. Typical solvent bonds in shrink sleeve labels have a bond strength of 9.8 N/in to 34 N/in (see for example US 2008/0197540). The seamed samples are cut into 3/16 inch to 1-inch wide strips, and the ends are held by clamps. An Instron tensiometer is used to measure the force required to break the bond at a pulling speed of 15 cm/min. The results are expressed in N or N/in. In the present case, “good” bonds may be defined as bond strength values greater than 5 N/in, or preferably greater than 9 N/in, or more preferably greater than 30 N/in as measured at room temperature.

[0063] Suitable compositions of the invention form a coating layer onto the desired label substrate and provide good bond strength via a solvent or heat seaming process, or to function as a coating and seaming material in one step (without the need for an additional step of applying seaming solvent), replacing the traditional seaming solvent, to form a sleeve. Coatings of the invention withstand the heat shrinking process, whereby the labels are shrunk to fit snugly around the container, providing a seam with sufficient strength to hold the label around the container. During heat shrinking, heat may be applied through a steam tunnel, an IR tunnel, a convection tunnel, or by direct exposure to hot air. Typical temperature and residence time depends on the material, container shape, desired shrink rate, and the technique used to provide the heat. For example, a steam tunnel used for PET-G sleeves reaches between 70°C and 95°C, with a residence time typically between 5 and 8 seconds, which is enough to achieve up to 75%

shrink rate. There may also be a 15 second dip in 85°C water post shrinkage for PET-G sleeves. Coatings of the invention are also resistant to cold water.

[0064] Coatings of the invention will de-seam when placed in hot caustic environments, such as those used during the whole container washing step that is part of the recycling process. The washing step is generally done at 85°C to 90°C, with 2% to 3% NaOH.

[0065] In certain embodiments, coatings of the invention will de-seam when placed in a solvent wash.

[0066] The sleeves used to perform the seaming and forming tests were sized according to common practices for shrink labels in the industry. A typical sleeve for solvent seaming would be slit to provide a total length equal to the largest perimeter of the container plus 7 mm to account for the seaming area and overlap. A 7 mm margin typically provides a wide enough area for a good seam, but also a snug fit around the container at the largest perimeter in order to keep the sleeve in place during the hot shrinking process. Additional margin may be added to account for shrinkage due to thermal processes (such as the drying of the coating) which may induce some additional shrinkage. A larger sleeve may be used around a container to provide a desired effect such as a looser fit after shrinkage.

[0067] In one embodiment, the coatings of this invention comprise at least one resin with a Tg above about 25°C, preferably above about 50°C, more preferably above about 65°C, and most preferably above about 80°C, and one resin that is either hydrolysable or soluble in hot caustic solution. The first and second resin may or may not be the same. Hydrolysable or soluble resins include resins with an acid value greater than or equal to 4 (and preferably greater than or equal to 15, and more preferably greater than or equal to 25), resins with hydroxyl values greater than 5, and resins which will break down in hot caustic environments, such as polylactic acid. The coatings may be solvent based or water based, or use water/solvent mixtures, such as water/alcohol compositions. Examples of suitable resins, as identified in the examples, include certain polyesters, polyurethanes and also polyvinylalcohol and blends thereof.

[0068] In another embodiment, the de-seaming coatings are a blend of polyester resins comprising a resin with a Tg above about 25°C, preferably above about 50°C, more preferably above about 65°C, and most preferably above about 80°C, and a resin with a Tg below about 35°C having high acid group functionalities. In yet another embodiment, the de-seaming coating further comprises a polymer which decomposes in hot caustic environments, such as polylactic acid.

[0069] De-seaming coatings are generally applied onto the reverse side of the sleeve label substrate (which may be pre-treated with an antistatic coating to prevent dust accumulation during printing and handling). Inks are also generally applied on the reverse side, except when the sleeve substrate is opaque, in which case the inks are surface printed. The coatings will be applied over at least a portion of the seaming area. They may be applied over the entire sleeve or have only a partial coverage. They may be applied as a uniform coating or in the form of a pattern of halftone designed to provide a suitable balance of seaming, shrinking and de-seaming properties. They may be allowed to overlap the inks. In one embodiment, the inks may be printed to the edge of the sleeve and be overprinted with the coating in the seaming area while still allowing suitable seaming, shrinking and de-seaming properties.

[0070] Coatings are preferably applied through a printing process, such as gravure or flexographic printing, but other deposition methods, such as roll, spray, die coating, dosing via needle or wicking, or screen printing may be possible by adjusting the coating composition to the rheology required for proper deposition for a particular technique.

[0071] Coating weight depends on the deposition technique used but will generally be in the range of 0.5 to 10 g/m^2 dry, more preferably between 1 and 6 g/m^2, and even more preferably between 1.5 and 4 g/m^2.

[0072] The coating compositions may optionally contain a colorant, such as a dye, a pigment, a taggant, or a fluorophore, to provide means to visualize the deposition or warn end users about the presence of a special de-seaming coating on the label.

[0073] In order to ensure good handling and easy fitting of the sleeves onto containers, the coatings will typically have a coefficient of friction at or below 0.3, preferably between 0.10 and 0.40, and more preferably between 0.15 and 0.35.

[0074] In order to achieve the desired printing, seaming, shrinking and de-seaming properties, one or more coating layers may be used. In one embodiment, a first coating layer which is hydrolysable, degradable or soluble in a hot caustic environment, is applied and overprinted with a second coating layer designed to ensure good seaming characteristics for sleeves. Alternatively, the coating layers may be reversed, wherein the first coating layer is designed to ensure good seaming characteristics for sleeves, and the second coating layer is hydrolysable, degradable or soluble in a hot caustic environment. After application of the two coating layers, the sleeve seam may be bonded via a solvent or heat sealing process; or the coating layers/system may additionally function as a seaming material, and replace the traditional seaming solvents.

[0075] As illustrated in the examples, the methods of this invention apply not only to PET-G sleeves, but also to other substrates, such as OPP, PVC, or OPS, either as monolithic substrates or multilayer structures, whether they are homogenous in composition or comprise layers of different compositions (such as PETG/OPS/PETG or PETG/OPP/PETG based structures or similar co-extruded structures further comprising tie-layers).

[0076] In one embodiment, the de-seaming coating comprises one or more renewable resins. Non-limiting examples of such resins include polylactic acid and/or a coating grade of recycled polyester such as JD2-25.

EXAMPLES

[0077] Tables 1 and 2 summarize the key properties and source for the materials used in Examples 1-5. Coating solutions were formulated by adding solvent to the resin, or to the resin varnish if the polymer was already supplied in solution form. For the tests, all samples were reduced to about 50 cps viscosity, as measured using a Brookfield spindle viscometer at approximately 20°C. Polyurethane resins, polyester resins, and nitrocellulose were viscosity adjusted by addition of ethyl acetate. Shellac resin and polyvinylalcohol (Aquaseal X2281) were viscosity adjusted by adding ethanol. The seams in Examples 1-5 were formed by either a traditional solvent or heat sealing process.

Table 1: Polyurethane resin materials used in this invention

I.D	**Solids**	**Viscosity**	**Solvents**	**Tg (°C)**	**Acid Value mg KOH/g**	**Amine Value mg KOH/g**	**OH Value mg KOH/g**	**Mw Mn Pd**	**Building Blocks**
940-1071	32.0 - 35.0%	300 – 600 cps	1 : 1 (n-propanol : n-propyl acetate)	-36 & 41	0	3 - 8	0	24,000 13,200 1.8	IPDI 1,4 BD pTHF EDA
940-1133	49.0 – 51.0%	550 – 900 cps	1 : 1.25 (n-propanol : n-propyl acetate)	60	34 – 41	0	0	8,600 4,075 2.10	IPDI DMPA Dimer Diol MP Diol
940-1205	52.0 - 54.0%	250 – 450 cps	30 : 70 (n-propanol : n-propyl acetate)	49	3.6	0	277	1,986 1,131 1.76	IPDI TMP 1,4 BD
940-1151	33.0 - 36.0%	900 – 1,300 cps	1 : 1 (n-propanol : n-propyl acetate)	-22 & 81	2.6	5 – 12	0	24,761 15,194 1.63	IPDI 1,4 BD pTHF EDA
940-1033	29.5 – 33.0%	300 – 800 cps	1 : 1 (n-propanol : n-propyl acetate)	8.5 & 41	0	3 - 8	0	32,400 16,300 2.01	IPDI TDI 1,4BD pTHF EDA

IPDI: isophorone diisocyanate

TDI: toluene diisocyanate

1,4-BD: 1,4-butanediol

DMPA: Dimethylol propionic acid

EDA: Ethylene diamine

TMP: Trimethylol propane

MP Diol: 2-methyl-1,3-propanediol

Table 2: Other polymers used in the examples

Resins	**Chemistry**	**Supplier**	**Tg (°C)**	**Mn**	**OH Value mg KOH/g**	**Acid Value mg KOH/g**	**%Solids**
Vyloecol BE-400	Polylactic acid	Toyobo (JP)	50	43,000	3	-	100
3-V-6	Nitrocellulose varnish	-	-	-	-	-	38.5
Vylon 200	Polyester	Toyobo (JP)	47	17,000	5	<2	100
Vylon GK-360	Polyester	Toyobo (JP)	56	16,000	7	5	100
Vylon GK-390	Polyester	Toyobo (JP)	17	-	-	30	100
Vylon GK-800	Polyester	Totobo (JP)	50	18,000	7	<2	100
Aquaseal X2281	PVOH aq. dispersion	Paramelt (Netherlands)	~ 85	-	-	-	20
Gantrez ES225	Monoethyl ester of poly(methyl vinyl ether / maleic acid) in ethanol	Ashland, Inc. (Covington, KY- USA)	-	-	-	275 - 300	50
Mowital B30H	Polyvinylbutyral	Kuraray Europe GmbH (Germany)	68	-	18 – 21% (1)	-	100
JD2-25 R-PET	Polyester	Sun Chemical (internal sample)	31.2	6,150	100	36	100

Resins	**Chemistry**	**Supplier**	**Tg (°C)**	**Mn**	**OH Value mg KOH/g**	**Acid Value mg KOH/g**	**%Solids**
Tigerlac 5055	Shellac resin	Kane Int. Corp (Rye, NY – USA)	-	-	175 - 240	60 - 75	100

% hydroxyl expressed as the wt% of polyvinylalcohol in material

[0078] Coatings were applied to the reverse (print) side of the substrates with a #2 K Bar using a K-Coater (from RK Printcoat Instruments Ltd., Royston - United Kingdom) unless otherwise specified.

[0079] Films were then seamed with solvent so that the coated side faced the uncoated side (front side of the substrate). Suitable solvents include, but are not limited to, those sold for the purpose by Flexcraft Industries, Inc. of Newark, NJ, USA, such as Flexcraft 12-103 OB, a solvent blend comprising tetrahydrofuran (THF) as a major component. The seaming solvent composition may be optimized to provide the best seam strength given a specific substrate while meeting industrial application requirements in terms of evaporation speed, flash point, stability and toxicity. For seaming films composed of PET-G, solvent blends comprising THF are commonly used, but other solvents may be employed advantageously in conjunction with other shrink wrap substrates.

[0080] The solvent was applied using a solvent pen (felt tip) in combination with a manual seaming machine made by Ryback & Ryback (Monroe, NC, USA). This formed a sleeve label which was then placed around a blank bottle and shrunk with the heat produced either by a hot air gun, via immersion in hot water (95°C) bath, or by using a steam pot, for 5 to 10 seconds, depending on the technique. Sleeves were generally allowed to rest overnight in order to ensure that the solvent had fully evaporated before shrink tests.

[0081] For the above test, the PET bottle container used had an outer diameter of about 2.8 inches and a circumference of about 9 inches. The seam area on the sleeve label had a length of 6 inches and the sleeve was seamed to provide a snug fit around the bottle with a seamed sleeve perimeter of about 9.25" leaving about 7 mm for the seam area and ink overlap.

[0082] The labels were then checked after shrinking to see if the seam stayed intact (ie., passed the test) or came apart (failed). The seamed bottles that passed were then placed into plain hot water at 85°C for 15 seconds to assess the sensitivity of the seal to potential overexposure in the steam tunnel.

[0083] Finally, the sleeved bottles that had passed all the other tests were placed into a water bath containing 2% aq. NaOH at 85°C to simulate the recycling "bottle wash" conditions and timed to determine how long it would take for the seam to come apart.

[0084] Bond strength of the seamed area in the shrink direction was determined by making a solvent seam between the coated side of the film and the uncoated side using 1-inch wide samples. The ends of the print were then placed into an Instron Tensiometer (model number 3342 made by Instron in Norwood, MA - USA) and pulled in a direction perpendicular to the seam direction at a speed of 15 cm/min.

Example 1:

[0085] Coatings based on different resin compositions and their blends were applied to a freshly corona treated shrink grade PET-G film substrate (Eastman Embrace film / 50-micron thick) and tested for seaming performance. Samples that passed the seaming tests were then evaluated for shrink performance around a bottle container, and then, if applicable, de-seaming performance and hot non-caustic bath resistance test as described above. The solvent used for the seaming experiments was a custom mixture of Flexcraft 12-103 OB, a solvent blend available from Flexcraft Industries, Inc., and comprising1,3-dioxolane, tetrahydrofuran, and xylenes, blended with additional tetrahydrofuran (in a ratio of 85:15). The results are shown in Table 3.

Table 3: Results of seaming, shrink and de-seaming experiments with various compositions

Resin in Coating Sample	**Label Substrate**	**Bond Strength (N / inch)**	**Seaming Solvent**	**Shrink test around container**	**De-seaming (hot caustic bath)**	**Hot Water Bath resistance test**
940-1133	PET-G	5	85% 12-103OB:15% THF	Seam Separated	-	-
940-1205	PET-G	5	85% 12-103OB:15% THF	Seam Separated	-	-
Tigerlac 5055	PET-G	0.5	85% 12-103OB:15% THF	Seam Separated	-	-
JD2-25 R-PET	PET-G	7	85% 12-103OB:15% THF	Seam Separated	-	-
Vyloecol BE400	PET-G	5	85% 12-103OB:15% THF	Seam Separated	-	-
Vylon 880	PET-G	12	85% 12-103OB:15% THF	Seam Separated	-	-
Vylon 390	PET-G	8	85% 12-103OB:15% THF	Seam Separated	-	-
Vylon 360	PET-G	6	85% 12-103OB:15% THF	Seam Separated	-	-
940-1133/940-1205 (1:1 blend)	PET-G	6	85% 12-103OB:15% THF	Seam Separated	-	-
3-V-6 (NC)	PET-G	7	85% 12-103OB:15% THF	Seam Separated	-	-
940-1133/3-V-6 (1:1 blend)	PET-G	8	85% 12-103OB:15% THF	Seam Separated	-	-
JD2-25/Vyloecol BE400	PET-G	10	85% 12-103OB:15% THF	Seam Separated	-	-
JD2-25/940-1133 (1:1 blend)	PET-G	49	85% 12-103OB:15% THF	Seam Intact	Deseamed <10secs	Seam Intact
940-1133/JD-225 (1:1 blend)	PET-G	42	85% 12-103OB:15% THF	Seam Separated	N/A	N/A
Vylon 360/Vylon 390 (blend 1:1)	PET-G	50	85% 12-103OB:15% THF	Seam Intact	Deseamed <10secs	Seam Intact
Vylon 390/Vylon 880 (1:1 blend)	PET-G	48	85% 12-103OB:15% THF	Seam Intact	Deseamed <10secs	Seam Intact

Resin in Coating Sample	**Label Substrate**	**Bond Strength (N / inch)**	**Seaming Solvent**	**Shrink test around container**	**De-seaming (hot caustic bath)**	**Hot Water Bath resistance test**
Mowitol B30H	PET-G	6	85% 12-103OB:15% THF	Seam Separated	N/A	N/A
940-1071	PET-G	9	85% 12-103OB:15% THF	Seam Separated	N/A	N/A
940-1151	PET-G	7	85% 12-103OB:15% THF	Seam Separated	N/A	N/A
Gantrez ES-225	PET-G	4	85% 12-103OB:15% THF	Seam Separated	N/A	N/A
Aquaseal X2281	PET-G	45	85% 12-103OB:15% THF	Seam Intact	Deseamed <10secs	Seam Intact

[0086] Note: Bond strengths were measured with Instron Tensiometer model 3342 using 1 inch-wide (2.54 cm) samples and a speed of 15 cm/min.

[0087] 12-103OB is THF-based solvent blend made by Flexcraft Industries, Inc. (Newark, NJ – USA) which is commonly used for seaming PET-G sleeves.

[0088] For the selected combination of film substrate and seaming solvents, only a few coating compositions provided seams with the desirable combination of properties, which include high Instron bond strength values, and remained intact after the shrink test, but also delaminated in a hot caustic bath. Polyester coating compositions appeared to provide the best performance in the test, either alone, or as a blend with a polyurethane resin. In particular, the blend of a higher Tg polymer (polyester, acrylic, styrenic, nitrocellulosic or polyurethane), and lower Tg polyester with a higher acid value seemed the most effective for solvent-based coating compositions. The improved performance of polyester blends compared with single resins is not completely unexpected as combinations of high and low Tg polymers usually provide better film formation and general coating properties.

[0089] Additional examples not reported in Table 3, wherein polylactic acid (VyloEcol BE-400 from Toyobo JP) was added as a minor component up to 20wt% to polyester compositions, providing good bond strength such as 1:1 mixtures of Vylon 360 and 390 or Vylon 390 and 880, also resulted in compositions having the desired properties for the de-seamable coatings. The introduction of additional material hydrolysable under the conditions of recycling, usually comprising treatment with an aqueous medium of pH 12 or greater, such as polylactic acid, appeared to help accelerate de-seaming in the hot caustic bath, and also reduce the coefficient of friction from about 0.30 (static) and 0.26 (kinetic) to 0.21 (static) and 0.19 (kinetic). Other polyhydroxycarboxylic acids, such as polymers derived from caprolactone, are also of benefit, as are polymers with a hydroxyl value of 50 or greater, such as polyvinyl alcohols, starches and cellulosics, sulfopolyesters, acrylics, and polymers containing sulfonamide functionality. Note that a coefficient of friction (CoF) of 0.3 or less is desirable for shrink sleeves to provide suitable performance on shrink labeling production equipment. The CoF was measured with an instrument from Testing Machines, Inc., of New Castle, DE 19720, USA , model number 32-06-02, equipped with a 200 gram weight and of weight dimensions: 2 1/2 in by 2 1/5 in, at a speed setting of 6. The results in Table 3 also show that the water based polyvinyl alcohol composition tested (which comprised at print viscosity 11wt% solids, 46wt% water and 43wt% alcohol), and which was applied with a # 2 K-bar, provided suitable properties for the de-seaming coatings.

[0090] In summary, example 1 shows that de-seaming coatings may be formulated as either solvent-based or water-based compositions, and emphasizes the need to have at least one resin with a Tg of over 50°C, and a hydrolysable or high acid value resin.

Example 2:

[0091] Additional experiments were carried out with different substrates (PET-G, OPP and PVC) using pure Flexcraft 12-103 OB as the seaming solvent. Interestingly, some compositions, such as a polyurethane system, provided better performance on OPP and PVC than on PET-G. Also, the water-based coating made from polyvinylalcohol, which exhibited excellent results on PET-G, did not perform well on OPP and PVC. The results are shown in Table 4.

Table 4: Results of seaming, shrink and de-seaming experiments with various compositions

Substrate	Coating	Bond Strength (N / inch)	Seaming Solvent	Shrink Test	Hot Water Bath	De-seaming (hot caustic)
OPP	940-1133	41	12-103 OB	Seam Intact	Seam Intact	<30 seconds
PVC	940-1133	50	12-103 OB	Seam Intact	Seam Intact	<30 seconds
PVC	Vylon 360 / Vylon 390	39	12-103 OB	Seam Intact	Seam Intact	<30 seconds
PET-G	940-1133	1	12-103 OB	Poor Seam / separated	N/A	N/A
OPP	Aquaseal	1.4	12-103 OB	Seam separated	N/A	N/A
PVC	Aquaseal	10	12-103 OB	Seam separated	N/A	N/A
PVC	Aquaseal	1	12-103 OB	Seam separated	N/A	N/A
PET-G	Aquaseal	50	12-103 OB	Seam Intact	Seam Intact	<30 seconds
PET-G	None (control)	50	12-103 OB	Seam Intact	Seam Intact	>10 minutes

[0092] These results show that the de-seamable coating concept can be applied to other shrink label substrates besides PET-G, such as OPP and PVC, with the proper selection of resin systems for adhesion as well as seaming characteristics. Any structure based on these materials either as monolayers or multilayers, homogenous or heterogenous, may be a candidate to create de-seamable sleeves via selection of an optimized coating composition to be applied at least in the seaming area.

Example 3:

[0093] A coating based on a combination of polyester resin (Vylon 360 / Vylon 390) at a ratio of 9:1 was tested for performance on printed and unprinted PET-G shrink sleeves. The coating, adjusted to a viscosity of about 50 cps, was applied with a #2 K-bar. Seaming was performed with Flexcraft 12-103 OB solvent. On both substrates, the coating provided acceptable seaming and shrinking performance, and was able to de-seam in less than 4 minutes when placed in a hot caustic bath.

[0094] Similar experiments were performed with a combination of polyester resin (Vylon 360 / Vylon 880) at a ratio of 1:1 applied with a #2 K-bar on top of printed and unprinted PET-G sleeves. Seaming was performed with Flexcraft 12-103 OB solvent. On both substrates, the coating provided acceptable seaming and shrinking performance and was able to de-seam in less than 4 minutes when placed in a hot caustic bath.

Example 4:

[0095] PET-G shrink label film samples, some of which were printed with inks, were coated with a first hydrolysable coating comprising a primary resin with a Tg above 50°C. A second coating, selected for its solvent seaming characteristics to the substrate (such as a polyester), was applied on top of the first coating. The combination of the two coatings produced good solvent seaming characteristics and fast de-seaming in the hot caustic bath during the recycling wash step.

Example 5:

[0096] Using a structure similar to example 4, a first hydrolysable coating was applied onto the substrate followed by a second coating selected for its heat sealing properties. The sleeve was then formed using a heat sealing process to form the seam (solventless process) and then shrunk around the container/article. The combination of the two coatings produced good heat seaming characteristics and fast de-seaming in a hot caustic bath during the recycling wash step.

Examples 6-8:

[0097] Inventive coatings were made wherein the coating additionally functioned as a seaming material, replacing traditional seaming solvents, and eliminating the need for an additional step of solvent or heat sealing. The coatings of Examples 6-8 provided strong bonds, and were easily de-seamable during a hot caustic wash step. Table 4 lists material characteristics of representative components used in Examples 6-8. Table 5 shows non-limiting examples of coating solutions which would replace the traditional seaming solvent.

[0098] In general, test methods followed standard ASTM procedures wherever possible. Because of the small size of some of the samples, or equipment limitations, however, some minor modifications to the ASTM procedures were required.

[0099] The solids content of the coating solutions was determined by weight difference before, and after evaporating solvent by heating a 10 g sample at 150°C for 30 min.

[00100] Viscosity was measured by a Brookfield DV-E viscometer with spindle LV-1(61) at 60 rpm, and approximately 20°C. The viscosity of the coating solutions were adjusted to about 25 to about 50 cps.

[00101] "T-peel" bond strength of the seam was measured along the direction of seaming using Instron Model 3342 single column universal testing system, with a load of 50 N and crosshead speed of 300 mm/min, following ASTM Method D1876. The average peeling load at average value (integral) was determined from the autographic curve between the first and last peaks. The "T-peel" bond strength is the average peeling load in gram-force per in (or Newton per inch) of the seam width required to separate the adhered sleeves.

[00102] Break strength of the seam in the shrink direction, (perpendicular to seaming) was measured by the same general method as "T-peel" bond strength. Break strength is the maximum peeling load in gram-force per inch (or Newton per inch) of the seam width, and is the load required to separate the adhered sleeves.

[00103] Shrink test was performed by immersing a blank bottle wrapped with a seamed shrink sleeve into a Ryback and Ryback S3 steam machine for 5-10 seconds, depending on the technique. It is considered a pass if the sleeve shrinks snuggly around the bottle and the seam stays intact coming out from the steam pot.

[00104] De-seaming was measured by immersing the sleeved bottle into a water bath containing a caustic solution at a temperature which is aimed at simulating the conditions of a full bottle (pre) wash process used in typical wet grinding PET recycling. Unless specified otherwise, the conditions of the bath were 1 wt% NaOH at 65°C. The de-seaming time was the time measured between the immersion of the bottle into the caustic until the sleeve label fully separated from the bottle.

Table 4: Components used in Examples 6-8

	Mn ($x10^3$)	**Mw ($x10^3$)**	**Tg (°C)**	**Ring & Ball Softening Point (°C)**	**Acid Value (KOH mg/g)**	**Hydroxyl Value (KOH mg/g)**
Vylon GK880	18	N/A	84	N/A	< 4	5
SMA 2625	3.6	9.0	110	N/A	220	N/A
r-PET JD-2-25	1.4	6.2	31	N/A	36	100
Foralyn 90	N/A	N/A	N/A	82	8	N/A

Vylon GK880 is amorphous copolyester (Tyobo)

S2625 is partially esterified styrene maleic anhydride copolymer (Cray Valley)

r-PET JD-2-25is a proprietary recycled PET (Sun Chemical)

Foralyn 90 is an ester of hydrogenated rosin (Eastman Chemical)

[00105] Examples 6-8 were used to form a continuous, adhesively bonded seam at the overlapped longitudinal edge portions of PET-G shrink sleeves. Seaming was performed by a Stanford AccraSeam™ shrink sleeve seamer. The line speed was 300 m/min. The DSS volume set point was 36 ml/min for Examples 6 and 7, and 20 ml/min for Example 8. The width of the seam was about 3-3.5 mm. All tests on seamed shrink sleeves were taken at least 3 hours after seaming. The properties of Examples 6-8, and shrink sleeves seamed by them, are summarized in Table 6.

Table 5: Coating solutions

	Example 6	**Example 7**	**Example 8**
Vylon GK880	18	16.5	18
SMA 2625	3	4.5	3
r-PET JD-2-25	3	3	3
Foralyn 90	3	3	3
SAIB-90EA		1	1
EtOAc	42	41	20

	Example 6	Example 7	Example 8
MeOAc	21	21	
THF	10		5
1,3-dioxolane		10	
Acetone			47
Total	100	100	100

SAIB-90EA is a plasticizer solution comprising 90% sucrose acetate isobutyrate and 10% ethyl acetate (Eastman Chemical)

Table 6: Testing of Examples 6-8 coating solutions:

	Example 6	Example 7	Exmaple 8
Solids content (%)	29	31	22
Viscosity (cP)	32	30	25
Acid number of the solution (KOH mg/g)	9	12	9
Acid number of the solids (KOH mg/g)	32	44	32
T-peel strength of seam	271 gf/in (2.7 N/in)	262 gf/in (2.6 N/in)	152 gf/in (1.5 N/in)
Break strength of seam	21.6 kgf/in (212 N/in)	19.2 kgf/in (188 N/in)	18.3 kgf/in (179 N/in)
Shrink test	Pass	Pass	Pass
De-seaming time at 65°C (min:seconds)	6:25	3:56	7:50
De-seaming time at 75°C (min:seconds)	1:57	0:35	0:49

[00106] Examples 6-8 show that coatings of the invention can replace traditional seaming solvents, providing good bond strength, while being easily de-seamable during the recycling process.

<u>Example 9 (Comparative Example):</u>

[00107] A comparative example was made wherein a commercial seaming solvent, 12-103 (Flexcraft), was used in place of a coating solution of the invention to seam the shrink sleeves (i.e. seaming done in the traditional manner as found in the prior art). The seaming procedures and measurement conditions were the same as for Examples 6-8. Table 7 shows the test results.

Table 7: Testing of Comparative Example 9

	Comparative Example 9
Solids content (%)	0
Viscosity (cP)	1
Acid number of the solution (KOH mg/g)	0
Acid number of the solids (KOH mg/g)	0
T-peel strength of seam	821 gf/in (8 N/in)
Break strength of seam	23.7 kgf/in (232 N/in)
Shrink test	Pass
De-seaming time at 65°C) (min:seconds)	Cannot de-seam within 60 min
De-seaming time at 75°C (min:second)	Cannot de-seam within 60 min

[00108] Table 7 shows that although traditional solvent seaming provides good bond strength, the shrink sleeve wraps so produced are not easily de-seamed. Therefore, the coatings of the invention are superior in that they not only provide good bond strength, but also produce sleeves that are easily de-seamable in the hot caustic wash step of the recycling process, allowing for more efficient recycling of PET bottles.

Examples 10-12:

[00109] The coatings of Examples 10-12 were applied to PET-G sleeves that were subsequently heat-seamed. The coatings of Examples 10 and 11 provided strong bonds, and were easily de-seamed during a hot caustic wash step. Table 8 lists the compositions of Examples 10-12.

Table 8: Compositions of Examples of 10-12

	Example 10	**Example 11**	**Example 12**
Vylon GK880			9
Vylon GK800			9
Vylon 200		10.5	
SMA 2625			3
r-PET JD-2-25	27	16.5	3
Foralyn 90			3
SAIB-90EA	1		
EtOAc	10	41.5	
MeOAc	62	31.5	63
1,3-Dioxolane			10
Total	100	100	100

[00110] The coatings of Examples 10-12 were applied onto freshly corona-treated shrink grade PET-G film substrates with a #2 K-bar. After fully drying, the coated films were heat seamed using a Uline Impulse Sealer H-190, with a heat setting of 3.5 for 1.5 seconds. Break strength of the seams were measured on 1 inch seamed strips cut from the film by Theller Mini Tensile Tester Model D. The procedures for the shrink and de-seaming tests were the same as described in Examples 6-9. Table 9 shows the test results.

Table 9: Properties of coatings of Examples 10-12, and corresponding shrink sleeves

	Example 10	**Example 11**	**Example 12**
Solids content (%)	28	27	27
Dry coat weight (gsm)	2.2	3.0	1.8
Acid number of the solution (KOH mg/g)	10	6	8
Acid number of the solids (KOH mg/g)	36	22	31
Break strength of seam	3.3 kgf/in (33 N/in)	8.3 kgf/in (82 N/in)	2.2 kgf/in (22 N/in)
Shrink test	Pass	Pass	Pass
De-seaming time at 65°C (min:seconds)	< 2 min	3:30 min	> 25 min

[00111] Examples 10-11 show that coatings of the invention can be used in heat seam applications, providing good bond strength, while being easily de-seamable during the recycling process. Example 11 is particularly suitable as de-seamable coating due to the presence of a higher Tg resin in the composition.

<u>Example 13 (Comparative Example):</u>

[00112] A comparative example was made wherein an uncoated PET-G film substrate (Eastman Embrace film / 50 microns thick) was heat-seamed, and tested using the same procedures as described for Examples 10-12. The results are shown in Table 10.

Table 10: Testing of Comparative Example 13

	Example 13
Break strength of seam	3.0 kgf/in (29 N/in)
Shrink test	Pass
De-seaming time at 65°C (min:seconds)	Cannot de-seam within 60 min

[00113] Table 10 shows that the uncoated PET-G shrink film was unable to de-seam in the hot caustic condition, although its seam strength was comparable to Examples 10-11. Therefore the coatings of the invention are superior in that they not only provide good bond strength, but also produce heat-seamed sleeves that are easily de-seamable in the hot caustic wash step of the recycling process, allowing for more efficient recycling of PET bottles.

Example 14:

[00114] The coatings of Examples 6-8 can be adjusted to have a higher content of solids. The adjusted coatings can be applied to in-line wrap around labels that are placed and seamed directly onto the containers. The characteristics of the coatings, and the labels seamed with the coatings, can be tested as described above.

Example 15:

[00115] The coating of Example 11 can be applied to the target seam area of a label film, and the label wrapped around a container and heat-sealed. The characteristics of the coatings, and the labels seamed with the coatings, can be tested as described above.

[00116] The present invention has now been described in detail, including preferred embodiments. However, it will be appreciated that those skilled in the art, upon consideration of the present disclosure, may make modifications and/or improvements that fall within the scope and spirit of the invention.

We claim:

1. A method comprising applying a coating composition to a label substrate, wherein:
   a) the label substrate is applied to a plastic article; and
   b) the coating enables removal of the label during recycling.

2. The method of claim 1, wherein the coating composition comprises:

a) at least one first resin with a Tg above about 25 °C;

b) at least one second resin hydrolysable or solutionable in a hot caustic bath or solvent wash; and

wherein the first and second resin may be the same or different.

3. The coating composition of claim 2, wherein the coating comprises at least one resin with a Tg above about 25 °C selected from the group consisting of polyesters, nitrocelluloses, acrylics, styrenics, including styrenic copolymers such as styrene-maleic anhydride, shellacs, epoxies, polyurethanes, and vinyls.

4. The coating composition of any one of claims 2 or 3, further comprising at least one second resin which is at least partially solutioned or hydrolysed in an aqueous medium at a pH of 12 or greater.

5. The coating composition of claim 4, wherein the acid value of the coating composition based on dry film is greater than 20.

6. The coating composition of any one of claims 2-5, wherein the second resin is selected from the group consisting of polyhydroxycarboxylic acids, sulfopolyesters, acrylics, polymers containing sulfonamide functionality, and polymers with a hydroxyl level of about 50 or greater.

7 A label substrate coated with the coating composition of any one of claims 2-6.

8. The substrate of claim 7, wherein:

a) the coating composition produces a bond strength of coating to substrate after seaming to the substrate that is the lesser of 5 N/in or the tensile strength of the substrate;

b) the coating composition produces a bond that is suitable for hot shrinking around a container or article; and

c) the coating composition is delaminated when placed into a hot caustic environment.

9. The substrate of claim 7, wherein:

a) the coating composition produces a bond strength of coating to substrate after seaming to the substrate that is the lesser of 5 N/in or the tensile strength of the substrate;

b) the coating composition produces a bond that is suitable for hot shrinking around a container or article; and

c) the coating composition is delaminated when placed into a solvent wash.

10. The substrate of any one of claims 6 -9, wherein the coating composition produces a bond strength of greater than 9 N/in of coating to substrate after seaming to the substrate.

11. The substrate of any one of claims 6-10, wherein the coating composition produces a bond strength of greater than 30 N/in of coating to substrate after seaming to the substrate.

12. The substrate of any one of claims 6-11, wherein the coating composition forms a strong bond with the substrate via either a solvent or heat sealing process.

13. The substrate of any one of claims 6-11, wherein the coating composition itself functions as a seaming material, and replaces the traditional seaming solvent.

14. The substrate of any one of claims 6-13, which is entirely coated with the coating composition.

15. The substrate of any one of claims 6-13, which is partly coated with the coating composition.

16. The substrate of claim 15, wherein at least a 7 mm margin seaming area of the substrate is coated with the coating composition.

17. A coating system comprising:

a) a first coating layer in contact with a label substrate comprising at least one resin with a Tg above about 25 °C; and

b) a second coating layer applied over the first coating layer.

18. The coating system of claim 17, wherein the first coating layer is further in contact with inks printed on the substrate.

19. The coating system of claim 17, wherein the second coating layer is further in contact with inks printed on the substrate.

20. The coating system of claim 17, wherein both the first coating layer and the second coating layer are further in contact with inks printed on the substrate.

21. The coating system of any one of claims 17-20, wherein the coating system is at least partially hydrolysable or solutionable under the conditions of recycling.

22. The coating system of any one of claims 17-21, wherein:

a) the coating system produces a bond strength of coating to substrate after seaming to the substrate that is the lesser of 5 N/in or the tensile strength of the substrate;

b) the coating system produces a bond that is suitable for hot shrinking around a container or article; and

c) the coating system is delaminated when placed into a hot caustic environment.

23. The coating system of any one of claims 17-21, wherein:

a) the coating system produces a bond strength of coating to substrate after seaming to the substrate that is the lesser of 5 N/in or the tensile strength of the substrate,;

b) the coating system produces a bond that is suitable for hot shrinking around a container or article; and

c) the coating system is delaminated when placed into a solvent wash.

24. A method to produce a label for a plastic container that can be removed from the container during a hot caustic wash step in the recycling process.

25. A method to produce a label for a plastic container that can be removed from the container during a solvent wash step in the recycling process.

26. The method of any one of claims 24 or 25, wherein a coating composition according to any one of claims 1-6, or 17-23, is applied to the substrate.

27. The method of any one of claims 24-26, wherein the label is removed by de-seaming from the container.

28. An article wrapped with a sleeve label applied according to any one of claims 7-27.

29. The article of claim 28, wherein the label separates from the article when the article is placed into a hot caustic wash.

30. The article of any one of claims 28 or 29, wherein the label separates in less than 5 minutes at 65°C.

31. The article of any one of claims 28-30, wherein the label separates in less than 3.5 minutes at 65°C.

32. The article of any one of claims 28 or 29, wherein the label separates in less than 2 minutes at 75°C.

33. The article of any one of claims 28 or 29, wherein the label separates in less than 1 minute at 85°C.

34. The article of claim 28, wherein the label separates from the article when the article is placed into a solvent wash.

35. The article of any one of claims 28-34, wherein the label is comprised of a seamed plastic substrate.

36. The article of claim 35, wherein the label is a shrink label.

37. The article of any one of claims 28-36, wherein the label is a full wrap label.

38. The article of any one of claims 28-36, wherein the label is a partial wrap label.

39. The article of any one of claims 28-38, wherein the sleeve label is a shrink wrap label.

40. The article of any one of claims 28-39, wherein a coating composition that is not a hot melt glue or a water soluble adhesive composition is applied to the sleeve label.

41. The article of claim 40, wherein the coating composition comprises the coating composition of any one of claims 2-6, or 17-23.

42. The article of any one of claims 28-41, wherein the article is a plastic article.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US14/48057

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B65C 3/08; G09F 3/00; D21H 19/58 (2014.01)
CPC - G09F 2003/0216, 2003/0202, 2003/0244
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - B65C 3/08; G09F 3/00; D21H 19/58 (2014.01)
CPC - G09F 2003/0216, 2003/0202, 2003/0244; USPC - 428/343, 346, 349

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
MicroPatent (US-G, US-A, EP-A, EP-B, WO, JP-bib, DE-C,B, DE-A, DE-T, DE-U, GB-A, FR-A); Google Scholar; IP.com; ProQuest; coating, covering, layer, label, shrink sleeve, plastic, container, bottle, remove, separate, detach, recycle, acid value, caustic, pH, solutionable, dissolved, hydrolysable, hydrolysis

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2012/0018098 A1 (HENDERSON, KO) 26 January 2012; abstract; paragraphs [0006], [0023]-[0028], [0035], [0038], [0041], [0044]	1, 17-20, 24-25 --- 2-3, 4/2-3, 5, 21/17-20
Y	US 6,224,974 B1 (WUU, F) 01 May 2001; abstract; column 4, lines 25-59; column 7, lines 9-25	2-3, 4/2-3, 5, 21/17-20
Y	WO 2012/161758 A2 (NIEDERST, J et al.) 29 November 2012; paragraphs [0231]-[0232]	5

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
“A” document defining the general state of the art which is not considered to be of particular relevance
“E” earlier application or patent but published on or after the international filing date
“L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
“O” document referring to an oral disclosure, use, exhibition or other means
“P” document published prior to the international filing date but later than the priority date claimed
“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
“&” document member of the same patent family

Date of the actual completion of the international search 29 September 2014 (29.09.2014)	Date of mailing of the international search report 27 OCT 2014
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Shane Thomas PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US14/48057

Box No. II **Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 6-16, 22-23, and 26-42
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III **Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (July 2009)

SCORE Placeholder Sheet for IFW Content

Application Number: 18103234 Document Date: 01/31/2023

The presence of this form in the IFW record indicates that the following document type was received in electronic format on the date identified above. This content is stored in the SCORE database.

Since this was an electronic submission, there is no physical artifact folder, no artifact folder is recorded in PALM, and no paper documents or physical media exist. The TIFF images in the IFW record were created from the original documents that are stored in SCORE.

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At the time of document entry (noted above):

- USPTO employees may access SCORE content via DAV or via the SCORE web page.
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Form Revision Date: March 1, 2019

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.:	18/103,234	Attorney Docket No.:	0644.000001US01
Confirmation No.:	8140	Customer No.:	26813
Filing Date:	January 31, 2023	Examiner Name:	Unassigned
First Named Inventor:	Andrew Sharp	Group Art Unit:	Unassigned
Title of Invention:	RECYCLABLE HEAT SHRINK FILM FOR RECYCLABLE CONTAINER		

COMMUNICATION REGARDING INADVERTENTLY OMITTED PORTION OF APPLICATION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

This communication is submitted with a copy of the prior filed application, under 37 CRF § 1.57(b). Upon filing of the application on January 30, 2023, the drawings were inadvertently omitted.

This application contains a claim under § 1.78 for the benefit of a prior-filed International Application and Provisional Application that was present on the filing date of the application, and the inadvertently omitted drawings are completely contained in the prior-filed application. This claim for benefit under 37 CFR § 1.78 is considered an incorporation by reference of the prior-filed application, including the inadvertently omitted portion of the drawings.

Applicant respectfully requests the Office consider the drawings in the present application. Attached is the publication of the prior filed International Application, of which this application claims priority.

Applicant invites the Examiner to contact the undersigned Applicant's Representative at the telephone number listed below if doing so may advance prosecution of this application.

Authorization is given to charge Deposit Account No. 13-4895 any necessary fees for this filing and all required extension of time fees.

Respectfully submitted by

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1/31/2023
Date

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(74) Agent: **KIURU-RIBAR, Lotta** et al.; Mueting Raasch Group, 111 Washington Avenue S., Suite 700, Minneapolis, Minnesota 55401 (US).

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(54) Title: RECYCLABLE HEAT SHRINK FILM FOR RECYCLABLE CONTAINER

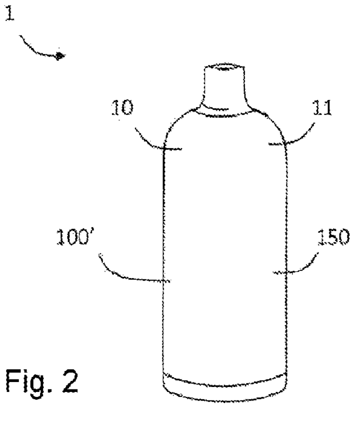

Fig. 2

(57) **Abstract:** A recyclable shrink label includes a heat shrink film having a first surface and a second surface opposite of the first surface; and a light blocking layer disposed adjacent the first surface and comprising a light blocking component, the light blocking layer being constructed for the recyclable shrink label to block at least 80 % of incident light having wavelengths in a range of 200 nm to 900 nm. The recyclable shrink label may further include an indicia layer. The recyclable shrink label may further include a high opacity layer. The recyclable shrink label may be applied to a container, e.g., a recyclable container. Articles including the recyclable shrink label may be recycled in a process where both the container and the label are recognized as a resin and may be directed into a corresponding recycling stream. In some cases, both the container and the label include PET.

RECYCLABLE HEAT SHRINK FILM FOR RECYCLABLE CONTAINER

RELATED APPLICATIONS

This application claims priority to U.S. Provisional Patent Application No. 63/188,794, filed on 14 May, 2021, which is incorporated herein in its entirety.

BACKGROUND

The consumer packaged-goods markets globally aspire to utilize recyclable packaging for most products. Clear PET packaging provides a cost effective recyclable option. The dairy, food, nutraceutical, and other markets also require light protective packaging to block ingredient harmful light waves from impacting the shelf life and performance of those products. Traditionally, color impregnated bottles or containers, and/or white shrink films printed with or sometimes without functional light blocking layers are used to block the harmful light waves. The market for recycling color impregnated PET is very small and most of those bottles and containers are not recycled.

Therefore, there remains a need for recyclable, light protective packaging options for many markets, including the food and nutraceutical markets.

Any discussion of prior publications and other prior knowledge does not constitute an admission that such material was published, known, or part of the common general knowledge.

SUMMARY

Disclosed herein are recyclable shrink labels.

According to an embodiment, a recyclable shrink label includes a heat shrink film having a first surface and a second surface opposite of the first surface; and a light blocking layer disposed adjacent the first surface and comprising a light blocking component, the light blocking layer being constructed for the recyclable shrink label to block at least 80 % of incident light having wavelengths in a range of 200 nm to 900 nm. The heat shrink film may have a thickness from 15 μm to 100 μm or 30 μm to 80 μm.

The recyclable shrink label may further include an indicia layer. The indicia layer may be disposed on the first surface. The recyclable shrink label may further include a high opacity layer. The high opacity layer may include a white pigment. The high opacity layer may be disposed between the indicia layer and the light blocking layer.

According to an embodiment, a method of making a label for a container includes depositing an indicia layer on a heat shrinkable film; optionally depositing a high opacity layer on the indicia layer; and depositing a light blocking composition on the indicia layer, on the heat shrinkable film, or on the high opacity layer, wherein the light blocking layer includes one or more light blocking components, and wherein the label is capable of blocking at least 80 % of incident light having wavelengths in a range of 200 nm to 900 nm.

According to an embodiment, a method of recycling an article including a container defining an external surface; and the recyclable shrink label described above, disposed on the container, optionally with the first surface facing the external surface of the container, the method including: determining that the container and recyclable shrink label comprise polyethylene terephthalate (PET); directing the article into a polyethylene terephthalate (PET) recycling stream; and washing the article to remove inks and pigments from the recyclable shrink label. The washed article may be clear and not be stained by the light blocking component or other pigments or inks. The article may be washed in a caustic bath. The article may be chopped into pieces prior to washing. According to an embodiment, during the recycling process, the inks and coating layers cleanly separate from the PET heat shrink film, allowing pure PET to be recovered and processed into reusable resin.

The above summary of the present invention is not intended to describe each disclosed embodiment or every implementation of the present invention. The description that follows more particularly exemplifies illustrative embodiments. In several places throughout the application, guidance is provided through lists of examples, which examples can be used in various combinations. In each instance, the recited list serves only as a representative group and should not be interpreted as an exclusive list.

DEFINITIONS

The words “preferred” and “preferably” refer to embodiments of the invention that may afford certain benefits, under certain circumstances. However, other embodiments may also be preferred, under the same or other circumstances. Furthermore, the recitation of one or more preferred embodiments does not imply that other embodiments are not useful and is not intended to exclude other embodiments from the scope of the invention.

The term “comprises” and variations thereof do not have a limiting meaning where these terms appear in the description and claims. Such terms will be understood to imply the inclusion of

All headings are for the convenience of the reader and should not be used to limit the meaning of the text that follows the heading, unless so specified.

Reference throughout this specification to “one embodiment,” “an embodiment,” “certain embodiments,” or “some embodiments,” etc., means that a particular feature, configuration, composition, or characteristic described in connection with the embodiment is included in at least one embodiment of the disclosure. Thus, the appearances of such phrases in various places throughout this specification are not necessarily referring to the same embodiment of the disclosure. Furthermore, the particular features, configurations, compositions, or characteristics may be combined in any suitable manner in one or more embodiments.

Unless otherwise indicated, all numbers expressing quantities of components, molecular weights, and so forth used in the specification and claims are to be understood as being modified in all instances by the term “about.” As used herein in connection with a measured quantity, the term “about” refers to that variation in the measured quantity as would be expected by the skilled artisan making the measurement and exercising a level of care commensurate with the objective of the measurement and the precision of the measuring equipment used. Accordingly, unless otherwise indicated to the contrary, the numerical parameters set forth in the specification and claims are approximations that may vary depending upon the desired properties sought to be obtained by the present invention. At the very least, and not as an attempt to limit the doctrine of equivalents to the scope of the claims, each numerical parameter should at least be construed in light of the number of reported significant digits and by applying ordinary rounding techniques.

Notwithstanding that the numerical ranges and parameters setting forth the broad scope of the invention are approximations, the numerical values set forth in the specific examples are reported as precisely as possible. All numerical values, however, inherently contain a range necessarily resulting from the standard deviation found in their respective testing measurements.

The terms “polymer” and “polymeric material” include, but are not limited to, organic homopolymers, copolymers, such as for example, block, graft, random, and copolymers, terpolymers, etc., and blends and modifications thereof. Furthermore, unless otherwise specifically limited, the term “polymer” shall include all possible geometrical configurations of the material. These configurations include, but are not limited to, isotactic, syndiotactic, and atactic symmetries.

The term “copolymer” refers to polymers containing two or more different monomeric units or segments, including terpolymers, tetrapolymers, etc.

objects or imaginary compositions or any kind of marking. A single dot of a single color can be indicia. Indicia can be the type, texture, smell, or sound when rustled of the material used to form a package. Indicia can be a combination of any and all of the indicia described previously.

As used herein, the term "ppr" refers to pounds per ream and is used as the unit of measurement of dry pounds of ink or coating per area of substrate (e.g., film or label). One ream is understood to mean 3000 sq ft (about 289 m^2).

As used herein, the term "BCM" refers to billion cubic microns per square inch ($\mu m^3/inch^2$) and is used as a unit of measurement of liquid volume of ink or coating.

As used herein, the term "line-screen" refers to how many halftone lines are printed per each linear inch.

As used herein, the term "viscosity" refers to the flowrate of a liquid and is measured using a calibrated #2 Zahn viscosity cup.

As used herein, the term "COF" refers to the kinetic and static coefficient of friction values. COF can be measured as described in ASTM D1894-14 Standard Test Method for Static and Kinetic Coefficients of Friction of Plastic Film and Sheeting.

BRIEF DESCRIPTION OF THE FIGURES

The disclosure will be further explained with reference to the drawings, wherein:

These figures, which are idealized, are not to scale and are intended to be merely illustrative and non-limiting.

FIG. 1A schematically depicts an embodiment of a disclosed article according to an embodiment.

FIG. 1B schematically depicts an embodiment of a disclosed article according to an embodiment.

FIG. 1C schematically depicts an embodiment of a disclosed article according to an embodiment.

FIG. 1D schematically depicts an embodiment of a disclosed article according to an embodiment.

FIG. 1E schematically depicts an embodiment of a disclosed article according to an embodiment.

FIG. 2 is a schematic representation of an article including the label of the present disclosure, according to an embodiment.

Previously, white PET films with a black coating printed on the inside of the label were the only shrink label solution that met the desirable light blocking thresholds. White PET cannot be recycled with clear PET bottles or containers and therefore those products are not recycled and go to the landfill. According to an embodiment, the labels of the present disclosure are light blocking and offer the ability to maintain and improve product shelf life with a light blocking clear shrink film while preserving the recyclability of the clear PET package.

According to an embodiment, the inks utilized in the labels of the present disclosure, including the light blocking inks, are designed to wash off the film during a reclaiming process allowing the labels and containers they cover to be recycled.

Further according to an embodiment, the labels of the present disclosure allow the use of a clear PET underlying container or bottle, which preserves the recyclability of the container or bottle. The labels may also potentially reduce or remove the need to include any additional additives in the container itself (e.g., pigments). For example, the labels may be used on clear, rigid PET containers and bottles. Any inks and coatings printed onto the PET shrink film may be formulated to wash off the film during the recycling process, allowing the underlying clear PET film and the clear PET rigid plastic to be recycled together. The inks and coatings may be formulated to group together during the wash off process in a coagulation-like reaction, which prevents or reduces the ink and coatings from staining the clear film and rigid PET that resides at the bottom of the PET caustic recycling bath process. For example, the inks and coatings may be crosslinked and/or have additives that help the smaller particles glomerate into larger particles during the wash off process. Such larger particles can then be filtered out of the wash water, helping to prevent staining of the PET film and clear PET rigid plastic.

FILMS

According to an embodiment, the label includes a heat shrinkable film or heat shrink film. The terms heat shrink film and shrink film are used here interchangeably. Any suitable heat shrink film may be used. In some embodiments, the heat shrink film is a polyester heat shrink film, of the type that is used in the packaging industry. The heat shrink film can also be described as a film that is not heat stabilized so that it will shrink when exposed to heat.

The heat shrink film is a polymeric film that is substantially two-dimensional with two major surfaces. The term substantially two-dimensional is used to refer to an object having a significantly large size measurement in two dimensions compared to a significantly small size

In some embodiments, the heat shrink film shrinks primarily in the transverse direction only. In some embodiments, the heat shrink film shrinks primarily in the machine direction only.

In some embodiments, the polymeric films useful in the label possess balanced shrink properties. The balanced shrink properties allow the film to tighten darts and wrinkles initially formed in the label when the label is applied over curved surfaces and allow the darts and wrinkles to be wiped down with minimal graphics distortion of the label. In some embodiments, the films used in the label have unbalanced shrink properties. Films having unbalanced shrink, that is, films having a high degree of shrink in one direction and low to moderate shrink in the other direction may be particularly useful. In some embodiments, particularly useful films are those that have one dimensional shrink (e.g., in the transverse direction) because they may provide the ability to pre distort indicia formed thereon more easily versus those that have biaxial shrinkage. In some embodiments, the film may be used in a process called "roll-on-shrink-on," where the film shrinks primarily in the machine direction.

Preferably, the shrink film is thermally shrinkable and yet has sufficient stiffness (e.g., modulus) to be dispensed using conventional labeling application equipment and converting processes, including treating, printing, coating, slitting, seaming, cutting, and label application. The desired stiffness of the film depends on the size of the label, the speed of application, the shape and moisture content on the surface of the container, and the labeling equipment being used.

The shrink film may be made by conventional processes. For example, the shrink film may be produced using blown, calendared, or tentered extrusion processes.

The shrink film useful in the label may be a single layer construction or a multilayer construction. The layer or layers of the shrink film may be formed from a polymer chosen from numerous types of polymers, including for example polyesters and polyolefins. Illustrative specific polymers or polymer types that can be utilized to form shrink films can include, for example, polyethylene terephthalate (PET), polyethylene terephthalate glycol-modified (PETG or PET-G), polyvinyl chloride (PVC), polystyrene or oriented polystyrene (OPS), polylactic acid (PLA), copolymers, non-petroleum based biopolymers, and copolymers and blends thereof. Additional illustrative specific types of polymers that can be utilized to form shrink films can include, polyolefins, such as polypropylene (PP), polyethylene (PE), and copolymers and blends thereof. In some embodiments, illustrative specific copolymers can include copolymers of PP and PE, for example. In a preferred embodiment, the shrink film includes polyethylene terephthalate (PET) and composition may decrease the drying time of some inks. Such ink-receptive compositions are described in U.S. Pat. No. 6,153,288 (Shih et al.) and the disclosure of this patent is hereby incorporated by reference.

The adhesion of the ink to the surface of the polymeric shrink film can be improved, if necessary or desired, by techniques well known to those skilled in the art. For example, as mentioned above, an ink primer or other ink adhesion promoter can be applied to the surface layer of the shrink film before application of the ink. Alternatively, the surface of the shrink film can be treated by methods such as corona treated or flame treated, for example, to improve the adhesion of the ink to the polymeric film layer.

Useful ink primers may be transparent or opaque and the primers may be solvent based, water-based, or UV-based, digital printing ink diluted with known solvents and/or additives to achieve a desired viscosity for the specific printing process. In one embodiment, the primers are radiation curable (e.g., UV). The ink primer may comprise a lacquer and a diluent. The lacquer may be comprised of one or more polyolefins, polyamides, polyesters, polyester copolymers, polyurethanes, polysulfones, polyvinylidene chloride, styrene-maleic anhydride copolymers, styrene-acrylonitrile copolymers, ionomers based on sodium or zinc salts or ethylene methacrylic acid, polymethyl methacrylates, acrylic polymers and copolymers, polycarbonates, polyacrylonitriles, ethylene-vinyl acetate copolymers, and mixtures of two or more thereof. Examples of the diluents that can be used include alcohols such as ethanol, isopropanol and butanol; esters such as ethyl acetate, propyl acetate and butyl acetate; aromatic hydrocarbons such as ketones such as acetone and methyl ethyl ketone; aliphatic hydrocarbons such as heptane; and mixtures thereof. The ratio of lacquer to diluent is dependent on the viscosity desired for application of the ink primer, the selection of such viscosity being within the skill of the art. The ink primer layer may have a thickness of from about 0.5 μm to about 20 μm, about 1 μm to about 4 μm, or from about 1.5 μm to about 3 μm.

A transparent or non-transparent polymer topcoat or overcoat layer may be present in the labels of the present disclosure. The topcoat or overcoat layer could provide desirable protective properties to the label before and after the label is affixed to an article, such as a container. The presence of a transparent or non-transparent topcoat layer over the print layer may, in some embodiments, provide additional properties such as antistatic properties, stiffness, and/or weatherability, and the topcoat may protect the print layer from, e.g., weather, sun, abrasion, moisture, water, etc. The transparent or non-transparent topcoat layer can enhance the properties of can be considered as certifying that the film is fully recyclable with the container or bottle. In some embodiments, the labels of the present disclosure are recyclable according to Evaluation of the Near Infrared (NIR) Sorting Potential of a Whole Plastic Article (SORT-B-01), Evaluation of Sorting Potential for Plastic Articles Utilizing Metal, Metalized or Metallic Printed Components (SORT-B-03), or both. That is, according to an embodiment, the labels of the present disclosure are fully recyclable. For example, the labels may include inks that can be washed off in a typical PET recycling wash (caustic wash) and the polymers used in the labels are preferably clear (preferably clear PET). According to an embodiment, the labels are free or substantially free of inks that cannot be washed off in a caustic wash. According to an embodiment, the labels are free or substantially free of colored plastics (including white plastics) that cannot be recycled.

HIGH OPACITY COATING COMPOSITIONS

According to an embodiment, the label includes a high opacity layer formed from a high opacity coating composition. In some embodiments where clear shrink films are used, it may be useful for disclosed articles to include an optional high opacity layer applied thereon or on a layer applied onto the clear shrink film. The high opacity layer may be applied by applying a high opacity coating composition to one or more layers of the label.

Useful high opacity coating compositions can include aqueous or non-aqueous ink compositions. In some embodiments, the high opacity coating composition includes a white pigment. Examples of useful white pigments include, for example, titanium dioxide (TiO_2), precipitated calcium carbonate (PCC), aluminum silicate, aluminum oxide (i.e., alumina), mica-based pigments coated with thin layer(s) of white pigment (such as TiO_2), and combinations thereof.

In some embodiments, a high opacity coating composition can include a white pigment, an anionic surfactant, latex particles, and a balance of water. In other instances, high opacity coating composition can include additives, such as an optical brightener, a biocide, additional surfactant, a co-solvent, and/or a humectant.

Useful high opacity coating compositions can include compositions formulated for use as rotogravure inks (e.g., rotogravure solvent-based inks), flexographic inks, lithographic inks, or digital printing inks (e.g., ink jet, nanographic), for example.

The high opacity coating composition can be placed on the shrink film using any methods known in the art including but not limited to gravure printing (e.g., rotogravure printing), ppr or greater. The desired dry coat weight may be 25 ppr or less, 20 ppr or less or 15 ppr or less. The desired dry coat weight may range from 0.5 ppr to 25 ppr.

Application of the high opacity coating composition onto the shrink film or onto a layer on the shrink film forms a high opacity layer. The high opacity layer need not be constant, continuous, or complete across the entirety of the shrink film. In some embodiments, the high opacity layer forms a pattern of discrete dots of ink. In other embodiments, the high opacity layer forms a continuous layer of ink.

LIGHT BLOCKING LAYER

According to an embodiment, the label includes a layer of light blocking material, such as light blocking ink. The light blocking material may be applied onto the shrink film or on a layer applied onto the shrink film, including for example onto the high opacity layer discussed above. The light blocking material may be applied in the form of a light blocking composition that includes one or more light blocking components.

According to an embodiment, the label containing the light blocking layer blocks at least 80 %, at least 90 %, at least 95 %, at least 96 %, at least 98 %, at least 99 %, or even almost 100 % or 100 % of incident light having wavelengths from 200 nm to 900 nm. According to an embodiment, the label containing the light blocking layer blocks at least 95 %, at least 96 %, at least 98 %, at least 99 %, at least 99.5 %, about 100 %, or 100 % of incident light having wavelengths from 220 nm to 800 nm. According to an embodiment, the label containing the light blocking layer blocks at least 98 %, at least 99 %, at least 99.5 %, about 100 %, or 100 % of incident light having wavelengths from 220 nm to 750 nm. According to an embodiment, the label containing the light blocking layer blocks at least 99 %, at least 99.5 %, about 100 %, or 100 % of incident light having wavelengths from 220 nm to 600 nm. According to an embodiment, the label containing the light blocking layer blocks at least 99 %, at least 99.5 %, about 100 %, or 100 % of incident light having wavelengths from 220 nm to 500 nm. According to an embodiment, the label containing the light blocking layer blocks at least 99 %, at least 99.5 %, about 100 %, or 100 % of incident light having wavelengths from 220 nm to 450 nm. The amount of light blocked by the label may be measured using a UV-Vis spectrophotometer, such as the Shimadzu model UV-2600i.

According to an embodiment, the label includes a light blocking layer containing one or more light blocking components. In some embodiments, the light blocking components include one or more metals. In some embodiments, useful light blocking components can include pigments that rotogravure printing), flexographic printing, and lithographic printing (e.g., offset lithographic), plateless printing (e.g., digital), post press applications, and screen printing for example. Gravure printing is the direct transfer of liquid ink to substrate from a metal image carrier. The image is lower than the surface of the image carrier base. Flexographic printing is the direct transfer of liquid ink to substrate, typically from a photopolymer image carrier although other image carriers exist. The image is raised above the surface of the image carrier base. Offset lithographic printing is the indirect transfer of paste ink to substrate from a rubber 'blanket' that is intermediate to substrate and the thin planographic metal image carrier. Some examples of plateless printing include liquid toner electrophotography, dry toner electrophotography, drop on demand inkjet, continuous inkjet, or NANOGRAPHY™.

In embodiments where the light blocking coating composition is applied to the shrink film or layer on the shrink film via rotogravure coating or printing, the light blocking coating composition can have a viscosity from 16 seconds or greater, 17 seconds or greater, 18 seconds or greater, or 19 seconds or greater, measured with a #2 Zahn Cup. The viscosity may be 40 seconds or less, 25 seconds or less, or 24 seconds or less. For example, the viscosity may range from 16 seconds to 40 seconds, from 15 seconds to 25 seconds, or even from 19 seconds to 24 seconds.

The light blocking composition may be applied onto the label at a suitable rate to result in the desired light blocking performance. When gravure coating or rotogravure coating is used, the amount of composition used may be controlled by adjusting the engraving specifications of the gravure cylinder(s). The cylinder(s) may have a cell volume of 1.0 BCM or greater, 5 BCM or greater, 10 BCM or greater, or 15 BCM or greater. The cell volume may be 2 BCM or less, 25 BCM or less, or 20 BCM or less. The cell volume may range, for example, from 1.0 BCM to 30.0 BCM, or from 5 BMC to 25 BCM. The cylinder(s) may have cell width values of 25 μm or greater, 50 μm or greater, or 100 μm or greater. The cylinder(s) may have cell width values of 300 μm or less, 250 μm or less, or 200 μm or less. The cell width values may range, for example, from 25 μm to 300 μm. The cylinder(s) may have channel widths of 1 μm or greater, 5 μm or greater, 10 μm or greater, 20 μm or greater, or 30 μm or greater. The channel widths may be 75 μm or less or 50 μm or less. The channel widths may range from 1 μm to 75 μm. The cylinder(s) may have line screen values of 25 LPI or greater, 50 LPI or greater, 100 LPI or greater, 150 LPI or greater, or 200 LPI or greater. The line screen values may be 400 LPI or less, 350 LPI or less, 300 or less, 250 or less, or 200 or less. The line screen values may range from 25 LPI to 400 LPI. According to exemplary embodiments, a desired dry coat weight may be 0.1 ppr or greater, 0.2 ppr or greater, 0.3 ppr or adjusted to provide a desirable color density and viscosity (e.g., as measured using a calibrated #2 Zahn cup.).

The image-forming composition may include any suitable inorganic or organic pigment. Examples of the inorganic pigments include pigments such as titanium dioxide, chrome yellow, molybdate orange, iron blue, cadmium yellow, milori green, ultramarine blue, calcium carbonate, magnesium carbonate, silica aerogel or kaolin, for example. Examples of the organic pigments include Hansa yellow, lampblack, phthalocyanine, red lake C, diarylide yellow, phloxine, channel black, or rhodamine for example. Typical amounts of pigment in the ink composition for gravure printing may range from 1 wt-% to 20 wt-%.

The image-forming composition may include a binder resin, such as a polyamides, nitrocellulose, shellac, vinyl polymers, rosin esters, or acrylic polymers..

The image-forming composition can be placed on the shrink film (or on a layer thereon) using any methods known in the art including but not limited to gravure printing (e.g., rotogravure printing), flexographic printing, and lithographic printing (e.g., offset lithographic), plateless printing (e.g., digital), post press applications, and screen printing for example. Gravure printing is the direct transfer of liquid ink to substrate from a metal image carrier. The image is lower than the surface of the image carrier base. Flexographic printing is the direct transfer of liquid ink to substrate, typically from a photopolymer image carrier although other image carriers exist. The image is raised above the surface of the image carrier base. Offset lithographic printing is the indirect transfer of paste ink to substrate from a rubber 'blanket' that is intermediate to substrate and the thin planographic metal image carrier. Some examples of plateless printing include liquid toner electrophotography, dry toner electrophotography, drop on demand inkjet, continuous inkjet, or NANOGRAPHY™.

Application of the image-forming composition onto the shrink film or onto a layer on the shrink film forms an indicia layer. The indicia layer need not be constant, continuous, or complete across the entirety of the shrink film.

The indicia layer may be an ink or graphics layer, and the indicia layer may be a mono-colored or multi-colored print layer depending on the printed message and/or the intended pictorial design. These include variable imprinted data such as serial numbers, bar codes, trademarks, etc. The thickness of the indicia layer is typically in the range of about 0.5 to about 10 μm, and in one embodiment about 1 to about 5 μm, and in another embodiment about 3 μm. The inks used in the indicia layer may include commercially available water-based, solvent-based, oil-based, or energy-curable inks. Examples of commercially available inks include INXFlex Contour (a product of INX identified as an energy curable ink for shrink sleeve applications), Genesis GS (a product of INX identified as gravure solvent-based ink for shrink sleeve and roll fed applications), FlexiTech Shrink-U (a product of Flint Group identified as a flexographic solvent-based ink for shrink sleeve applications), or PluriTech Shrink-U (a product of Flint Group identified as a gravure solvent-based ink for shrink sleeve applications).

In one embodiment, the indicia layer may comprise a polyester/vinyl ink, a polyamide ink, an acrylic ink and/or a polyester ink. The indicia layer may be formed in the conventional manner by, for example, rotogravure, flexographic or lithographic printing processes, or the like, an ink composition comprising a resin of the type described above, a suitable pigment or dye and one or more suitable volatile solvents onto one or more desired areas of the shrink film or a layer formed thereon. After application of the indicia forming composition, the volatile solvent component(s) of the ink composition evaporate(s), leaving only the non-volatile ink components to form the indicia layer.

The total amount of inks on the label depends on the graphics (indicia layer), the background (e.g., white) layers, and the light blocking layer(s). The total amount of inks may be 0.5 ppr or greater, 1 ppr or greater, 5 ppr or greater, 10 ppr or greater, or 15 ppr or greater. The total amount of inks may be 30 ppr or less, 25 ppr or less, 20 ppr or less or 15 ppr or less. The total amount of inks may range from 0.5 ppr to 30 ppr.

ARTICLES AND CONTAINERS

FIG. 1A shows an article 10 (e.g., a bottle or other container) having a heat shrink label 100 applied on its outside surface. The heat shrink label 100 includes a heat shrink film 120, upon which indicia layer 125 (e.g., graphics) is disposed on one surface thereof and an opposing surface includes a high opacity layer 110 and a light blocking layer 115 on the high opacity layer 110. In this embodiment, the light blocking layer 115 is the closest to the article that the heat shrink label 100 is applied to.

FIG. 1B shows an article 10 (e.g., a bottle or other container) having a heat shrink label 101 applied on its outside surface. The heat shrink label 101 includes a heat shrink film 120, upon which a light blocking layer 115 is disposed on one surface and an opposing surface having a high opacity layer 110. Disposed on the surface of the high opacity layer 110 opposite the heat shrink film 120 is an indicia layer 125. In this embodiment, the light blocking layer 115 is the closest to the article 10 that the heat shrink label 101 is applied to.

FIG. 1C shows an article 10 (e.g., a bottle or other container) having a heat shrink label 102 applied on its outside surface. The heat shrink label 102 includes a heat shrink film 120, upon which an indicia layer 125 is disposed on its surface, a high opacity layer 110 is disposed on the surface of the indicia layer 125, and a light blocking layer 115 is disposed on the high opacity layer 110. In this embodiment, the light blocking layer 115 is the closest to the article 10 that the heat shrink label 102 is applied to.

FIG. 1D shows an article 10 (e.g., a bottle or other container) having a heat shrink label 103 applied on its outside surface. The heat shrink label 103 includes a heat shrink film 120, upon which a light blocking layer 115 is disposed on one surface and an opposing surface has an indicia layer 125 disposed thereon. In this embodiment, the light blocking layer 115 is the closest to the article 10 that the heat shrink label 103 is applied to. Such an embodiment could be useful for example, in circumstances where it is acceptable or desirable for the background of the printed label to be dark or black.

FIG. 1E shows an article 10 (e.g., a bottle or other container) having a heat shrink label 104 applied on its outside surface. The heat shrink label 104 includes a heat shrink film 120, upon which an indicia layer 125 is disposed on its surface and a light blocking layer 115 is disposed on the surface of the indicia layer 125. In this embodiment, the light blocking layer 115 is the closest to the article 10 that the heat shrink label 104 is applied to.

It should also be noted that additional layers not depicted in these embodiments, including tie layers, adhesion layers, primer layers, etc. could optionally be included in between or adjacent any of the depicted layers.

The article or container to which the label is applied can be provided in a variety of forms or shapes. Non-limiting examples of suitable articles include containers with and without closures, such as bottles, jars, tubes, trays, lids, toys, appliances, etc. An exemplary article 1 is shown in FIG. 2. The article 1 includes a container 10 (e.g., a bottle) defining an outer surface 11. A recyclable shrink label 100' according to embodiments of this disclosure is disposed on the outer surface 11. The first side of the recyclable shrink label 100' faces the container 10 and the second side 150 faces out. The article or container may be made of any polymer (e.g., conventional polymer or biopolymer), glass, or metal such as aluminum. Examples of suitable polymeric materials include high density polyethylene (HDPE), low density polyethylene (LDPE), polyethylene terephthalate

(PET), polypropylene (PP), polylactic acid (PLA), polyvinyl chloride, polycarbonate, nylon, fluorinated ethylene propylene, polystyrene, etc. The article or container may be made of a recyclable material. The article or container may be made of the same or similar polymer as the label, e.g., PET. The article or container can be made by a number of various processes known in the art, such as blow molding, injection molding, thermoforming, rotational molding and the like.

Useful containers include, for example, a bottle with a closure, a tube with a closure, a jar, or the like. In some embodiments, useful beverage containers may include one or more recyclable synthetic pigments and/or resins. Preferably the container may be processed in existing recycling streams, such as mechanical PET recycling streams. Non-limiting examples of suitable pigments and/or resins include, but not limited to, high melting point PET fines; PET comonomers; reactants or byproducts of PET polymerization; polyethylene naphthalate (PEN); terephthalic acid (TPA or PTA); bis(hydroxyethyl) terephthalate (BHET); dimethyl terephthalate (DMT); dimethyl-2,6 naphthalenedicarboxylate (NDC); and isophthalic acid (IPA).

The container or article may have a transparent appearance. In one embodiment, the container or article has a translucent appearance. The translucent appearance can be achieved by, for example, treatments of the transparent container or article, the addition of ingredients such as dyes and pearlescent agents to base polymers, the use of polypropylene and/or polyethylene that are mixed with clarifying agents. The treatments include, for example, spray coating, sandblasting, and mold surface treatment.

In one embodiment, a continuous roll label according to embodiments of the present disclosure can be applied to the article or container in an automated labeling line process. The automated labeling line process may have a line speed of at least 10 units per minute, at least 25 units per minute, at least 50 units per minute, at least 100 units per minute, or at least 250 units per minute. While there is no desirable upper limit, in practice, the automated labeling line process may have a line speed of up to 2000 units per minute, e.g., not more than 500, not more than 600, not more than 700, not more than 800, not more than 900, or not more than 1000 units per minute.

The invention is defined in the claims. However, below there is provided a non-exhaustive listing of non-limiting exemplary aspects. Any one or more of the features of these aspects may be combined with any one or more features of another example, embodiment, or aspect described herein.

According to one exemplary embodiment, clear shrink films (e.g., clear PET shrink films) with thicknesses ranging from 15 μm to 100 μm, 20 μm to 80 μm, or 25 μm to 70 μm (for example) are formed from a wide master roll. The process provides the correct width for the production orders material size requirement. Typically, artwork is printed repeatedly across the film's web width to maximize the total number of labels printed from the respective roll. The slitting step allows the film to be converted into the correct width for the seaming process. The shrink films can be printed using a rotogravure press (for example) with solvent based inks (for example). A light blocking ink can be printed in one or more print stations on either side of the film. An optional high opacity coating layer can also be applied along with the light blocking layer on either side of the film to provide a white opaque background for the label's artwork or graphics provided in the indicia layer. When clear films are used, the graphics may be printed directly onto the film, followed by the high opacity layer (e.g., a white ink) and then the light blocking layer. The graphics are visible through the clear film and are protected by the film. Alternatively, the graphics may be printed on top of the white opaque background. When the graphics are printed using a rotogravure printing press, typically the graphics are printed repeatedly across the film's web and then slit into individual label rolls. Any number of colors can be printed, each color having its own printing cylinder and ink station to apply the different inks, colors, and/or coatings. The ink is then dried with hot air convection blowers at each print station. Line screens ranging from not less than 25 LPI to up to 300 LPI can be utilized for the rotogravure printing. Viscosity readings ranging from 16 – 28 measured using a #2 Zahn Cup are typical for the inks. The light blocking layer can be a solvent-based or water-based composition, diluted with known solvents, and/or additives to achieve a desired viscosity for the specific printing process. Multiple engravings can be used for both the light blocking and the high opacity layer (when utilized) to afford the desired ink coverage at commercial press speeds of 100 meters per minute to 300 meters per minute, in some embodiments. All layers including the high opacity layer and the light blocking layer can shrink along with the shrink film to ensure proper adhesion and color density after being subjected to the shrink process. The layers can preferably pass an adhesion tape test using the recommended tape type for the ink system, a Sutherland ink rub tester of over 100 rubs using the 4 lb block, or both. The light blocking layer is typically designed to have low kinetic coefficients of friction (COF), for example less than 0.22.

The printed film can then be converted from a flat wound roll and formed into a continuous tube with the application of a solvent applied to one side of the film's edge. A seaming machine can fold the solvent edge side of the film onto the un-solvent coated edge, creating a chemical bond of the two sides resulting in a continuous tube of film wound into a large roll. Standard seaming speeds can range from 200 meters per minute up to 500 meters per minute for example. The seamed/tubed label rolls can then be wound into smaller length finished rolls to be shipped to a customer and applied onto intended containers, for example. The label including the light blocking can block at least 80 %, at least 90 %, at least 95 %, at least 96 %, at least 98 %, at least 99 %, or even almost 100 % or 100 % of incident light having wavelengths from 200 nanometers to 900 nanometers for example.

According to an embodiment, a method of recycling the article includes determining the type of material (e.g., type of plastic) that the container and recyclable shrink label are made of, directing the article into a corresponding recycling stream, and washing the article to remove inks and pigments from the recyclable shrink label. In some cases, the article and label include or are made of PET and can be recognized as PET and be directed into a PET recycling stream. In other cases, the article and label may include or be made of another resin and be directed to a corresponding recycling stream. In some preferred embodiments, the label applied to the article includes or is made of the same resin as the article. The washed article may be clear and not be stained or substantially stained by the light blocking component. The article may be washed in a caustic bath. The article may be chopped into pieces prior to washing. According to an embodiment, during the recycling process, the inks and coating layers cleanly separate from the heat shrink film, allowing pure resin to be recovered and processed into reusable resin.

Exemplary Embodiments

Embodiment 1 is a recyclable shrink label comprising a heat shrink film having a first surface and a second surface opposite of the first surface, optionally wherein the heat shrink film has a thickness from 15 μm to 100 μm or 30 μm to 80 μm; and a light blocking layer disposed adjacent the first surface and comprising a light blocking component, the light blocking layer being constructed to block at least 80 % of incident light having wavelengths in a range of 200 nm to 900 nm.

Embodiment 2 is the recyclable shrink label of embodiment 1 further comprising an indicia layer, optionally wherein the indicia layer is disposed on the first surface. The indicia layer may be immediately adjacent the first surface. The indicial layer may be immediately adjacent the light blocking layer. The indicial layer may be disposed between the first surface and another layer, e.g., a high opacity layer.

Embodiment 3 is the recyclable shrink label of embodiment 1 further comprising a high opacity layer, the high opacity layer optionally comprising a white pigment.

Embodiment 4 is the recyclable shrink label of embodiment 3, wherein the high opacity layer is disposed between the indicia layer and the light blocking layer. The high opacity layer may be immediately adjacent the indicia layer. The high opacity layer may be immediately adjacent the light blocking layer.

Embodiment 5 is the recyclable shrink label according to any of embodiments 1 to 4, wherein the heat shrink film comprises polyester, polyolefin, or a combination thereof.

Embodiment 6 is the recyclable shrink label according to any of embodiments 1 to 5, wherein the heat shrink film comprises polyethylene terephthalate (PET), polyethylene terephthalate glycol-modified (PETG or PET-G), polyvinyl chloride (PVC), polystyrene or oriented polystyrene (OPS), polylactic acid (PLA), polypropylene (PP), polyethylene (PE), or a combination thereof. The heat shrink film may consist of polyethylene terephthalate (PET), polyethylene terephthalate glycol-modified (PETG or PET-G), polyvinyl chloride (PVC), polystyrene or oriented polystyrene (OPS), polylactic acid (PLA), polypropylene (PP), polyethylene (PE), or a combination thereof. The heat shrink film may consist of only one of polyethylene terephthalate (PET), polyethylene terephthalate glycol-modified (PETG or PET-G), polyvinyl chloride (PVC), polystyrene or oriented polystyrene (OPS), polylactic acid (PLA), polypropylene (PP), or polyethylene (PE). The heat shrink film may consist of polyethylene terephthalate (PET).

Embodiment 7 is the recyclable shrink label according to any of embodiments 1 to 6, wherein the heat shrink film comprises a seam.

Embodiment 8 is the recyclable shrink label according to any of embodiments 1 to 7, wherein the heat shrink film is in the form of a sleeve or tube. The heat shrink film may be constructed to be fitted over a bottle.

Embodiment 9 is the recyclable shrink label according to any of embodiments 1 to 8, wherein when heated to 100 °C, the heat shrink film contracts or shrinks by about 1 % to about 90 %. The heat shrink film may shrink 1 % or more, 2 % or more, 5 % or more, 10 % or more, 20 % or more, 30 % or more, 40 % or more, or 50 % or more of the size it was before heating. When heated to 100 °C, the heat shrink film may shrink 90 % or less, 80 % or less, 75 % or less, or 70 % or less of the size it was before heating. The heat shrink film may shrink in the transverse direction.

Embodiment 10 is the recyclable shrink label according to any of embodiments 1 to 9, wherein when heated to 100 °C, the entire recyclable shrink label contracts or shrinks by about 1 % to about 90 %. The entire recyclable shrink label may shrink in the transverse direction.

Embodiment 11 is the recyclable shrink label of embodiment 1, wherein the high opacity layer comprises a pigment selected from titanium dioxide (TiO2), precipitated calcium carbonate (PCC), aluminum silicate, aluminum oxide (alumina), mica-based pigments coated with thin layer(s) of white pigment, or a combination thereof.

Embodiment 12 is the recyclable shrink label according to any of embodiments 1 to 11, wherein the light blocking component comprises a metal particulate, optionally wherein the metal particulate has a particle size of 0.1 μm to 100 μm.

Embodiment 13 is the recyclable shrink label according to any of embodiments 1 to 12, wherein the light blocking component comprises zinc, aluminum, copper, silver, or an alloy thereof, titanium dioxide, carbon black, mica, a reflective pigment, a polymer capable of blocking light, a mineral capable of blocking light, or a combination thereof. The light blocking component may consist of an aluminum-based component.

Embodiment 14 is the recyclable shrink label according to any of embodiments 1 to 13, wherein the light blocking layer is present in an amount of 0.5 ppr to 25 ppr. The light blocking layer may have a dry coat weight of 0.1 ppr or greater, 0.2 ppr or greater, 0.3 ppr or greater, 0.4 ppr or greater, 0.5 ppr or greater, 1 ppr or greater, 5 ppr or greater, 10 ppr or greater, or 15 ppr or greater. The dry coat weight may be 25 ppr or less, 20 ppr or less or 15 ppr or less. The dry coat weight may range from 0.1 ppr to 25 ppr, from 0.4 ppr to 15 ppr, or from 0.5 ppr to 10 ppr.

Embodiment 15 is the recyclable shrink label according to any of embodiments 1 to 14, wherein the light blocking layer comprises from 0.1 ppr to 10 ppr, from 0.2 ppr to 5 ppr, or from 0.3 ppr to 3 ppr of the light blocking component.

Embodiment 16 is the recyclable shrink label according to any of embodiments 1 to 15, wherein the label including the light blocking layer blocks at least 80 %, at least 90 %, at least 95 %, at least 96 %, at least 98 %, at least 99 %, or even almost 100 % or 100 % of incident light having wavelengths from 200 nm to 900 nm. The label including the light blocking layer may block at least 95 %, at least 96 %, at least 98 %, at least 99 %, at least 99.5 %, about 100 %, or 100 % of incident light having wavelengths from 220 nm to 800 nm. The label including the light blocking layer may block at least 98 %, at least 99 %, at least 99.5 %, about 100 %, or 100 % of incident light having wavelengths from 220 nm to 750 nm. The label including the light blocking layer may block at least 99 %, at least 99.5 %, about 100 %, or 100 % of incident light having wavelengths from 220 nm to 600 nm. The label including the light blocking layer may block at least 99 %, at least 99.5 %, about 100 %, or 100 % of incident light having wavelengths from 220 nm to 500 nm.

The label including the light blocking layer may block at least 99 %, at least 99.5 %, about 100 %, or 100 % of incident light having wavelengths from 220 nm to 450 nm.

Embodiment 17 is an article comprising: a container comprising an external surface; and the recyclable shrink label of any one of embodiments 1 to 16 disposed on the container, optionally with the first surface facing the external surface of the container.

Embodiment 18 is the article according to embodiment 17, wherein the container comprises polymer, glass, metal, or a combination thereof.

Embodiment 19 is the article according of any one of embodiments 16 to 18, wherein the container comprises polyethylene terephthalate (PET), optionally wherein the container consists of polyethylene terephthalate (PET), optionally wherein the container comprises clear polyethylene terephthalate (PET).

Embodiment 20 is the article of any one of embodiments 16 to 19, wherein the recyclable shrink label comprises polyethylene terephthalate (PET), and optionally wherein the polyethylene terephthalate (PET) forms the outermost layer of the recyclable shrink label.

Embodiment 21 is the article of any one of embodiments 16 to 20, wherein the container and the recyclable shrink label comprise the same material. The container and the recyclable shrink label may comprise polyethylene terephthalate (PET).

Embodiment 22 is a method of making a label for a container, the method comprising depositing an indicia layer on a heat shrinkable film; optionally depositing a high opacity layer on the indicia layer; and depositing a light blocking composition on the indicia layer, on the heat shrinkable film, or on the high opacity layer, wherein the light blocking layer comprises one or more light blocking components, and wherein the light blocking layer is capable of blocking at least 80 % of incident light having wavelengths in a range of 200 nm to 900 nm.

Embodiment 23 is a method of recycling an article comprising a container defining an external surface; and the recyclable shrink label of any one of embodiments 1 to 16 disposed on the container, optionally with the first surface facing the external surface of the container, the method comprising determining that the container and recyclable shrink label comprise polyethylene terephthalate (PET); directing the article into a polyethylene terephthalate (PET) recycling stream; and washing the article to remove inks and pigments from the recyclable shrink label.

Embodiment 24 is the method of embodiment 23, wherein the washed article is clear and is not stained by the light blocking component or other pigments or inks.

Embodiment 25 is the method of embodiment 24, wherein washing comprises washing in a caustic bath.

Embodiment 26 is the recyclable shrink label of any one of embodiments 1 to 16, further comprising an additional layer comprising an additional polymeric layer, an additional indicia layer, an adhesive layer, a slip coat, a protective top layer, another functional layer, or a combination thereof.

The present invention is illustrated by the following examples. It is to be understood that the particular examples, materials, amounts, and procedures are to be interpreted broadly in accordance with the scope and spirit of the invention as set forth herein.

Objects and advantages of this disclosure are further illustrated by the following examples, but the particular materials and amounts thereof recited in these examples, as well as other conditions and details, should not be construed to unduly limit this disclosure.

Unless otherwise noted, all parts, percentages, ratios, etc. in the Examples and the rest of the specification are by weight. These abbreviations are used in the following examples: g = gram, min = minute, hr = hour, mL = milliliter, L = liter. If not otherwise indicated in the table, below, chemicals were obtained from Sigma-Aldrich, St. Louis, MO.

EXAMPLES

EXAMPLE 1

Exemplary articles were made as seen in Table 1A below. The samples were tested with a UV-Vis spectrophotometer (Shimadzu model UV-2600i) for their light blocking ability at wavelengths of 400 nm, 500 nm, 600 nm, and 700 nm. The samples were tested prior to shrinking. Samples 6 and 7 were also tested after shrinking. The results are shown in TABLE 1B.

First and second layers were high opacity layers printed using white ink. The third layer included white ink and for Samples 1-3 also blue ink. The fourth and fifth layers were light blocking layers. The light blocking component was a metallic particulate exhibiting a bronze color.

TABLE 1A: Samples

Sample	1st Layer (# line screens)	2nd Layer (# line screens)	3rd layer (# line screens and pigment color)	4th Layer – Light blocking (# line screens)	5th Layer – Light blocking (# line screens)
1	120	150	150 white + blue	---	----
2	120	150	150	200	--

			white + blue		
3	120	150	150 white + blue	200	175
4	150	150	120 white	175	200
5	150	150	120 white	175	--
6	150	150	120 white	200	--
7	120	150	150 white	175	200

TABLE 1B: Light Blocking Percentage at Various Wavelengths

Sample	400 nm (% Light blocked)	500 nm (% Light blocked)	600nm (% Light blocked)	700 nm (% Light blocked)
Black + White Film	100.0	99.7	99.4	99.0
1	97.2	79.0	79.9	71.9
2	99.1	93.6	92.9	89.8
3	99.7	97.9	97.3	96.1
4	99.5	96.9	95.2	94.4
5	98.6	93.6	91.1	89.7
6	99.5	93.8	91.5	89.9
6 – shrunk	99.7	95.6	93.6	92.3
7	99.6	98.5	97.5	97.2
7-shrunk	99.9	99.5	99.1	98.9

Figures 3-5 show UV-Vis spectra of the samples. Figure 3 shows the transmittance of each of the samples in TABLE 1B. Figure 4 is a close-up of the lower section, showing samples 2-7. Figure 5 compares samples 6 and 7 (before shrinking) to samples 6—shrunk and 7—shrunk.

EXAMPLE 2

Samples with various color graphics were prepared to evaluate the effect of the color on the light blocking and the effect of the light blocking layer on the appearance of the color.

Samples were prepared using APR certified recyclable 40 µm clear PET shrink sleeve film. The inks were printed onto the film with solvent rotogravure inks. The film was first printed with a single color (yellow, red, or reflex blue). The printed color was then overlaid with three layers of white ink. Over the white ink layers, a light blocking composition was applied by a rotogravure cylinder that had a volume of 12 BCM (billion cubic micron per square inch, or 10^9 μm^3/inch^2).

The samples were tested with a UV-Vis spectrophotometer (Shimadzu model UV-2600i) or their light blocking ability (prior to shrinking) at wavelengths ranging from 220 nm to 900 nm. The results are shown in TABLE 2. The samples were also visually observed to evaluate the effect of the light blocking layer on the appearance of the color.

TABLE 2. Light blocking.

Wavelength (nm)	Yellow film	Red film	Blue film
220	100.0 %	100.0 %	100.0 %
300	100.0 %	100.0 %	100.0 %
400	100.0 %	100.0 %	100.0 %
500	99.8 %	99.9 %	99.9 %
600	98.6 %	99.1 %	100.0 %
700	98.3 %	98.5 %	99.9 %
800	98.2 %	98.3 %	98.6 %
900	97.9 %	98.2 %	98.3 %

It was observed that lower L* value (darker color on the L*a*b* scale) inks slightly improved light blocking at certain wave lengths (e.g., 600-700 nm). It was also observed that the light blocking composition had an effect on the visual appearance of the color. It was concluded that more saturated or more opaque colors may be used to produce the intended color effect.

EXAMPLE 3

The impact of the thickness of the light blocking layer on the ability to block light was evaluated. Various samples were prepared using APR certified recyclable 40 μm clear PET shrink sleeve film. The inks were printed onto the film with solvent rotogravure inks. The film was first printed with three layers of white ink. Over the white ink layers, various thicknesses of a light blocking composition were applied, using a "banded" rotogravure cylinder (each printing lane has different engraving specifications) with lanes having volumes ranging from 5 BCM to 12 BCM (billion cubic micron per square inch, or 10^9 $\mu m^3/inch^2$). The light blocking composition included a metallic light blocking component having a gray or silver appearance.

The samples were tested with a UV-Vis spectrophotometer (Shimadzu model UV-2600i) for their light blocking ability (prior to shrinking) at wavelengths ranging from 220 nm to 900 nm. The results are shown in TABLE 3. The samples were also visually observed to evaluate the effect of the light blocking layer on the appearance of the white layer printed before it. It was observed that the thickness of the light blocking layer had an inverse correlation with the lightness of the white. As the thickness of the light blocking layer increased, the lightness of the white decreased. As the thickness of the light blocking layer decreased, the lightness of the white layer increased.

TABLE 3. Light blocking

Wavelength (nm)	**5 BCM**	**6 BCM**	**7 BCM**	**8 BCM**	**10 BCM**	**12 BCM**
220	99.9 %	99.9 %	100.0 %	100.0 %	100.0 %	100.0 %
300	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %
400	99.8 %	99.8 %	99.9 %	99.9 %	100.0 %	100.0 %
500	95.4 %	96.1 %	97.6 %	98.1 %	99.1 %	99.6 %
600	94.5 %	95.3 %	97.1 %	97.7 %	98.9 %	99.5 %
700	93.5 %	94.4 %	96.6 %	97.3 %	98.6 %	99.4 %
800	92.6 %	93.7 %	96.2 %	96.9 %	98.5 %	99.3 %
900	91.8 %	93.0 %	95.7 %	96.5 %	98.3 %	99.2 %

EXAMPLE 4

The light blocking performance of labels prepared according to the present disclosure was compared to commercially available light blocking labels.

The sample labels were prepared similar to Example 3 by a "banded" rotogravure cylinder that had lanes engraved with 12 BCM, 10 BCM, 8 BCM, and 6 BCM volumes to apply the light blocking layer.. The comparative samples were two (2) different commercially available white PET films, each printed on one side with black ink by a rotogravure cylinder that had a volume of 10 BCM. The comparative samples are non-recyclable.

The samples were tested as described in Example 3. The results are shown in TABLE 4. above.

TABLE 4. Light blocking

Wavelength (nm)	**Comparative Sample 1**	**Comparative Sample 2**	**12 BCM**	**10 BCM**	**8 BCM**	**6 BCM**
220	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %
300	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %

400	99.9 %	99.9 %	99.8 %	99.8 %	99.7 %	99.5 %
500	99.8 %	99.6 %	98.3 %	98.0 %	97.8 %	96.0 %
600	99.5 %	99.3 %	98.0 %	97.6 %	97.0 %	94.5 %
700	99.1 %	98.8 %	97.7 %	97.2 %	96.3 %	93.4 %
800	98.4 %	97.9 %	97.4 %	96.9 %	95.8 %	92.4 %
900	97.8 %	97.0 %	97.2 %	96.6 %	95.3 %	91.7 %

It was observed that the labels according to the present disclosure provided comparable light blocking properties to the commercially available labels when the light blocking layer was thicker. When the light blocking layer was less thick, the light blocking properties decreased as seen in Example 3.

It was observed upon visual comparison that the labels according to the present disclosure exhibited better lightness properties.

EXAMPLE 5

The light blocking performance of labels prepared according to the present disclosure was compared to comparative labels that are used to block light and are commercially available in the market.

The sample label was prepared using APR certified recyclable 40 μm clear PET shrink sleeve film. The inks were printed onto the film with solvent rotogravure inks. The film was first printed with an indicia layer (four different colored inks). The printed indicia layer was then overlaid with three layers of white ink. Over the white ink layers, a light blocking composition was applied by a rotogravure cylinder that had a volume of 12 BCM (billion cubic micron per square inch, or 10^9 μm^3/inch^2).

The comparative samples (Comparative Sample 3 and Comparative Sample 4) were two (2) different printed labels that are currently used for a product that needs to block light to protect its contents. Comparative Sample 3 was printed on white film, had graphics that were almost identical to the sample label, and black print on the inside to help block light. Comparative Sample 4 was printed on white film, had graphics that were different than the sample label or Comparative Sample 3, and had black print on the inside to help block light. The comparative samples are non-recyclable.

The samples were tested as described in Example 3. The light blocking results are shown in TABLE 5 below.

TABLE 5. Light blocking

Wavelength (nm)	Sample label	Comparative Sample 3	Comparative Sample 4
220	100.0%	100.0%	100.0%
300	100.0%	100.0%	100.0%
400	99.9%	99.8%	99.8%
500	99.3%	99.7%	99.7%
600	99.1%	99.5%	99.5%
700	98.9%	99.3%	99.3%
800	98.8%	99.1%	99.1%
900	98.7%	98.9%	98.9%

It was observed that the labels according to the present disclosure provided comparable light blocking properties as the commercially available labels.

It was observed upon visual comparison that the labels according to the present disclosure exhibited better lightness properties with the colors of the indicia layer appearing more vibrant.

EXAMPLE 6

The ability of typical recycling equipment to correctly sort bottles with labels according to the present disclosure was tested to test compatibility with APR sorting requirements. The samples were tested according to APR Document number SORT-B-03, Evaluation of Sorting Potential for Plastic Articles Utilizing Metal, Metalized, or Metallic Printed Components, published on May 15, 2018. Further guidance can be found in APR documents PET-CG-02, Critical Guidance Protocol for Clear PET Articles with Labels and Closures; and PET-B-02, Benchmark Evaluation for Clear PET Articles with Labels and Closures.

Labels were prepared as described in Example 2 with 12 BCM a light blocking layer. The labels were applied onto clear PET bottles. The bottles with labels were tested in an Eriez Xtreme Test Line in both vertical and horizontal orientation. Before testing begins candidate articles are compressed. Articles are the determined to be ferrous or not. Ferrous articles are tested with a plate magnet. Articles are then passed through a tunnel-style metal detector at vertical and horizontal orientations and the spherical equivalent of the of the sample is calculated. Sphere sizes of 0-2 mm indicate a recyclable sample.

The sample was found to exhibit a sphere size of 0.5 mm in the portrait orientation and 0.6 mm in the landscape orientation.

The bottles were also run through an eddy current sorter and an NIR sorter that is used to identify PET articles. The bottles were recognized as PET by the NIR sorter The bottles were also not caught by the eddy current sorter. In other words, the bottles passed the recycling criteria for plastic (e.g., PET) bottles.

The complete disclosure of all patents, patent applications, and publications, and electronically available material cited herein are incorporated by reference. In the event that any inconsistency exists between the disclosure of the present application and the disclosure(s) of any document incorporated herein by reference, the disclosure of the present application shall govern. The foregoing detailed description and examples have been given for clarity of understanding only. No unnecessary limitations are to be understood therefrom. The invention is not limited to the exact details shown and described, for variations obvious to one skilled in the art will be included within the invention defined by the claims.

What is claimed is:

1. A recyclable shrink label comprising:

a heat shrink film having a first surface and a second surface opposite of the first surface, the heat shrink film having a thickness from 15 μm to 100 μm or 30 μm to 80 μm; and

a light blocking layer disposed adjacent the first surface and comprising a light blocking component, the light blocking layer being constructed for the recyclable shrink label to block at least 80 % of incident light having wavelengths in a range of 200 nm to 900 nm.

2. The recyclable shrink label of claim 1 further comprising an indicia layer, optionally wherein the indicia layer is disposed on the first surface.

3. The recyclable shrink label of claim 1 or 2 further comprising a high opacity layer, the high opacity layer optionally comprising a white pigment.

4. The recyclable shrink label of claim 3, wherein the recyclable shrink label comprises an indicia layer and wherein the high opacity layer is disposed between the indicia layer and the light blocking layer.

5. The recyclable shrink label according to any of claims 1 to 4, wherein the heat shrink film comprises polyester, polyolefin, or a combination thereof.

6. The recyclable shrink label according to any of claims 1 to 5, wherein the heat shrink film comprises polyethylene terephthalate (PET), polyethylene terephthalate glycol-modified (PETG or PET-G), polyvinyl chloride (PVC), polystyrene or oriented polystyrene (OPS), polylactic acid (PLA), polypropylene (PP), polyethylene (PE), or a combination thereof.

7. The recyclable shrink label according to any of claims 1 to 6, wherein the heat shrink film comprises a seam.

8. The recyclable shrink label according to any of claims 1 to 7, wherein the heat shrink film is in a form of a sleeve or tube.

9. The recyclable shrink label according to any of claims 1 to 8, wherein when heated to 100 °C, the heat shrink film contracts or shrinks by about 1 % to about 90 %, optionally wherein the heat shrink film contracts of shrinks by about 1 % to 90 % in a transverse direction.

10. The recyclable shrink label according to any of claims 1 to 9, wherein when heated to 100 °C, the entire recyclable shrink label contracts or shrinks by about 1 % to about 90 %, optionally wherein the entire recyclable shrink label contracts of shrinks by about 1 % to 90 % in a transverse direction.

11. The recyclable shrink label according to any of claims 3 to 10, wherein the high opacity layer comprises a pigment selected from titanium dioxide (TiO_2), precipitated calcium carbonate (PCC), aluminum silicate, aluminum oxide (alumina), mica-based pigments coated with thin layer(s) of white pigment, or a combination thereof.

12. The recyclable shrink label according to any of claims 1 to 11, wherein the light blocking component comprises a metal particulate, optionally wherein the metal particulate has a particle size of 0.1 μm to 100 μm.

13. The recyclable shrink label according to any of claims 1 to 12, wherein the light blocking component comprises zinc, aluminum, copper, silver, or an alloy thereof, titanium dioxide, carbon black, mica, a reflective pigment, a polymer capable of blocking light, a mineral capable of blocking light, or a combination thereof.

14. The recyclable shrink label according to any of claims 1 to 13, wherein the light blocking layer is present in an amount of 0.5 ppr to 25 ppr.

15. The recyclable shrink label according to any of claims 1 to 14, wherein the light blocking layer comprises from 0.1 ppr to 10 ppr, from 0.2 ppr to 5 ppr, or from 0.3 ppr to 3 ppr of the light blocking component.

16. An article comprising:

a container comprising an external surface; and

the recyclable shrink label of any one of claims 1 to 15 disposed on the container, optionally wherein the first surface of the heat shrink film faces the external surface of the container.

17. The article according to claim 16, wherein the container comprises polymer, glass, metal, or a combination thereof.

18. The article according of claim 16 or 17, wherein the container comprises polyethylene terephthalate (PET), optionally wherein the container consists of polyethylene terephthalate (PET), optionally wherein the container comprises clear polyethylene terephthalate (PET).

19. The article of any one of claims 16 to 18, wherein the recyclable shrink label comprises polyethylene terephthalate (PET), and optionally wherein the polyethylene terephthalate (PET) forms an outermost layer of the recyclable shrink label.

20. A method of making a label for a container, the method comprising:

depositing an indicia layer on a heat shrinkable film;

optionally depositing a high opacity layer on the indicia layer; and

depositing a light blocking composition on the indicia layer, on the heat shrinkable film, or on the high opacity layer,

wherein the light blocking layer comprises one or more light blocking components, and wherein the label is capable of blocking at least 80 % of incident light having wavelengths in a range of 200 nm to 900 nm.

21. A method of recycling an article comprising a container defining an external surface; and the recyclable shrink label of any one of claims 1 to 15 disposed on the container, optionally with the first surface facing the external surface of the container, the method comprising:

determining that the container and recyclable shrink label comprise polyethylene terephthalate (PET);

directing the article into a polyethylene terephthalate (PET) recycling stream; and

washing the article to remove inks and pigments from the recyclable shrink label.

22. The method of claim 21, wherein the washed article is clear and is not stained by the light blocking component or other pigments or inks.

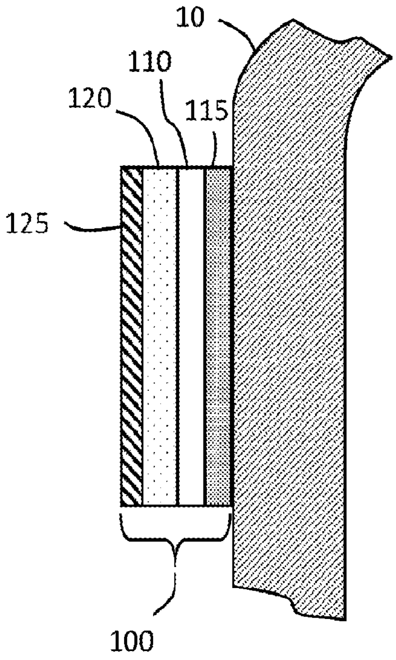

FIG. 1A

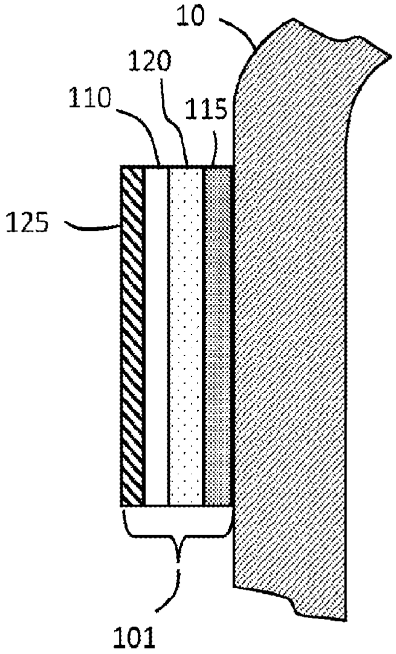

FIG. 1B

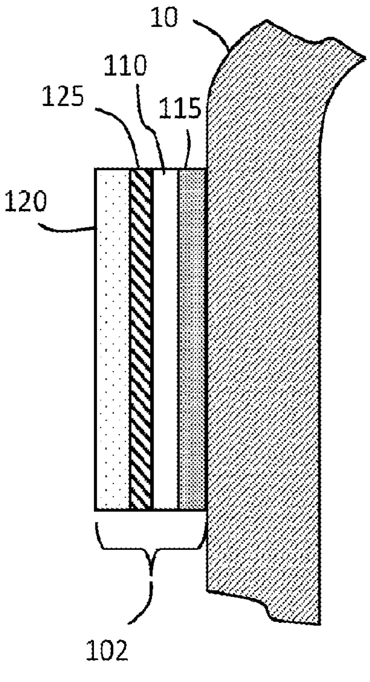

FIG. 1C

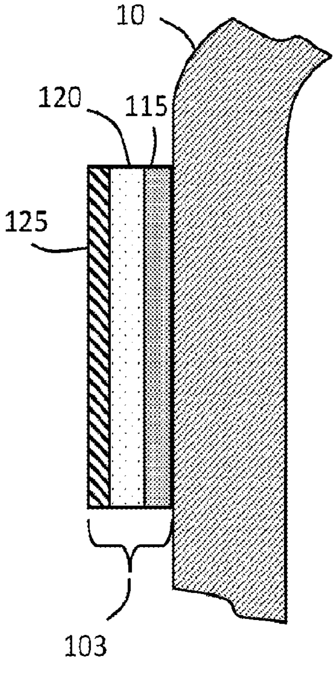

FIG. 1D

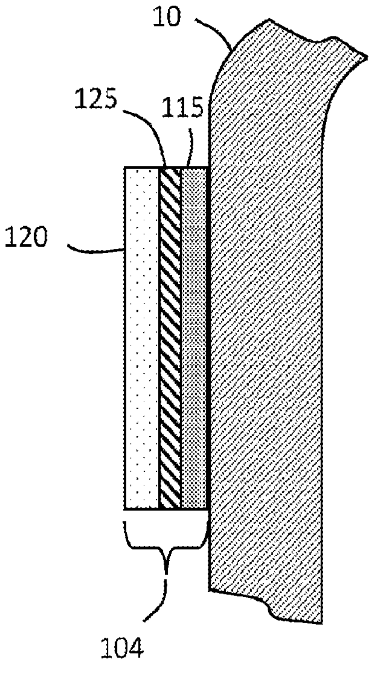

FIG. 1E

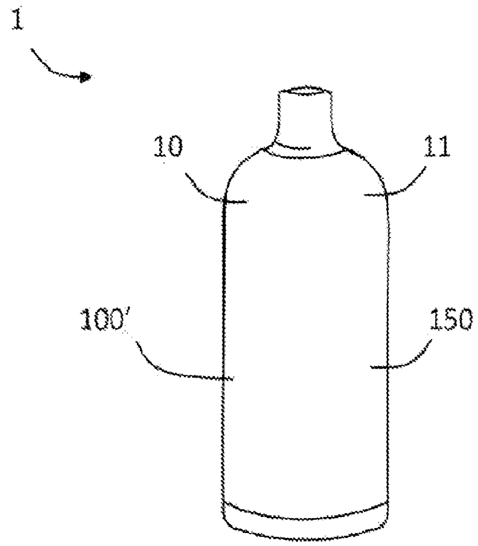

Fig. 2

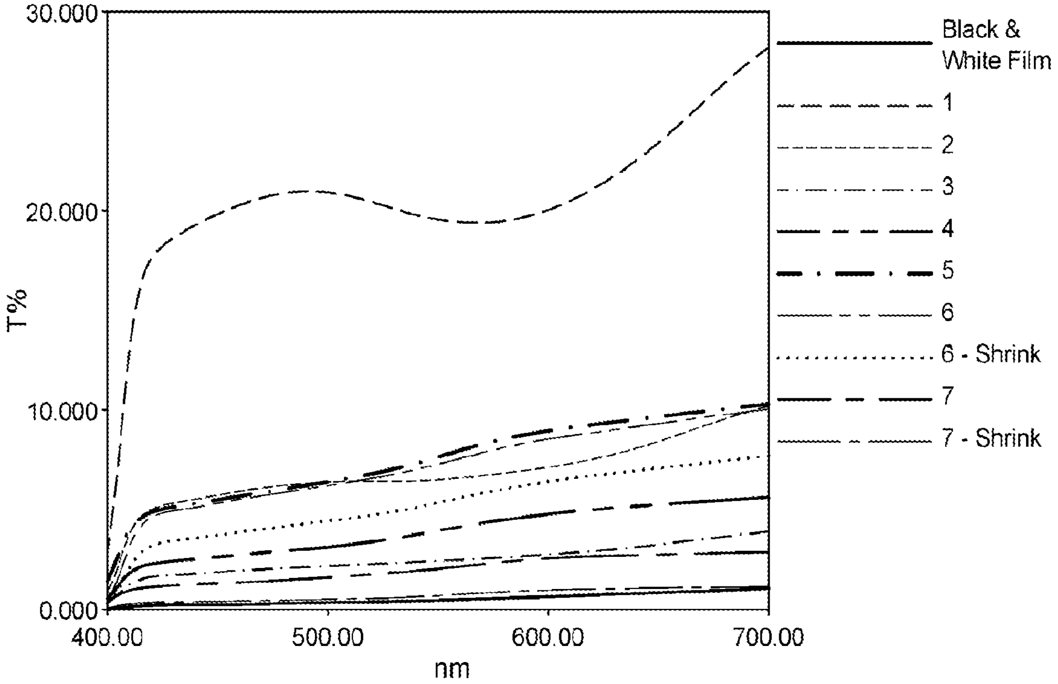

Fig. 3

SUBSTITUTE SHEET (RULE 26)

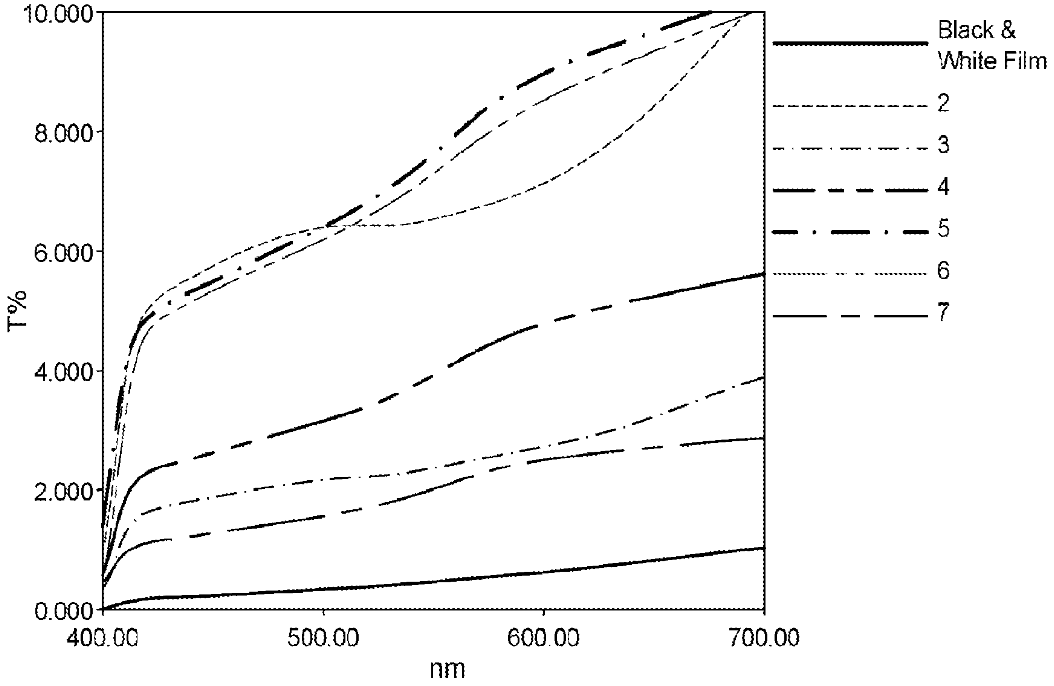
10.000
8.000
6.000
4.000
2.000
0.000
T%
400.00
500.00
600.00
700.00
nm
Black & White Film
2
3
4
5
6
7

Fig. 4

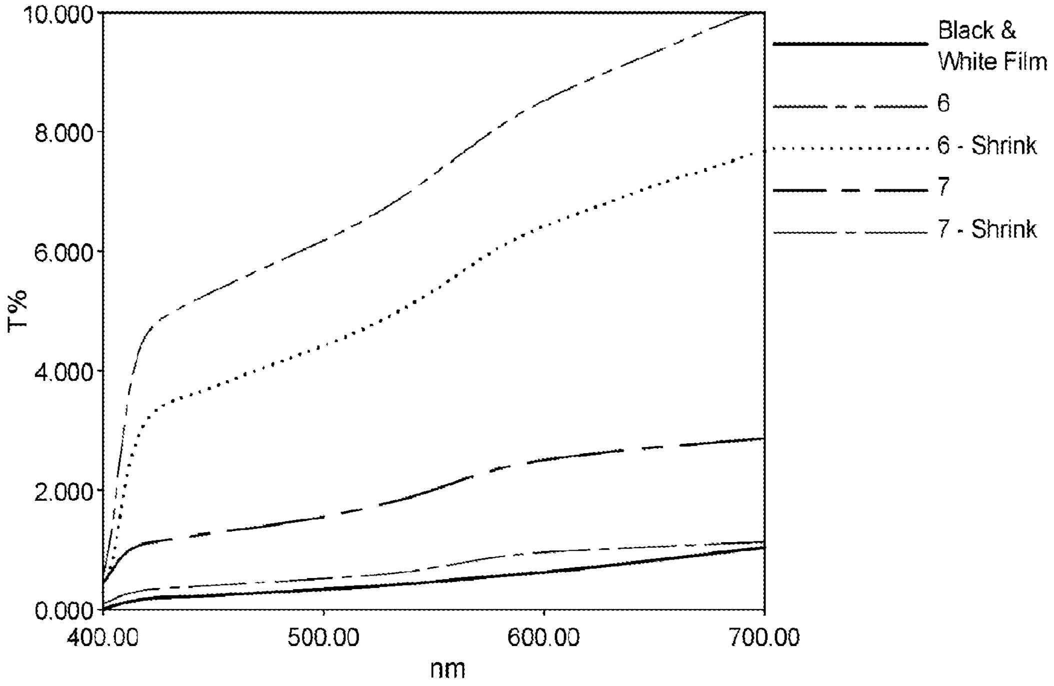
10.000
8.000
6.000
4.000
2.000
0.000
T%
400.00
500.00
600.00
700.00
nm
Black & White Film
6
6 - Shrink
7
7 - Shrink

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2022/029280

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B32B 1/02; B32B 27/08; B65B 53/02 (2022.01)
CPC - B32B 27/08; B65B 53/02; B32B 2519/00 (2022.05)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
See Search History document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2009/0233067 A1 (DOORNHEIM et al) 17 September 2009 (17.09.2009) entire document	1-4, 20
A	US 2003/0068453 A1 (KONG) 10 April 2003 (10.04.2003) entire document	1-4, 20

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:
"A"	document defining the general state of the art which is not considered to be of particular relevance
"D"	document cited by the applicant in the international application
"E"	earlier application or patent but published on or after the international filing date
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O"	document referring to an oral disclosure, use, exhibition or other means
"P"	document published prior to the international filing date but later than the priority date claimed
"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&"	document member of the same patent family

Date of the actual completion of the international search 17 July 2022	Date of mailing of the international search report AUG 11 2022
Name and mailing address of the ISA/US *Mail Stop PCT, Attn: ISA/US, Commissioner for Patents* P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	Authorized officer Taina Matos Telephone No. PCT Helpdesk: 571-272-4300

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2022/029280

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 5-19, 21, 22
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (July 2019)

The heat shrink film may include or be made of polyester, polyolefin, or a combination thereof. In some cases, the heat shrink film includes or is made of polyethylene terephthalate (PET), polyethylene terephthalate glycol-modified (PETG or PET-G), polyvinyl chloride (PVC), polystyrene or oriented polystyrene (OPS), polylactic acid (PLA), polypropylene (PP), polyethylene (PE), or a combination thereof. In some cases, the heat shrink film consists of polyethylene terephthalate (PET), polyethylene terephthalate glycol-modified (PETG or PET-G), polyvinyl chloride (PVC), polystyrene or oriented polystyrene (OPS), polylactic acid (PLA), polypropylene (PP), polyethylene (PE), or a combination thereof. In some cases, the heat shrink film consists of polyethylene terephthalate (PET).

When heated to 100 °C, the heat shrink film may contract or shrink by about 1 % to about 90 %. The heat shrink film may contract of shrink by about 1 % to 90 % in the transverse direction. When the heated to 100 °C, the entire recyclable shrink label may contract or shrink by about 1 % to about 90 %. The entire recyclable shrink label may contract of shrink by about 1 % to 90 % in the transverse direction.

The high opacity layer may include a pigment selected from titanium dioxide (TiO2), precipitated calcium carbonate (PCC), aluminum silicate, aluminum oxide (alumina), mica-based pigments coated with thin layer(s) of white pigment, or a combination thereof.

The light blocking component may include a metal particulate. The metal particulate may have a particle size of 0.1 μm to 100 μm. The light blocking component may include or consist of zinc, aluminum, copper, silver, or an alloy thereof, titanium dioxide, carbon black, mica, a reflective pigment, a polymer capable of blocking light, a mineral capable of blocking light, or a combination thereof. The light blocking layer may be present on the label in an amount of 0.5 ppr to 25 ppr. The light blocking component may be present at 0.1 ppr to 10 ppr, from 0.2 ppr to 5 ppr, or from 0.3 ppr to 3 ppr.

According to an embodiment, an article includes a container comprising an external surface; and the recyclable shrink label described above, disposed on the container. In some embodiments, the first surface of the heat shrink film faces the external surface of the container. The container may include or be made of polymer, glass, metal, or a combination thereof. The container may include or be made (e.g., consist of) polyethylene terephthalate (PET). The container may include or be made (e.g., consist of) clear polyethylene terephthalate (PET). The recyclable shrink label may include or be made polyethylene terephthalate (PET). In some cases, the polyethylene terephthalate (PET) forms the outermost layer of the recyclable shrink label.

a stated step or element or group of steps or elements but not the exclusion of any other step or element or group of steps or elements.

By “consisting of” is meant including, and limited to, whatever follows the phrase “consisting of.” Thus, the phrase “consisting of” indicates that the listed elements are required or mandatory, and that no other elements may be present. By “consisting essentially of” is meant including any elements listed after the phrase and limited to other elements that do not interfere with or contribute to the activity or action specified in the disclosure for the listed elements. Thus, the phrase “consisting essentially of” indicates that the listed elements are required or mandatory, but that other elements are optional and may or may not be present depending upon whether or not they materially affect the activity or action of the listed elements.

The term “substantially” as used here has the same meaning as “nearly completely,” and can be understood to modify the term that follows by at least about 90 %, at least about 95 %, or at least about 98 %. The term “not substantially” as used here has the same meaning as “not significantly,” and can be understood to have the inverse meaning of “substantially,” i.e., modifying the term that follows by not more than 10 %, not more than 5 %, or not more than 2 %.

Unless otherwise specified, “a,” “an,” “the,” and “at least one” are used interchangeably and mean one or more than one.

As used herein, the term “or” is generally employed in its usual sense including “and/or” unless the content clearly dictates otherwise.

The term “and/or” means one or all of the listed elements or a combination of any two or more of the listed elements.

Any reference to standard methods (e.g., ASTM, TAPPI, AATCC, etc.) refer to the most recent available version of the method at the time of filing of this disclosure unless otherwise indicated.

Also herein, the recitations of numerical ranges by endpoints include all numbers subsumed within that range (e.g., 1 to 5 includes 1, 1.5, 2, 2.75, 3, 3.80, 4, 5, etc.).

Herein, “up to” a number (for example, up to 50) includes the number (for example, 50).

The term “in the range” or “within a range” (and similar statements) includes the endpoints of the stated range.

For any method disclosed herein that includes discrete steps, the steps may be conducted in any feasible order. And, as appropriate, any combination of two or more steps may be conducted simultaneously.

As used herein, the term "ink" refers to a colored material for writing and printing. Generally, ink has four main ingredients: (1) colorant, which is composed of a pigment, dye, or mixture of pigments and/or dyes which define the color of the colorant, (2) resin, which is a binder that can be soluble or in a solvent and the binder holds the colorant on a substrate, (3) optionally solvent or water to dissolve the resin (the solvent or water is removed after printing onto the label), and (4) optionally additives to adjust properties of the ink. Pigments can be organic and inorganic substances. Inks herein can be differentiated as metallic inks and non-metallic inks. As used herein, the term "metallic ink" refers to an ink to which metal flakes or powder are added as a pigment additive to the ink. Metallic inks when printed can appear to be reflective or shiny. Therefore, "non-metallic ink" herein referred to inks without such metal flakes or powder components.

As used herein, the term "opaque" refers to a substrate or printed substrate that has an opacity greater than or equal to 50 %.

As used herein, the term "opacity" refers to the property of a substrate or printed substrate which measures the capacity of the substrate to hide or obscure from view an object placed behind the substrate relative to the point from which an observation is made. Opacity can be reported as the ratio, in percent, of the diffuse reflectance of a substrate backed by a black body having a reflectance of 0.5 % to the diffuse reflectance of the same substrate backed with a white body having an absolute reflectance of 89 %. Opacity can be measured as described in ASTM D 589-97, Standard Test Method for Opacity of Paper (15°/Diffuse Illuminant A, 89 % Reflectance Backing and Paper Backing). A substrate high in opacity will not permit much, if any, light to pass through the substrate. A substrate having low opacity will permit much, if not nearly all, light to pass through the substrate. Opacity can range from 0 to 100 %. As used herein, the term "low opacity" refers to a substrate or printed substrate having opacity less than 50 %. As used herein, the term "high opacity" refers to a substrate or printed substrate having opacity greater than or equal to 50 %.

As used herein, the term "indicia" refers to markings or indications that can be used to convey a message. The message conveyed can be an indication of source, the characteristics of a product in a package, the quantity of a product in a package, the quality of a product in a package, or any other message. Indicia can be a symbol such as a graphic resembling a target used for training archers to indicate a particular retail store. Indicia can be text in any language or combination of languages representative of verbal communication. Indicia can be patterns of colors, lines, or combinations thereof. Indicia can be illustrations of tangible objects such as an apple indicating the source of a particular brand of computer. Indicia can be artwork depicting tangible

FIGS. 3-5 are graphical representations of data from Example 1.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

The present disclosure relates to labels that are opaque and recyclable. The present disclosure further relates to shrinkable labels that are opaque and recyclable.

The term label is used here broadly. Although many embodiments described herein may be characterized as shrink sleeves, the disclosure and the term label are not limited to such embodiments only. The label may cover at least some clear or transparent parts of a package. The label may serve to block light from reaching a product inside the package. The label may be used to provide graphic elements and information about the product, such as product information required by law, if applicable (e.g., ingredient list and/or nutritional facts).

According to an embodiment, the labels of the present disclosure have a layered construction. The layered construction may include one or more shrink film layers and one or more light blocking (opaque) layers. The layered construction may further include other layers, such as additional polymeric layers, indicia, adhesive layers, a slip coat, a protective top layer, another functional layer, or a combination thereof. Such additional layers may be placed between the shrink film, indicia layer, high opacity layer, or light blocking layer, or on the outside of any such layers. The shrink film has a first surface and a second surface opposite of the first surface. When the label is applied onto a container (e.g., a bottle), the first surface may be the side facing the container and the second surface may face the outside of the container. The light blocking layer may be disposed adjacent the first surface. That is, generally, the light blocking layer may be disposed between the shrink film and the container. The other layers, if included, may be disposed adjacent the first surface or the second surface. The term "adjacent" is used here to indicate which the side of the label the layer is closest. Additional optional layers may be disposed between adjacent layers. The term "immediately adjacent" is used to indicate that the layers in question are in contact with one another and there are no intervening layers.

It is desirable that the label blocks light (e.g., ambient light and sun light, e.g., from 200 nm to 900 nm) such that the contents of a container covered by the label can be protected from light. It is further desirable that the label is recyclable. Generally clear crystallizable heat shrink films (e.g., PET shrink films) are considered recyclable if no inks are retained on the film after a caustic wash cycle typically used in PET reclaiming processes.

measurement in the third dimension (e.g., the thickness). In some embodiments, useful heat shrink films or articles including such heat shrink films shrink from 1 % to 90 % in the transverse direction (TD) and up to 10% in the machine direction (MD). In some embodiments, useful heat shrink films or articles including such heat shrink films shrink from 1 % to 90 % in the machine direction and up to 10% in the transverse direction. As used herein, transverse direction means a direction perpendicular to the direction of working. As used herein, machine direction means a direction parallel to the direction of working.

The composition of the heat shrink film, whether two- or three-dimensional, is not particularly limited and can comprise high- or low-density polymers, or combinations thereof. Low density polymers that have a density of less than 1 g/cm^3 may be preferred. Such low densities allow for water flotation separation from a denser substrate during recycling processes. In some embodiments, the label includes a heat shrink film having a density of 1 g/cm^3 or less.

According to an embodiment, the label includes a heat shrink film having a thickness of 15 µm or greater, 30 µm or greater, 35 µm or greater, 37 µm or greater, 40 µm or greater, 45 µm or greater, 50 µm or greater, or even 60 µm or greater. The preferred heat shrinkable film is comprised of a film having a thickness of not greater than 100 µm or less, 90 µm or less, 90 µm or less, 85 µm or less, 80 µm or less, 75 µm or less, 70 µm or less, 65 µm or less, or even 60 µm or less. In some embodiments, the heat shrink film has a thickness ranging from 15 µm to 100 µm, 30 µm to 80 µm, 40 µm to 60 µm, or even 40 µm to 55 µm.

According to an embodiment, the label includes a heat shrink film that shrinks when heated to or above a shrink initiation temperature. The shrink initiation temperature may be above 22.5 °C or in the range from about 40 °C to about 200 °C. Shrinkage of heat shrink films is typically measured using a hot water bath method, where the film is immersed in a heated water bath for 10 seconds. The measurement may be repeated at different temperatures, such as at 100 °C and 80 °C. Shrinkage may be reported at a given temperature, or shown as a shrink curve. Shrinkage numbers here are given as measured at 100 °C. When heated to 100 °C, the heat shrink film shrinks 1 % or more, 2 % or more, 5 % or more, 10 % or more, 20 % or more, 30 % or more, 40 % or more, or 50 % or more of the size it was before heating. When heated to 100 °C, the heat shrink film shrinks 90 % or less, 80 % or less, 75 % or less, 70 % or less, or 50 % or less of the size it was before heating. When heated to 100 °C, the heat shrink film may shrink from 1 % to 90 %, from 2 % to 80 %, or from 5 % to 70 %. The shrinkage may be in the machine direction, the transverse direction, or both.

is recyclable with PET bottles. In some embodiments, the shrink film consists of polyethylene terephthalate (PET).

Shrink films are typically polymeric films that are applied over or around a substrate or, for example, a container (e.g., a bottle, jar, tube, or the like) or multiple containers (e.g., a multipack of containers). Two portions (e.g., two edges) of the film can be bonded together to form a seal or seam that results in a sleeve or tube configuration. When heated to 100 °C, the shrink film contracts or shrinks by 1 % or more, 2 % or more, 5 % or more, 10 % or more, 20 % or more, 30 % or more, 40 % or more, or 50 % or more. When heated to 100 °C, the shrink film may contract or shrink by 90 % or less, 80 % or less, 75 % or less, 70 % or less, or 50 % or less of the size it was before heating.. The shrink film may contract or shrink 1 % to 90 %, from 2 % to 80 %, or from 5 % to 70 % upon heating to or above the shrink initiation temperature. The shrinkage may be in the machine direction, the transverse direction, or both. In some embodiments, the heat shrink film shrinks primarily in the transverse direction only. In some embodiments, the heat shrink film shrinks primarily in the machine direction only. The amount that a shrink film shrinks can be largely dependent or may be chosen based on the container which it is to be shrunk around. The film shrinks to conform to the contours of the underlying article. In one embodiment, the shrink film is microperforated to allow trapped air to be released from the interface between the label and the article to which it is adhered. In another embodiment, the shrink film is permeable to allow fluid to escape from the adhesive or from the surface of the article. In one embodiment, vent holes or slits are provided in the shrink film. In some embodiments, perforations, pin holes, or such features may desirably be avoided in order to maximize light blocking characteristics.

The layers of the shrink film, or layers applied to the shrink films may optionally contain pigments, fillers, stabilizers, light protective agents, or other suitable modifying agents if desired.

The shrink film may have any suitable color. However, for recyclability, useful shrink films may specifically include clear shrink films and white shrink films (e.g., white floatable films). Clear shrink films may be made white by including an additional layer or layers that includes a pigment that makes the heat shrink film appear white when viewed. White shrink films may also be made by adding white pigments during the extrusion or formation process for example.

Useful shrink films may also contain a layer of an ink-receptive composition that enhances the printability of the shrink film, and the quality of the print layer thus obtained. A variety of such compositions are known in the art, and these compositions generally include a binder and a pigment, such as silica or talc, dispersed in the binder. The presence of the ink-receptive the underlying print layer to provide a glossier and richer image. The transparent or non-transparent topcoat layer could change the aesthetics of the underlying print layer or label (e.g., matte finish or soft touch finish). The protective transparent protective layer may also be designed to be abrasion resistant, radiation resistant (e.g., UV resistant), chemically resistant, thermally resistant, thereby protecting the label and, particularly the print layer from degradation from such causes. The overcoat may also contain antistatic agents or anti-block agents to provide for easier handling when the labels are being applied to containers at high speeds. The layer may be applied to the print layer by techniques known to those skilled in the art. The polymer film may be deposited from a solution or applied as a preformed film (laminated to the print layer), or by any other suitable means known in the art.

When a transparent or non-transparent topcoat or overcoat layer is present, it may have a single layer or a multilayered structure. The thickness of the protective layer is generally in the range of about 1 μm to about 125 μm, about 12.5 μm to about 125 μm, and in one embodiment about 25 μm to about 75 μm. Examples of topcoat layers are described in U.S. Pat. No. 6,106,982 (Mientus et al.) which is incorporated herein by reference.

The topcoat or overcoat layer may comprise polyolefins, thermoplastic polymers of ethylene or propylene, polyesters, polyurethanes, polyacryls, polymethacryls, epoxy, vinyl acetate homopolymers, co- or terpolymers, ionomers, and mixtures thereof.

The transparent topcoat or overcoat may contain UV light absorbers and/or other light stabilizers. Suitable UV light absorbers include those available from BASF under the trade designations “Tinuvin” and “Chimassorb,” for example Tinuvin 111, Tinuvin 123, Tinuvin 622, Tinuvin 770, Tinuvin 783, Chimassorb 119, and Chimassorb 944. The concentration of the UV light absorber and/or light stabilizer is in the range of up to about 2.5 % by weight of the transparent protective layer and in one embodiment about 0.05 % to about 1 % by weight. However, in some embodiments, the transparent topcoat or overcoat does not include a UV light absorber or stabilizer.

The transparent topcoat or overcoat layer may contain an antioxidant. Any antioxidant useful in making thermoplastic films can be used.

According to an embodiment, an exemplary label includes clear recyclable shrink PET film having an optional anti-static coating, high TD shrinkage, low MD shrinkage, very low shrink force, and gradual shrink curve. According to an embodiment, the labels of the present disclosure can meet certain industry standards, including for example the Association for Plastic Recyclers (APR) Critical Guidance Protocol for Clear PET Articles with Labels and Closures (PET-CG-02), which flexographic printing, and lithographic printing (e.g., offset lithographic), plateless printing (e.g., digital), post press applications, and screen printing for example. Gravure printing is the direct transfer of liquid ink to substrate from a metal image carrier. The image is lower than the surface of the image carrier base. Flexographic printing is the direct transfer of liquid ink to substrate, typically from a photopolymer image carrier although other image carriers exist. The image is raised above the surface of the image carrier base. Offset lithographic printing is the indirect transfer of paste ink to substrate from a rubber 'blanket' that is intermediate to substrate and the thin planographic metal image carrier. Some examples of plateless printing include liquid toner electrophotography, dry toner electrophotography, drop on demand inkjet, continuous inkjet, or NANOGRAPHY™.

In embodiments where the high opacity coating composition is applied to the shrink film or layer on the shrink film via rotogravure coating or printing, the high opacity coating composition can have a viscosity from 16 seconds to 40 seconds, from 16 seconds to 25 seconds, or from 19 seconds to 24 seconds, measured with a #2 Zahn Cup, for example.

In embodiments where the high opacity coating composition is applied to the shrink film or layer on the shrink film via gravure coating or rotogravure coating, the high opacity coating composition can be applied using a one or more rotogravure cylinders. The cylinder(s) may be adjusted to provide a desired amount of coating composition on the surface of the shrink film or layer. The cylinder(s) may have a cell volume of 1.0 BCM or greater, 5 BCM or greater, 10 BCM or greater, or 15 BCM or greater. The cell volume may be 2 BCM or less, 25 BCM or less, or 20 BCM or less. The cell volume may range, for example, from 1.0 BCM to 30.0 BCM, or from 5 BMC to 25 BCM. The cylinder(s) may have cell width values of 25 μm or greater, 50 μm or greater, or 100 μm or greater. The cylinder(s) may have cell width values of 300 μm or less, 250 μm or less, or 200 μm or less. The cell width values may range, for example, from 25 μm to 300 μm. The cylinder(s) may have channel widths of 1 μm or greater, 5 μm or greater, 10 μm or greater, 20 μm or greater, or 30 μm or greater. The channel widths may be 75 μm or less or 50 μm or less. The channel widths may range from 1 μm to 75 μm. The cylinder(s) may have line screen values of 25 LPI or greater, 50 LPI or greater, 100 LPI or greater, 150 LPI or greater, or 200 LPI or greater. The line screen values may be 400 LPI or less, 350 LPI or less, 300 or less, 250 or less, or 200 or less. The line screen values may range from 25 LPI to 400 LPI. According to exemplary embodiments, a desired dry coat weight may be 0.5 ppr or greater, 1 ppr or greater, 5 ppr or greater, 10 ppr or greater, or 15 are encapsulated with a metal or metal containing compound. Examples of light blocking components include but are not limited to organic and inorganic pigments, e.g., metallic pigments, that are designed for solvent printing or water-based printing. The pigments may be encapsulated or non-encapsulated. Useful metallic pigments can include, for example, zinc, copper, silver, aluminum, and alloys and combinations thereof. In other embodiments, the light blocking components include titanium dioxide and associated fillers, carbon black, mica, reflective pigments, and other polymers and minerals capable of blocking light.

According to an embodiment, the light blocking component is a particulate material. The particles of the light blocking component may have a particle size of 0.1 µm or greater, 0.5 µm or greater, 1 µm or greater, 2 µm or greater, 3 µm or greater, 4 µm or greater, or 5 µm or greater. The particle size of the particles of the light blocking component may be 100 µm or smaller, 50 µm or smaller, 25 µm or smaller, 15 µm or smaller, 12 µm or smaller, 10 µm or smaller, 8 µm or smaller, 7 µm or smaller, or 6 µm or smaller. In some embodiments, the particle size of the light blocking component is in the range of 0.1 µm to 100 µm, 1 µm to 50 µm, or 2 µm to 25 µm. The particle size referred to here is an average particle size diameter measured by laser diffraction.

Useful light blocking coating compositions can include compositions formulated for use as rotogravure inks (e.g., rotogravure solvent-based inks), flexographic inks, lithographic inks, or digital printing inks (e.g., ink jet, nanographic), for example.

In addition to the light blocking components, the light blocking composition may further include solvents such as alcohols, esters, ketones, or hydrocarbon mixtures, resins such as nitrocellulose, polyamide, vinyl, or acrylic, or additives such as waxes, plasticizers, surfactants, corrosion inhibitors, or crosslinkers to adjust properties of the composition.

The amount of light blocking component in the light blocking composition may be 3.0 wt-% or greater, 5.0 wt-% or greater, or 10 wt-% or greater. The amount of light blocking component in the light blocking composition may be 50.0 wt-% or less, 40 wt-% or less, 30 wt-% or less, or 25 wt-% or less. The amount of light blocking component in the light blocking composition may be from 3.0 wt-% to 50 wt-%, 5.0 wt-% to 40 wt-%, or from 10 wt-% to 25 wt-%. The amount of light blocking component on the label may vary based on the desired amount of light blocking and on the specific light blocking component used. In some embodiments, the light blocking component may be present on the label at 0.1 ppr to 10 ppr, from 0.2 ppr to 5 ppr, or from 0.3 ppr to 3 ppr.

The light blocking coating composition can be applied on the shrink film (or on a layer thereon) using any methods known in the art including but not limited to gravure printing (e.g., greater, 0.4 ppr or greater, 0.5 ppr or greater, 1 ppr or greater, 5 ppr or greater, 10 ppr or greater, or 15 ppr or greater. The desired dry coat weight may be 25 ppr or less, 20 ppr or less or 15 ppr or less. The desired dry coat weight may range from 0.1 ppr to 25 ppr, from 0.4 ppr to 15 ppr, or from 0.5 ppr to 10 ppr.

In embodiments the light blocking coating composition may be applied to the shrink film or layer on the shrink film via rotogravure coating or printing using a single (1) rotogravure cylinder having a line screen number ranging from 25 LPI to 400 LPI. In some embodiments, the light blocking coating composition may be applied to the shrink film or layer on the shrink film via rotogravure coating using a single (1) rotogravure cylinder having a line screen number of 120 LPI or using two (2) rotogravure cylinders having a line screen number of 200 LPI. The resulting dry coat weight may be in a range of 0.5 ppr to 10 ppr.

Application of the light blocking coating composition onto the shrink film or onto a layer on the shrink film forms a light blocking layer. The light blocking layer need not be constant, continuous or complete across the entirety of the shrink film. In some embodiments, the high opacity layer forms a pattern of discrete dots of light blocking component. In other embodiments, the high opacity layer forms a continuous layer of light blocking component.

INDICIA LAYER

Disclosed labels may also include an indicia layer applied thereon or on a layer applied onto the shrink film, including for example the high opacity layer discussed above. The indicia layer can be applied by applying one or more layers or one or more partial layers of an image-forming composition.

Useful image-forming compositions can include compositions formulated for use as rotogravure inks (e.g., rotogravure solvent-based inks), flexographic inks, lithographic inks, or digital printing inks (e.g., ink jet, nanographic), for example. Virtually any ink or combination of ink compositions that are useful in forming indica (e.g., an image and associated text for forming a product label) can be utilized in forming an indicia layer as disclosed herein.

Suitable components of the image-forming composition are not particularly limited. Some examples of suitable components that may be used in the image-forming composition are disclosed below.

In some embodiments, the image-forming composition includes a solvent, such as an organic solvent or water or a combination thereof. The amount of solvent in the composition may be

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APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/103,234	**01/31/2023 04:46:49 PM ET**	**0644.000001US01**

Title of Invention

RECYCLABLE HEAT SHRINK FILM FOR RECYCLABLE CONTAINER

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	8140	FILED BY	Margaret Rausch
PATENT CENTER #	61522514	FILING DATE	-
CUSTOMER #	26813	FIRST NAMED INVENTOR	Andrew Sharp
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Lotta Kiuru-Ribar

Documents

TOTAL DOCUMENTS: 3

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
WO2022241272A1-PCT publication.pdf	45	Miscellaneous Incoming Letter	10026 KB
2023-01-31-PCTDrawings.pdf	3	Drawings-only black and white line drawings	669 KB
2023-01-31-Communication re Drawings.pdf	2	Miscellaneous Incoming Letter	79 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)

WO2022241272A1-PCT publication.pdf	F8AC39C04463D1A6D58CF1AD313282BBD1675E5A6CC8744B B7F4C4913BBEBF9C8F8EC2FA5821216D4E40937367D32E5C9 D2993BA716250914CB5EFFD722F2E54
2023-01-31-PCTDrawings.pdf	B31DD31276883D002311EB6B6A527CE0075B50389EA2D6FA0 5679684DB3662E04653F85014F7B55195882803C8F552F60453 689C98D8FD9087295CB1936ED145
2023-01-31-Communication re Drawings.pdf	7E09FF80C054747C540EBFB7BD7464F83ED9E52F656919AD7 D6C642FDC78D0D606CFF12C87A849EEAB678467529208F026 D001C11E505465E880C5D5C32DB1D7

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

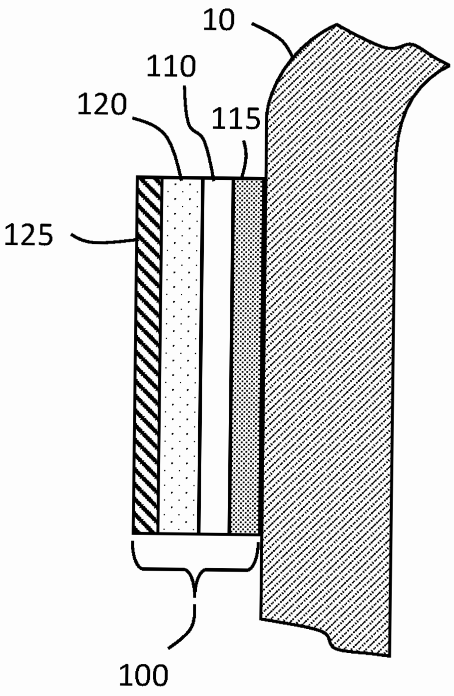

FIG. 1A

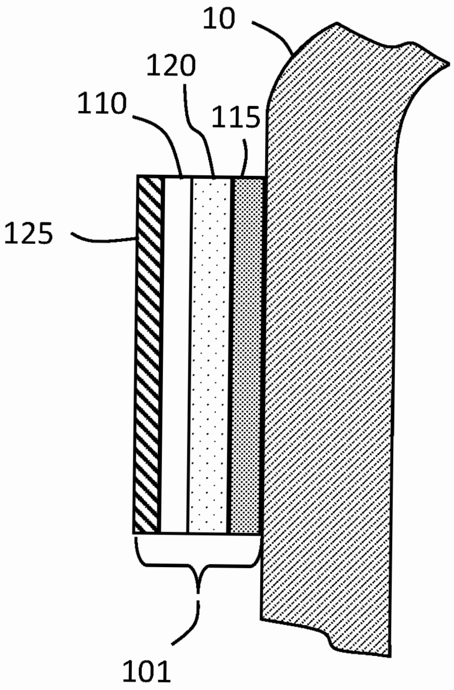

FIG. 1B

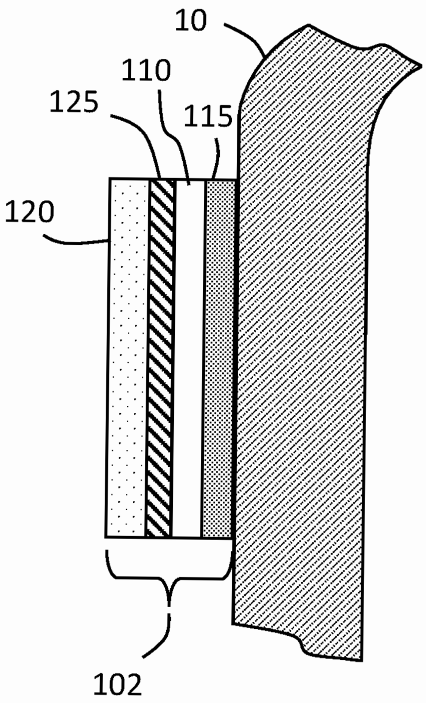

FIG. 1C

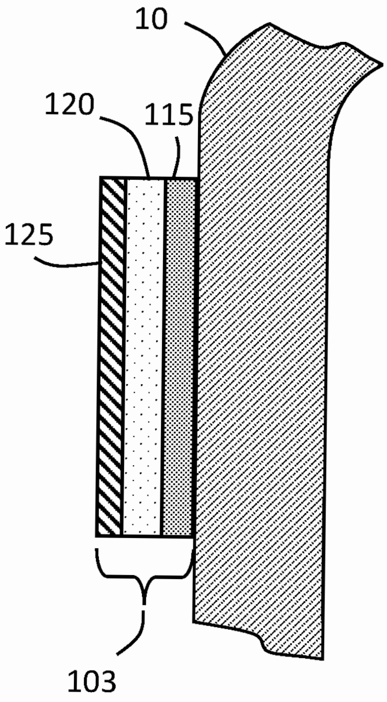

FIG. 1D

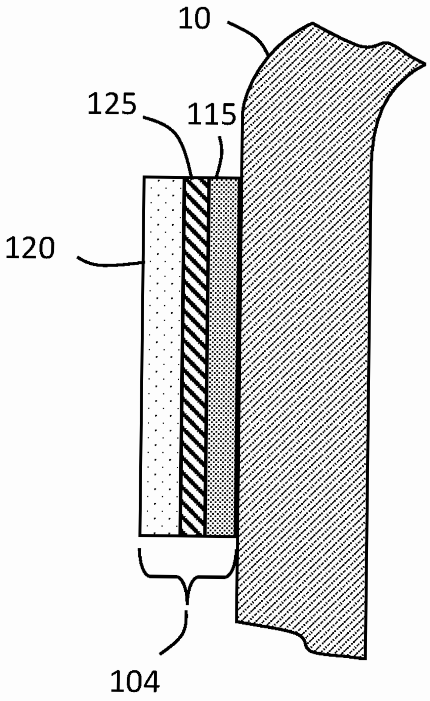

FIG. 1E

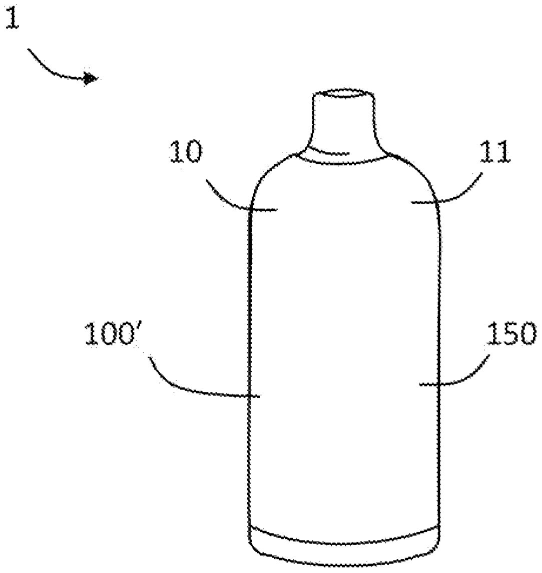
1
10
11
100′
150

Fig. 2

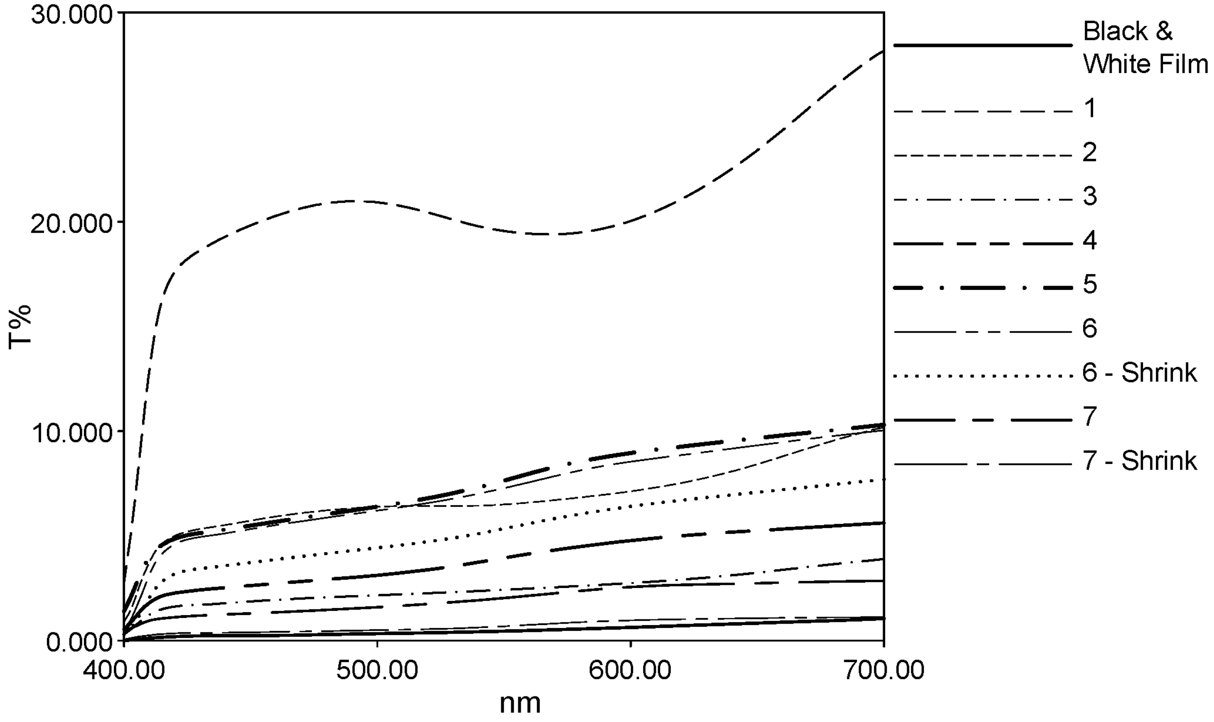
30.000
20.000
10.000
0.000
T%
400.00
500.00
600.00
700.00
nm
Black & White Film
1
2
3
4
5
6
6 - Shrink
7
7 - Shrink

Fig. 3

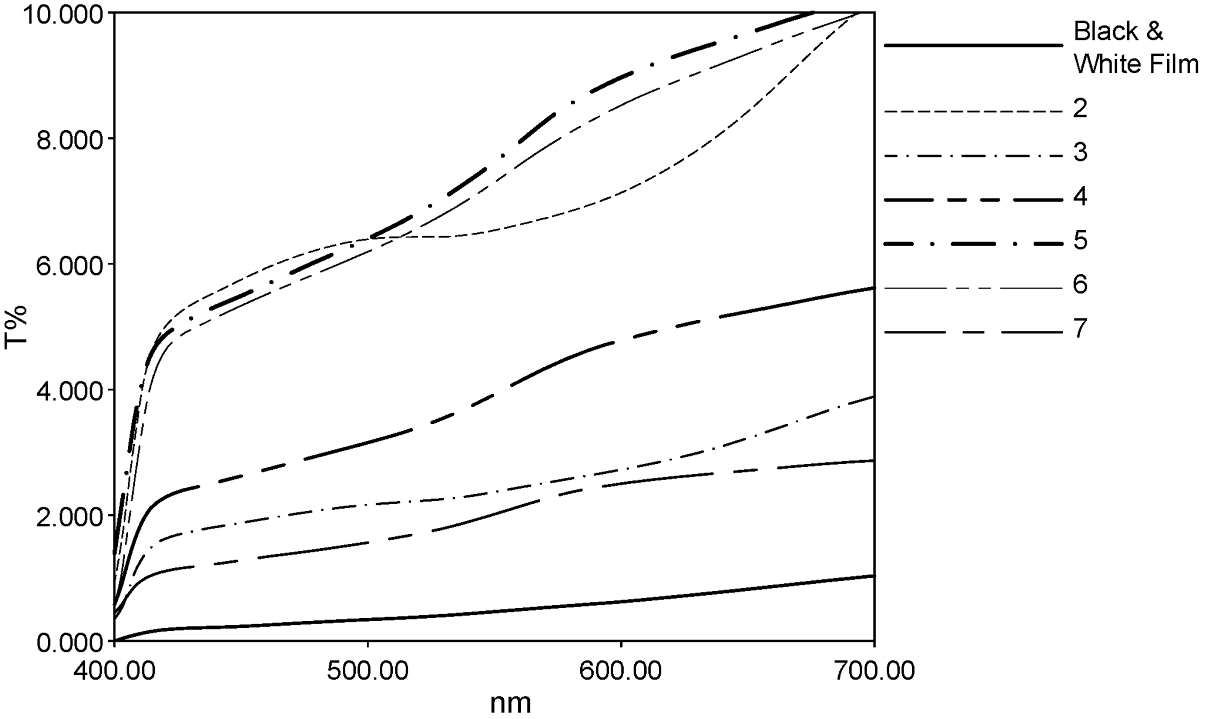
10.000
8.000
6.000
4.000
2.000
0.000
T%
400.00
500.00
600.00
700.00
nm
Black & White Film
2
3
4
5
6
7

Fig. 4

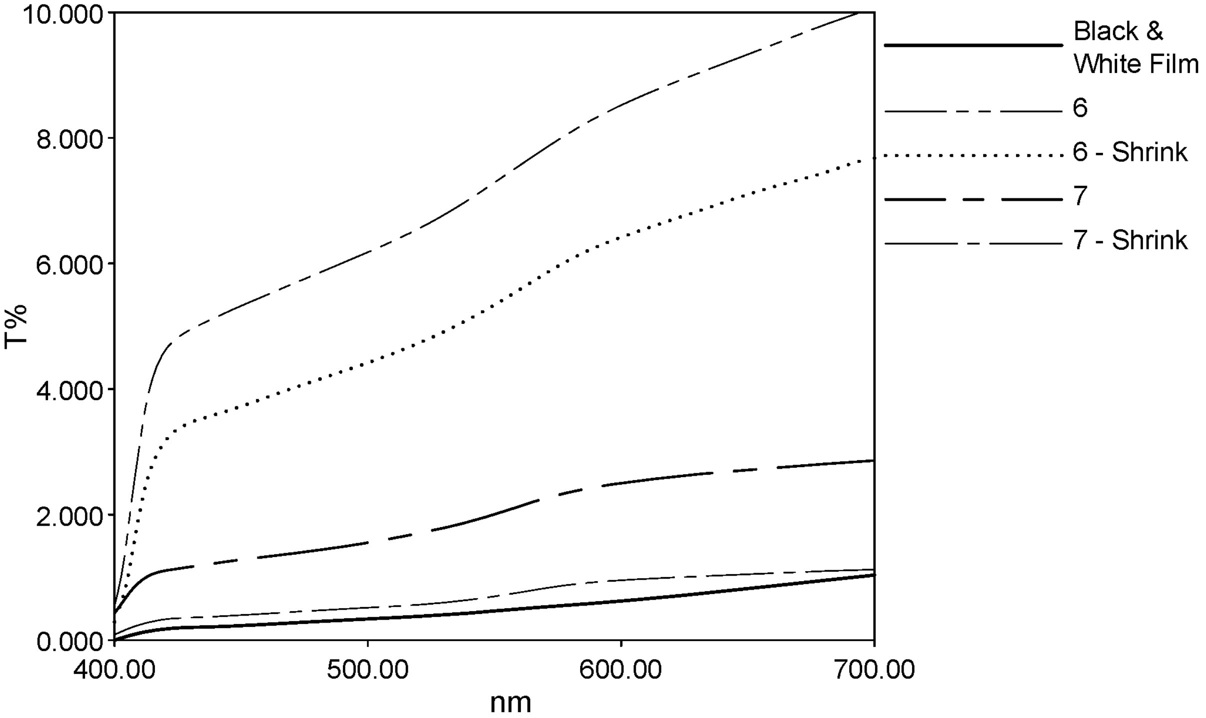
10.000
8.000
6.000
4.000
2.000
0.000
T%
400.00
500.00
600.00
700.00
nm
Black & White Film
6
6 - Shrink
7
7 - Shrink

Fig. 5

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
18/103,234	01/30/2023		2020	0644.000001US01	22	2

CONFIRMATION NO. 8140

26813
MUETING RAASCH GROUP
111 WASHINGTON AVE. S., SUITE 700
MINNEAPOLIS, MN 55401

FILING RECEIPT

OC000000054150441

Date Mailed: 03/01/2023

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Andrew Sharp, Orchard Park, NY;
Mitchell J. Morgan, Buffalo, NY;

Applicant(s)

BROOK & WHITTLE LIMITED, Amherst, NY;

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of PCT/US2022/029280 05/13/2022
which claims benefit of 63/188,794 05/14/2021

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 02/24/2023

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 18/103,234**

Projected Publication Date: 06/08/2023

Non-Publication Request: No

Early Publication Request: No
Title

RECYCLABLE HEAT SHRINK FILM FOR RECYCLABLE CONTAINER

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 18/103,234

APPLICATION AS FILED - PART I

	(Column 1)	(Column 2)	SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
FOR	NUMBER FILED	NUMBER EXTRA	RATE($)	FEE($)		RATE($)	FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	320
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	700
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	800
TOTAL CLAIMS (37 CFR 1.16(i))	22 minus 20 =	* 2			OR	x 100 =	200
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*				x =	0
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1820

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)	SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
AMENDMENT A		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1)		(Column 2)	(Column 3)					
AMENDMENT B		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/103,234	01/30/2023	Andrew Sharp	0644.000001US01	8140

26813 7590 03/22/2023
MUETING RAASCH GROUP
111 WASHINGTON AVE. S., SUITE 700
MINNEAPOLIS, MN 55401

EXAMINER

ART UNIT	PAPER NUMBER

NOTIFICATION DATE	DELIVERY MODE
03/22/2023	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ptodocketing@mrgs.com

PTOL-90A (Rev. 04/07)

Decision Granting Request for Prioritized Examination (Track I)	**Application No.** 18/103,234	**Applicant(s)** Sharp et al.	
	Examiner CHERYL P GIBSON BAYLOR	**Art Unit** OPET	**AIA (FITF) Status** Yes

1. THE REQUEST FILED 30 January 2023 IS **GRANTED** .

The above-identified application has met the requirements for prioritized examination
   A. ☑ for an original nonprovisional application (Track I).
   B. ☐ for an application undergoing continued examination (RCE).

2. **The above-identified application will undergo prioritized examination**. The application will be accorded special status throughout its entire course of prosecution until one of the following occurs:
   A. filing a **petition for extension of time** to extend the time period for filing a reply;
   B. filing an **amendment to amend the application to contain more than four independent claims, more than thirty total claims** , or a multiple dependent claim;
   C. filing a **request for continued examination** ;
   D. filing a notice of appeal;
   E. filing a request for suspension of action;
   F. mailing of a notice of allowance;
   G. mailing of a final Office action;
   H. completion of examination as defined in 37 CFR 41.102; or
   I. abandonment of the application.

Telephone inquiries with regard to this decision should be directed to CHERYL GIBSON BAYLOR at (571)272-3213. In his/her absence, calls may be directed to Petition Help Desk at (571) 272-3282.

/CHERYL GIBSON BAYLOR/
Paralegal Specialist, OPET

U.S. Patent and Trademark Office
PTO-2298 (Rev. 02-2012)

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
18/103,234	01/30/2023	Andrew Sharp	0644.000001US01

CONFIRMATION NO. 8140

PUBLICATION NOTICE

OC000000138040159

26813
MUETING RAASCH GROUP
111 WASHINGTON AVE. S., SUITE 700
MINNEAPOLIS, MN 55401

Date Mailed: 06/08/2023

Title:RECYCLABLE HEAT SHRINK FILM FOR RECYCLABLE CONTAINER
Publication No.US-2023-0177980-A1
Publication Date:06/08/2023

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211,et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to the applicant. A copy of the publication may be obtained from the Office upon payment of the application fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571)272-3150 or (800)972-6382, by facsimile at (571)273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic business center at www.upsto.gov using the public side of the Patent Application Information and Retrieval(PAIR) system. The direct link to access this status information is currently https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Furhter assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Management, Application Assistance Unit (571) 272-4000 or (571) 272-4200 or 1-888-786-0101

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Alexandria, Virginia 22313-1450
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/103,234	01/30/2023	Andrew Sharp	0644.000001US01	8140

26813 7590 06/08/2023
MUETING RAASCH GROUP
111 WASHINGTON AVE. S., SUITE 700
MINNEAPOLIS, MN 55401

EXAMINER
DAVIS, CASSANDRA HOPE

ART UNIT	PAPER NUMBER
3631	

NOTIFICATION DATE	DELIVERY MODE
06/08/2023	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ptodocketing@mrgs.com

PTOL-90A (Rev. 04/07)

Office Action Summary	Application No. 18/103,234	Applicant(s) Sharp et al.	
	Examiner CASSANDRA DAVIS	Art Unit 3631	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 2 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).

Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.
2a)☐ This action is **FINAL.** 2b) ☐ This action is non-final.
3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-22 is/are pending in the application.
5a) Of the above claim(s) _____ is/are withdrawn from consideration.
6) ☐ Claim(s) _____ is/are allowed.
7) ☐ Claim(s) _____ is/are rejected.
8) ☐ Claim(s) _____ is/are objected to.
9) ☑ Claim(s) 1-22 are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.
11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
Certified copies:
a)☐ All b)☐ Some** c)☐ None of the:
1.☐ Certified copies of the priority documents have been received.
2.☐ Certified copies of the priority documents have been received in Application No. _____.
3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)
Paper No(s)/Mail Date ______.
3) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date ______.
4) ☐ Other: ______.

Notice of Pre-AIA or AIA Status

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Election/Restrictions

Restriction to one of the following inventions is required under 35 U.S.C. 121:

I. Claims 1-19, drawn to a recyclable shrink label , classified in 428/34.9.

II. Claim 20-21, drawn to a method of making a label for a container, classified in 156/85.

The inventions are independent or distinct, each from the other because:

Inventions I and II are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make another and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case the product as claimed can be made by another and materially different process such providing a heat shrink film having a first surface and a second surface opposite of the first surface and a light blocking layer of recyclable shrink label disposed adjacent the first surface and comprising a light blocking component. The recyclable shrink label does not require depositing indicia layer on a heat shrinkable film or depositing a high opacity layer on the indicia layer.

Restriction for examination purposes as indicated is proper because all the inventions listed in this action are independent or distinct for the reasons given above <u>and</u> there would be a serious search and/or examination burden if restriction were not required because one or more of the following reasons apply:

The search required for Group I is not required for Group II.

Applicant is advised that the reply to this requirement to be complete must include (i) an election of an invention to be examined even though the requirement may be traversed (37 CFR 1.143) **and (ii) identification of the claims encompassing the elected invention**.

The election of an invention may be made with or without traverse. To reserve a right to petition, the election must be made with traverse. If the reply does not distinctly and specifically point out supposed errors in the restriction requirement, the election shall be treated as an election without traverse. Traversal must be presented at the time of election in order to be considered timely. Failure to timely traverse the requirement will result in the loss of right to petition under 37 CFR 1.144. If claims are added after the election, applicant must indicate which of these claims are readable upon the elected invention.

Should applicant traverse on the ground that the inventions are not patentably distinct, applicant should submit evidence or identify such evidence now of record showing the inventions to be obvious variants or clearly admit on the record that this is the case. In either instance, if the examiner finds one of the inventions unpatentable over the prior art, the evidence or admission may be used in a rejection under 35 U.S.C. 103 or pre-AIA 35 U.S.C. 103(a) of the other invention.

A telephone call was made to Lotta Kiuru-Ribar on June 2, 2023 to request an oral election to the above restriction requirement, but did not result in an election being made. Applicant is reminded that upon the cancelation of claims to a non-elected invention, the inventorship must be corrected in compliance with 37 CFR 1.48(a) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. A request to correct inventorship under 37 CFR 1.48(a) must be accompanied by an application data sheet in accordance with 37 CFR 1.76 that identifies each inventor by his or her legal name and by the processing fee required under 37 CFR 1.17(i).

The examiner has required restriction between product or apparatus claims and process claims. Where applicant elects claims directed to the product/apparatus, and all product/apparatus claims are subsequently found allowable, withdrawn process claims that include all the limitations of the allowable product/apparatus claims should be considered for rejoinder. All claims directed to a nonelected process invention must include all the limitations of an allowable product/apparatus claim for that process invention to be rejoined.

In the event of rejoinder, the requirement for restriction between the product/apparatus claims and the rejoined process claims will be withdrawn, and the rejoined process claims will be fully examined for patentability in accordance with 37 CFR 1.104. Thus, to be allowable, the rejoined claims must meet all criteria for patentability including the requirements of 35 U.S.C. 101, 102, 103 and 112. Until all claims to the elected product/apparatus are found allowable, an otherwise proper restriction requirement between product/apparatus claims and process claims may be maintained. Withdrawn process claims that are not commensurate in scope with an allowable product/apparatus claim will not be rejoined. See MPEP § 821.04. Additionally, in order for rejoinder to occur, applicant is advised that the process claims should be amended during prosecution to require the limitations of the product/apparatus claims. **Failure to do so may result in no rejoinder.** Further, note that the prohibition against double patenting rejections of 35 U.S.C. 121 does not apply where the restriction requirement is withdrawn by the examiner before the patent issues. See MPEP § 804.01.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to CASSANDRA DAVIS whose telephone number is (571)272-6642. The examiner can normally be reached Monday-Friday 8:00 AM-4:30 PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jonathan Liu can be reached on 571-272-8227. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit: https://patentcenter.uspto.gov. Visit https://www.uspto.gov/patents/apply/patent-center for more information about Patent Center and https://www.uspto.gov/patents/docx for information about filing in DOCX format. For additional questions, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/CASSANDRA DAVIS/
Primary Examiner, Art Unit 3631

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.:	18/103,234	Attorney Docket No.:	0644.000001US01
Confirmation No.:	8140	Customer No.:	26813
Filing Date:	January 30, 2023	Examiner Name:	Cassandra Hope Davis
First Named Inventor:	Andrew Sharp	Group Art Unit:	3631
Title of Invention:	RECYCLABLE HEAT SHRINK FILM FOR RECYCLABLE CONTAINER		

RESPONSE TO RESTRICTION REQUIREMENT

Commissioner for Patents
Mail Stop Amendment
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

The Restriction Requirement of June 8, 2023 has been received and reviewed.

In a Restriction Requirement, the Examiner required election of one of the following groups of inventions in the above-noted application:

Group I, claims 1-19, drawn to a recyclable shrink label, classified in 428/34.9.

Group II, claims 20-21, drawn to a method of making a label for a container, classified in 156/85.

Applicant notes that the application includes pending claims 1-22 (claim 22 was omitted from the Restriction Requirement). It is also noted that claims 16-19 are directed to an article comprising the recyclable shrink label of claim 1. Claims 21 and 22 are directed to a method of recycling an article comprising a container defining an external surface; and the recyclable shrink label of claim 1.

Applicant elects **Group I, claims 1-19**, drawn to a recyclable shrink label (and article comprising the recyclable shrink label). Applicant reserves the right to pursue examination of the non-elected claims in continuation or divisional applications.

Summary

Applicant invites the Examiner to contact the undersigned Applicant's Representative at the telephone number listed below if doing so may advance prosecution of this application.

Respectfully submitted by

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6/20/2023
Date

/Lotta Kiuru-Ribar/
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UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/103,234	**06/20/2023 04:31:37 PM ET**	**0644.000001US01**

Title of Invention

RECYCLABLE HEAT SHRINK FILM FOR RECYCLABLE CONTAINER

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	8140	FILED BY	Margaret Rausch
PATENT CENTER #	62303247	FILING DATE	01/30/2023
CUSTOMER #	26813	FIRST NAMED INVENTOR	Andrew Sharp
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Lotta Kiuru-Ribar

Documents

TOTAL DOCUMENTS: 1

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
2023-06-20-Response to Restriction Requirement.pdf	2	Response to Election / Restriction Filed	99 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
2023-06-20-Response to Restriction Requirement.pdf	E1D19F57A7A3905CB64702E4019EC14A807E1F82A71041A61F F5A5A01FFB39EEC095E1B08C191D2E4D59FCCCBDE76BD9D 71979F83EDC50FA7231FF3962701C49

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/103,234	01/30/2023	Andrew Sharp	0644.000001US01	8140

26813 7590 08/09/2023
MUETING RAASCH GROUP
111 WASHINGTON AVE. S., SUITE 700
MINNEAPOLIS, MN 55401

EXAMINER
POWERS, LAURA C

ART UNIT	PAPER NUMBER
1785	

NOTIFICATION DATE	DELIVERY MODE
08/09/2023	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ptodocketing@mrgs.com

PTOL-90A (Rev. 04/07)

Office Action Summary	**Application No.** 18/103,234	**Applicant(s)** Sharp et al.	
	Examiner LAURA POWERS	**Art Unit** 1785	**AIA (FITF) Status** Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
  Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 30 January 2023.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.
2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.
3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-22 is/are pending in the application.
5a) Of the above claim(s) 20-22 is/are withdrawn from consideration.
6) ☐ Claim(s) _____ is/are allowed.
7) ☑ Claim(s) 1-19 is/are rejected.
8) ☐ Claim(s) _____ is/are objected to.
9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.
11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
Certified copies:
a)☐ All b)☐ Some** c)☐ None of the:
1.☐ Certified copies of the priority documents have been received.
2.☐ Certified copies of the priority documents have been received in Application No. _____.
3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)
2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)
Paper No(s)/Mail Date 01/30/2023.
3) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date ______.
4) ☐ Other: ______.

U.S. Patent and Trademark Office
PTOL-326 (Rev. 11-13) **Office Action Summary** Part of Paper No./Mail Date 20230802

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Information Disclosure Statement

2. The information disclosure statement (IDS) submitted on 01/30/2023 is considered by the examiner.

Election/Restrictions

3. Applicant's election of Group I, claims 1-19 in the reply filed on 06/20/2023 is acknowledged. Because applicant did not distinctly and specifically point out the supposed errors in the restriction requirement, the election has been treated as an election without traverse (MPEP § 818.01(a)).

4. Claims 20-21 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected invention, there being no allowable generic or linking claim. Election was made **without** traverse in the reply filed on 06/20/2023.

Claim Rejections - 35 USC § 112

5. The following is a quotation of 35 U.S.C. 112(b):

> (b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

6. Claims 2, 3, 7, 8, 9, 10, 12, 14, 16, 18 and 19 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor (or for applications subject to pre-AIA 35 U.S.C. 112, the applicant), regards as the invention.

7. Regarding claim 2, the limitation “optionally wherein the indicia layer is disposed on the first surface” is indefinite. The use of the word “optionally” renders the claim indefinite as it is unclear whether the limitation that follows is a required feature of the claim, and therefore the scope of the claim is not clear. See MPEP §2173.05(d).

8. Regarding claim 3, the limitation “the high opacity layer optionally comprising a white pigment” is indefinite. The use of the word “optionally” renders the claim indefinite as it is unclear whether the limitation that follows is a required feature of the claim, and therefore the scope of the claim is not clear. See MPEP §2173.05(d).

9. Regarding claim 7, the limitation reciting “wherein the heat shrink film comprises a seam” is indefinite as it is unclear what structural requirements are necessary for this feature to be present. In looking to the disclosure, paragraph [0068] of the pg-pug discusses shrink films and how they are typically applied over or around a container, wherein two portions of the film can be bonded together to form a seal or seam that results in a sleeve or tube configuration. Paragraph [0127] of the pg-pub discusses a process for forming a sleeve label, wherein a seaming machine is used to fold a solvent edge side of the film to a non-solvent coated edge to form seamed/tubed label rolls. From the specification, it appears that the label needs to be in the form of a sleeve or tube to have a seam, however, such structural limitations are not required by claim 7 or claim 1. Dependent claim 8 recites a limitation to the heat shrink film being in the form of a sleeve or tube, therefore, it seems that the limitation of claim 7 should be combined with the limitations of claim 8.

10. **Regarding claim 8,** the limitation reciting “wherein the heat shrink film is in a form of a sleeve or tube” is indefinite. The heat shrink film is one component of the recyclable shrink label, which from claim 1, is comprised of a heat shrink film and a light blocking layer. It is not clear how only one of the components, the heat shrink film, can be claimed to be in the form of a sleeve or tube. It seems as though the recyclable heat shrink label should be claimed to be in the form of a sleeve or tube, and not just one layer of the recyclable heat shrink label.

11. **Regarding claim 9,** the limitation reciting “optionally wherein the heat shrink film contracts of shrinks by about 1% to 90% in a transverse direction” is indefinite. The use of the word “optionally” renders the claim indefinite as it is unclear whether the limitation that follows is a required feature of the claim, and therefore the scope of the claim is not clear. See MPEP §2173.05(d).

12. Additionally, there is a type in line 3 of the claim, wherein the phrase “contracts of shrinks” should read “contracts or shrinks”.

13. **Regarding claim 10,** the limitation reciting “optionally wherein the entire recyclable shrink label contracts of shrinks by about 1% to 90% in a transverse direction” is indefinite. The use of the word “optionally” renders the claim indefinite as it is unclear whether the limitation that follows is a required feature of the claim, and therefore the scope of the claim is not clear. See MPEP §2173.05(d).

14. Additionally, there is a type in line 3 of the claim, wherein the phrase “contracts of shrinks” should read “contracts or shrinks”.

15. **Regarding claim 12,** the limitation reciting “optionally wherein the metal particulate has a particle size of 0.1μm to 100μm” is indefinite. The use of the word “optionally” renders the claim indefinite as it is unclear whether the limitation that follows is a required feature of the claim, and therefore the scope of the claim is not clear. See MPEP §2173.05(d).

16. **Regarding claim 14,** the limitation reciting “wherein the light blocking layer is present in an amount of 0.5 ppr to 25 ppr” is indefinite. It is not clear what the context of “in an amount” is regarding the light blocking layer and the heat shrink film. It is not clear if the claimed amount is in reference to thickness, or implying that the layer is discontinuous, etc.

17. **Regarding claim 16,** the limitation reciting “optionally wherein the first surface of the heat shrink film faces the external surface of the container” is indefinite. The use of the word “optionally” renders the claim indefinite as it is unclear whether the limitation that follows is a required feature of the claim, and therefore the scope of the claim is not clear. See MPEP §2173.05(d).

18. Regarding claim 18, the limitation reciting “optionally wherein the container consists of polyethylene terephthalate (PET), optionally wherein the container comprises clear polyethylene terephthalate (PET)” is indefinite. The use of the word “optionally” renders the claim indefinite as it is unclear whether the limitation that follows is a required feature of the claim, and therefore the scope of the claim is not clear. See MPEP §2173.05(d).

19. Regarding claim 19, the limitation reciting “optionally wherein the polyethylene terephthalate (PET) forms an outermost layer of the recyclable shrink label” is indefinite. The use of the word “optionally” renders the claim indefinite as it is unclear whether the limitation that follows is a required feature of the claim, and therefore the scope of the claim is not clear. See MPEP §2173.05(d).

Claim Rejections - 35 USC § 103

20. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

21. The factual inquiries for establishing a background for determining obviousness under 35 U.S.C. 103 are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

22. Claims 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17 and 18 are rejected under 35 U.S.C. 103 as being unpatentable over Mitchell et al. (US 2017/0223879).

23. Regarding claims 1, 3, 11 and 13, Mitchell et al. teaches an electromagnetic radiation blocking label arrangement and a container comprising the radiation blocking label arrangement thereon (Figure 3-7, [0003-0018]). The radiation blocking label arrangement is comprised of a first skin layer (2; heat shrink film) comprised of a shrinkable film, a core layer (4; high opacity layer), a second skin layer (6) and a metallization layer (7; light blocking layer), wherein the metallization layer (7; light blocking layer) is disposed adjacent to a first surface of the first skin layer (2; heat shrink film) (Figure 3-7; [0004-0014, 0091-0109, 0112, 0138, 0149, 0176-0177, 0179, 0185-0187]).

24. The metallization layer (7; light blocking layer) is comprised of aluminum (light blocking component) and has a UV light and visible light transmittance below 5% (i.e. block at least 80% of incident light having wavelengths in a range of 200nm to 900nm) ([0101-0106]).

25. The core layer (4; high opacity layer) can comprise a pigment, such as titanium dioxide, which provides opacity as well as light scattering to the film ([0177]). The limitation reciting “the high opacity layer optionally comprising a white pigment” is indefinite for the reasons expressed above, and is interpreted as being an optional limitation that is not required.

26. The first skin layer (2; heat shrink film) has a thickness less than 15 microns ([0099]), while not overlapping, is close enough that one of ordinary skill in the art would have expected the claimed range (15μm to 100μm) and the prior art range to have the same or similar properties . It has been held that a prima facie case of obviousness exists where the claimed ranges or amounts do not overlap with the prior art but are merely close. See MPEP §2144.05(I).

27. The term "recyclable" is considered functional language related to the intended use of the product and is accorded limited weight as the language does not further limit the structure or the process. Mitchell et al. teaches all the structural features of claim 1 and therefore would be capable of performing in the manner claimed. Furthermore, Mitchell et al. teaches that the shrinkable labels provide easy separate during recycling processes ([0235-0252]).

28. **Regarding claim 2,** Mitchell et al. teaches all the limitations of claim 1 above, and further teaches that printed graphics (indicia layer) can be applied to a surface of the first skin layer ([0068, 0096, 0109, 202-203, 207-208]). The limitation reciting "optionally wherein the indicia layer is disposed on the first surface" is indefinite for the reasons expressed above, and is interpreted as being an optional limitation that is not required.

29. **Regarding claim 4,** Mitchell et al. teaches all the limitations of claim 3 above, and further teaches that printed graphics (indicia layer) can be applied to a surface of the first skin layer ([0068, 0096, 0109, 202-203, 207-208]). As shown by Figure 3, the core layer (4; high opacity layer) is between the printed graphics (indicia layer) on a surface of the first skin layer (2; heat shrink film) and the metallization layer (7; light blocking layer).

30. **Regarding claims 5 and 6,** Mitchell et al. teaches all the limitations of claim 1 above, and further teaches that the first skin layer (2; heat shrink film) can be comprised of cyclic olefin copolymers and polyethylene ([0185-0190]).

31. **Regarding claims 7 and 8,** Mitchell et al. teaches all the limitations of claim 1 above, and further teaches, as shown by Figure 8, that the electromagnetic radiation blocking label arrangement can be in the form of a cylindrical label, comprising an adhesive in a seam area that joins a training end and a leading end of the shrinkable label ([0109-0111, 0208, 0210-0234]).

32. **Regarding claims 9 and 10,** Mitchell et al. teaches all the limitations of claim 1 above.

33. The limitations "wherein when heated to 100°C, the heat shrink film contracts or shrinks by about 1% to about 90%, optionally wherein the heat shrink film contracts of shrinks by about 1% to 90% in a transverse direction" in claim 9 and "wherein when heated to 100°C, the entire recyclable shrink label contracts or shrinks by about 1% to about 90%, optionally wherein the entire recyclable shrink label contracts of shrinks by about 1% to 90% in a transverse direction" are method limitations and do not determine the patentability of the product, unless the method produces a structural feature of the product. The method of using the product is not germane to the issue of patentability of the product itself, unless Applicant presents evidence from which the Examiner could reasonably conclude that the claimed product differs in kind from those of the prior art. See MPEP § 2113. Furthermore, there does not appear to be a difference between the prior art structure and the structure resulting from the claimed method because Mitchell et al. discloses the structure of claim 1 as described above. Furthermore, Mitchell et al. teaches that the heat shrinkable label exhibit at least 15% between temperatures of 65 and 98°C ([0070-0248]).

34. Regarding claim 14, Mitchell et al. teaches all the limitations of claim 1 above and further teaches that the metallization layer (7; light blocking layer) has a thickness of 3 to 50nm ([0103]). While the reference does not expressly teach that the metallization layer (7; light blocking layer) is present in an amount of 0.5ppr to 25ppr, it would have been obvious to one of ordinary skill in the art to modify the amount/thickness of the metallization layer (7; light blocking layer) to fall within the claimed range based upon the required wavelength blockage to protect the contents of the package ([0102]).

35. Regarding claim 15, Mitchell et al. teaches all the limitations of claim 1 above and further teaches that the metallization layer (7; light blocking layer) has a thickness of 3 to 50nm ([0103]). While the reference does not expressly teach that aluminum (light blocking component) is present in the metallization layer (7; light blocking layer) in an amount of 0.1ppr to 20ppr, it would have been obvious to one of ordinary skill in the art to modify the amount/thickness of the aluminum in the metallization layer (7; light blocking layer) to fall within the claimed range based upon the required wavelength blockage to protect the contents of the package ([0102]).

36. Regarding claims 16, 17 and 18, Mitchell et al. teaches all the limitations of claim 1 above and further teaches that the shrinkable film is used for labeling a wide range of products, including bottles comprised of polyethylene terephthalate ([0205]).

37. Claims 1, 2, 3, 4, 5, 6, 9, 10, 12, 13, 14, 15, 16, 17 and 19 are rejected under 35 U.S.C. 103 as being unpatentable over Doornheim et al. (WO 2006/076327,herein citing US equivalent US 2009/0233067, cited on IDS).

38. Regarding claims 1, 2, 3, 4 and 13, Doornheim et al. teaches removable curl labels that can withstand recycling operations comprised of a transparent topcoat or overcoat layer (15), a print layer (14; indicia layer), a metal layer (13; high opacity layer), a first polymeric layer (11; heat shrink layer), a second polymeric layer (12; light blocking layer) and an adhesive (16) (Figure 8, [0008, 0014-0027, 0034-0038, 0054-0056, 0063-0068, 0072, 0077-0079]). The thickness of the first polymeric layer (11; heat shrink layer) is at least 15 microns, which fully encompasses the claimed range of 15-100μm ([0056]). The metal layer (13; high opacity layer) can be comprised of copper, aluminum, silver (light blocking component)([0065]).

39. The limitations reciting “optionally wherein the indicia layer is disposed on the first surface” in claim 2 and “the high opacity layer optionally comprising a white pigment” in claim 3 are indefinite for the reasons expressed above, and are interpreted as being an optional limitation that is not required.

40. The second polymeric layer (12; light blocking layer) can comprise inorganic fillers and/or pigments and/or contain inorganic fillers and other organic or inorganic additives to provide desired properties to the film, wherein titanium dioxide and metal particles are listed as appropriate materials ([0054]). It would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to include titanium dioxide in the second polymeric layer (12; light blocking layer) to provide desired properties to the film in terms of appearance, durability and processing characteristics.

41. Titanium dioxide is disclosed by the instant application (see pg-pub [0092]), therefore, the second polymer layer (light blocking layer) comprising titanium dioxide would block at least 80% of incident light having wavelengths in a range of 200nm to 900nm.

42. The term “recyclable” is considered functional language related to the intended use of the product and is accorded limited weight as the language does not further limit the structure or the process. Furthermore, Doornheim et al. teaches all the structural features of claim 1 and would be capable of performing in the manner claimed.

43. Regarding claims 5 and 6, Doornheim et al. teaches all the limitations of claim 1 above, and further teaches that the first polymeric layer (11; heat shrink layer) is comprised of polyethylene terephthalate ([0063]).

44. Regarding claims 9 and 10, Doornheim et al. teaches all the limitations of claim 1 above.

45. The limitations “wherein when heated to 100°C, the heat shrink film contracts or shrinks by about 1% to about 90%, optionally wherein the heat shrink film contracts of shrinks by about 1% to 90% in a transverse direction” in claim 9 and “wherein when heated to 100°C, the entire recyclable shrink label contracts or shrinks by about 1% to about 90%, optionally wherein the entire recyclable shrink label contracts of shrinks by about 1% to 90% in a transverse direction” are method limitations and do not determine the patentability of the product, unless the method produces a structural feature of the product. The method of using the product is not germane to the issue of patentability of the product itself, unless Applicant presents evidence from which the Examiner could reasonably conclude that the claimed product differs in kind from those of the prior art. See MPEP § 2113. Furthermore, there does not appear to be a difference between the prior art structure and the structure resulting from the claimed method because Doornheim et al. discloses the structure of claim 1 as described above.

46. The limitations reciting “optionally wherein the heat shrink film contracts of shrinks by about 1% to 90% in a transverse direction” in claim 9 and “optionally wherein the entire recyclable shrink label contracts of shrinks by about 1% to 90% in a transverse direction” are indefinite for the reasons expressed above, and are interpreted as being an optional limitation that is not required.

47. **Regarding claim 12,** Doornheim et al. teaches all the limitations of claim 1 above, and, as previously stated, teaches that the second polymeric layer (12; light blocking layer) can comprise inorganic fillers and/or pigments and/or contain inorganic fillers and other organic or inorganic additives to provide desired properties to the film, wherein titanium dioxide and metal particles are listed as appropriate materials ([0054]). It would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to include metal particles in the second polymeric layer (12; light blocking layer) to provide desired properties to the film in terms of appearance, durability and processing characteristics.

48. The limitation “optionally wherein the metal particulate has a particle size of 0.1μm to 100μm” is indefinite for the reasons expressed above, and are interpreted as being an optional limitation that is not required.

49. Regarding claims 14 and 15, Doornheim et al. teaches all the limitations of claim 1 above. While Doornheim et al. does not expressly teach that the second polymeric layer (12; light blocking layer) comprising titanium dioxide (light blocking component) is present an amount of 0.5ppr to 25ppr as recited by claim 14 or that the second polymeric layer (12; light blocking layer) comprises from 0.1ppr to 10ppr of titanium dioxide (light blocking component), such a modification would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to provide desired properties to the film in terms of appearance, durability and processing characteristics.

50. Regarding claims 16 and 17, Doornheim et al. teaches all the limitations of claim 1 above and further teaches that the removable curl labels can be applied to glass, polymeric and metal containers ([0079]). The limitation reciting “optionally wherein the first surface of the heat shrink film faces the external surface of the container” is indefinite for the reasons expressed above, and is interpreted as being an optional limitation that is not required.

51. Regarding claim 19, Doornheim et al. teaches all the limitations of claim 1 above and further teaches that the first polymeric layer (11; heat shrink layer) is comprised of polyethylene terephthalate ([0063]). The limitation reciting “and optionally wherein the polyethylene terephthalate (PET) forms an outermost layer of the recyclable shrink label” is indefinite for the reasons expressed above, and is interpreted as being an optional limitation that is not required.

52. Claim 18 is rejected under 35 U.S.C. 103 as being unpatentable over Doornheim et al. (WO 2006/076327,herein citing US equivalent US 2009/0233067cited on IDS) in view of Mitchell et al. (US 2017/0223879).

53. Regarding claim 18, Doornheim et al. teaches all the limitations of claim 16 above, and while the reference teaches that the removable curl labels can be applied to glass, polymeric and metal containers ([0079]), it does not expressly teach that the containers are comprised of polyethylene terephthalate.

54. Mitchell et al. teaches shrinkable films that are used for labeling a wide range of products, including bottles comprised of polyethylene terephthalate ([0205]).

55. Both Doornheim et al. and Mitchell et al. teach labels used on products comprised of polymers, it would have been prima facie obvious to one of ordinary skill in the art to substitute the polymeric container comprised of polyethylene terephthalate taught by Mitchell et al. for the polymeric container taught by Doornheim et al.

56. Claims 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 13, 14, 15, 16, 17 and 18 are rejected under 35 U.S.C. 103 as being unpatentable over Mitchell et al. (US 2016/0136934, hereafter referred to as ‘934) in view of Mitchell et al. (US 2017/0223879, hereafter referred to as ‘879).

57. Regarding claims 1, 5, 6 and 13, ‘934 teaches a heat shrink label and film for labeling a wide range of products, wherein the label is easily removed from the container during a recycling process and both the container and the label can be recycled (Figure 1-3, 7, 8, [0003-0017, 0070-0080, 0094-0098, 0151-0154]). The heat shrink label is comprised of a first layer/skin (3) forming the front surface of the label, a second layer/core/intermediate layer (5; heat shrink film) and a third layer/skin (7; light blocking layer) forming the back surface of the label (Figure 1-3; [0003-0017, 0070-0080, 0094-0098]). The second layer/core/intermediate layer (5; heat shrink film) is 15-50 microns think ([0072]), falling within the claimed range of 15-100μm and is comprised of a polyolefin plastomer or polyolefin elastomer such as polypropylene/ethylene plastomer, ethylene/octane elastomer or ethylene/butene elastomer ([0016]).

58. ‘934 teaches that the third layer/skin (7; light blocking layer) can contain additives such as inorganic fillers, pigments, ultraviolet absorbers ([0080]), however, does not expressly teach that additives block at least 80% of incident light having wavelengths in a range of 200-800nm.

59. ‘879 teaches an electromagnetic radiation blocking label arrangement and a container comprising the radiation blocking label arrangement thereon (Figure 3-7, [0003-0018]). The radiation blocking label arrangement is comprised of a first skin layer (2) comprised of a shrinkable film, a core layer (4), a second skin layer (6) and a metallization layer (7) (Figure 3-7; [0004-0014, 0091-0109, 0112, 0138, 0149, 0176-0177, 0179, 0185-0187]).

60. ‘879 teaches that the appearance and/or properties of the shrinkable films can include pigments and/or light blockers, wherein light blockers are ingredients that are able to absorb electromagnetic radiation such as visible and UV light ([0176-0177]). The light blockers reduce chemical reactions and photo-oxidation of a material caused by the radiation, and include titanium dioxide and zinc oxide in an amount between 0.1 and 30 wt.% of the layer ([0176]). ‘879 further teaches that titanium dioxide is a pigment that can be used to provide opacity and whiteness to the film ([0177]).

61. As both '934 and '879 teach shrinkable films comprising additives, it would have been obvious to on of ordinary skill in the art to modify the inorganic fillers, pigments, ultraviolet absorbers of the skin layer taught in '934 to include titanium dioxide as taught by '879 to reduce chemical reactions and photo-oxidation of a material caused by the radiation and absorb electromagnetic radiation such as visible and UV light.

62. **Regarding claim 2,** '934 in view of '879 teach all the limitations of claim 1 above, and '934 further teaches that the heat shrink label can be printed (indicia layer) to provide visual effects and/or display information ([0094]).

63. The limitation reciting "optionally wherein the indicia layer is disposed on the first surface" is indefinite for the reasons expressed above, and is interpreted as being an optional limitation that is not required.

64. **Regarding claim 3,** '934 in view of '879 teach all the limitations of claim 1 above. While '934 does not expressly teach a high opacity layer, '879 further teaches a metallization layer (high opacity layer) is present to provide electromagnetic radiation blocking for the label film ([0101-0106]). The composition of the metallization layer may be selected according to the required wavelength to be blocked, and can be provided on either of the skin layers ([0101-0106]).

65. It would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention, to modify the heat shrink label taught in '934 to include a metallization layer as taught by the heat shrink label in '879 to provide additional blockage of electromagnetic radiation.

66. The limitation reciting “the high opacity layer optionally comprises a white pigment” is indefinite for the reasons expressed above, and is interpreted as being an optional limitation that is not required.

67. **Regarding claim 4,** ‘934 in view of ‘879 teach all the limitations of claim 3 above, and 934 further teaches that the heat shrink label can be printed (indicia layer) to provide visual effects and/or display information ([0094]).

68. As stated above, ‘879 teaches that the metallization can be provided on either of the skin layers ([0101-0106]). It would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to provide the metallization layer (high opacity layer) such that it is positioned between the printing (indicia layer) and the third layer/skin (7; light blocking layer) to ensure the printing is visible and provide a metallic look to the label.

69. **Regarding claims 7 and 8,** ‘934 in view of ‘879 teach all the limitations of claim 3 above, and 934 further teaches that the heat shrink label can be a shrink sleeve label wherein a leading end of the label and the trailing end of the label are overlapped on the surface of an item as shown in Figure 5, forming a seam (10) ([0009, 0056, 0068-0069, 0087-0088, 0153-0157]).

70. **Regarding claims 9 and 10,** ‘934 in view of ‘879 teach all the limitations of claim 1 above.

71. The limitations “wherein when heated to 100°C, the heat shrink film contracts or shrinks by about 1% to about 90%, optionally wherein the heat shrink film contracts of shrinks by about 1% to 90% in a transverse direction” in claim 9 and “wherein when heated to 100°C, the entire recyclable shrink label contracts or shrinks by about 1% to