UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

AMERICAN FUJI SEAL, INC.,

Petitioner,

v.

BROOK + WHITTLE LTD.,

Patent Owner.

Case No.: IPR2025-01176

U.S. Patent No. 11,961,422

DECLARATION OF ROBSON F. STOREY, PH.D. IN SUPPORT OF PETITION FOR INTER PARTES REVIEW OF U.S. PATENT NO. 11,961,422

I, Robson F. Storey, do hereby declare and state, under penalty of perjury, that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, under Section 1001 of Title 18 of the United States Code.

Executed on: June 24, 2025

Robson F. Storey

TABLE OF CONTENTS

I. INTRODUCTION

A. Engagement

1. I have been retained by counsel for American Fuji Seal, Inc. ("Petitioner") to evaluate the patentability of claims 1-19 ("Challenged Claims") of U.S. Patent No. 11,961,422 ("the '422 Patent") (EX-1001). My evaluation considers certain prior art references and is from the perspective of a person of ordinary skill in the art ("POSITA") as of the '422 Patent's effective filing date. In connection with this evaluation, I have been asked to provide expert opinions in support of a petition for inter partes review ("IPR") of the '422 Patent that Petitioner is filing with the United States Patent and Trademark Office's ("USPTO") Patent Trial and Appeal Board ("PTAB" or "Board"). My opinions relate to, among other things, the background and understanding of the art pertaining to the '422 Patent, the knowledge, skill, and perspective of a POSITA at the time of the alleged invention of the '422 Patent, and the patentability of the Challenged Claims under United States patent law. The following is my written declaration on these topics.

B. Background and Qualifications

2. I have been a member of the faculty at The University of Southern Mississippi ("USM") since 1983. I began my academic career at USM as an Assistant Professor (1983-1990), then Associate Professor (1990-1992), and served as Professor of Polymer Science and Engineering from 1992 until 2021. In 2013, I

was named Bennett Distinguished Professor. Since 2021, I have been Professor Emeritus at the USM School of Polymer Science and Engineering. Before joining USM, I worked as a Research Chemist at American Cyanamid Company from 1982 to 1983.

3. I earned my Ph.D. in Polymer Science from The University of Akron, Akron, Ohio, in 1983. My dissertation, under the guidance of Professor J.P. Kennedy, was titled "Synthesis and Characterization of Novel Ionomers Based on Telechelic Polyisobutylenes." I also hold two Bachelor of Science degrees from The University of Southern Mississippi, awarded in 1978: one in Polymer Science and one in Mathematics. Both USM and Akron are internationally recognized centers of excellence for research and teaching in the field of polymer science and engineering.

4. I have been an active researcher and teacher in polymer chemistry and polymer science for over forty years and have published approximately 350 papers in international journals and conferences, the vast majority of which specifically relate to polymer synthesis, characterization, and properties. I am an inventor on 42 issued U.S. patents dealing with polymers, and I have one or more additional patent applications pending. I have also received numerous research grants from agencies such as the National Science Foundation, Department of Defense, Department of Energy, and various industrial sponsors, many focused on polymer synthesis, characterization, and applications including coatings and elastomers. A full list of

my publications and patents are listed in my curriculum vitae (EX-1005). My expertise, particularly relevant to the technology involved in the '422 Patent, includes:

- **Polymer Synthesis and Engineering**: Extensive work on polymerization mechanisms and kinetics (carbocationic, anionic, ring-opening, step-growth), macromolecular engineering (block copolymers, star polymers, telechelic polymers), and synthesis of polyolefins (specifically polyisobutylene-based polymers), elastomers (like butyl rubber), and degradable polymers.
- **Films and Coatings**: Research and teaching experience in polymer surface coatings, including waterborne coatings and polymer surface modification. This involves understanding film formation, adhesion, barrier properties, and surface characterization.
- **Polymer Characterization**: Deep familiarity with techniques used to analyze polymer structure, composition, thermal properties (including shrinkage behavior relevant to heat-shrink films), mechanical properties, and morphology.
- **Material Properties**: Understanding how polymer structure (composition, architecture, molecular weight) dictates material properties relevant to films and labels, such as flexibility, strength,

thermal behavior, and optical characteristics.

5. With respect to the technology of the '422 Patent, I have particular expertise in the area of polyester polymers and polymer surface coatings. I have many publications directed to polyester polymers, including polyesters based on terephthalic acid. For the last 41 years, I have Chaired (or co-Chaired) the International Waterborne, High-Solids, and Powder Coatings Symposium ("The Waterborne Symposium"), which is held annually in New Orleans, LA, and widely regarded as a leading technical conference in the area of surface coatings. For the last 33 years, I have organized and taught an annual two-day short course titled, "Reformulating to Waterborne Coatings." I am an inventor on a number of patents and patent applications in the field of surface coatings, and I have published scientific papers on this subject.

6. I am active in the professional scientific community. I am an inducted PolyFellow of the Division of Polymer Chemistry of the American Chemical Society ("ACS") (2010) and a former editor of the *Division of Polymer Chemistry, Polymer Preprints*. I am also a member of the Southern Society for Coatings Technology, where I was recognized as a Distinguished Professor (2008-2011), and the Mississippi Academy of Sciences. I have served on editorial advisory boards (e.g., *Macromolecules*, *Journal of Macromolecular Science*, *Polymers for Advanced Technologies*) and have chaired or organized numerous symposia and short courses

related to polymer science and coatings, including co-chairing the annual Waterborne Symposium in New Orleans from 1985-present. I have received awards and recognition for my work throughout my career. As noted above, I was named Bennett Distinguished Professor at The University of Southern Mississippi in 2013. I received a Lifetime Research Award (2023), an Innovation Award for Academic Partnership (2017), and an Innovation Award in Basic Research (2013) from the University Research Council. The Division of Polymer Chemistry of the American Chemical Society also honored me with a Distinguished Service Award in 2001. I received the Outstanding Alumni Award, Department of Polymer Science, The University of Akron, in 2006. Other awards, including numerous awards for specific papers and posters, are outlined in greater detail in my curriculum vitae (EX-1005).

7. I have prior experience serving as an expert witness. I have submitted declarations in multiple IPR proceedings before the PTAB and have testified as an expert witness in U.S. district courts.

C. <u>Compensation and Prior Testimony</u>

8. I am being compensated for my time spent on this matter through Teklicon, a consulting firm, which bills for my services at a rate of $875 per hour. I am also being reimbursed for reasonable and customary expenses associated with my work in this matter. My compensation is not contingent on the outcome of this matter, or any other proceeding or matter either before the Board or in litigation in

court involving the '422 Patent, or the specifics of my testimony.

D. Information Considered

9. In forming my opinions described in this declaration, I have relied upon my years of education, research, experience, and training, as well as my review of various materials including the '422 Patent, the associated patent prosecution history, and numerous pieces of prior art to the '422 Patent. I have considered the materials I identify in this declaration and those listed as exhibits in Appendix A, following this declaration.

10. I may rely upon these materials and/or additional materials to respond to arguments raised by the Patent Owner. I may also consider additional documents and information in forming any necessary opinions, including documents that may not yet have been provided to me.

11. My analysis of the materials relevant to this investigation is ongoing, and I will continue to review any new material as it is provided or becomes known to me. This declaration represents only those opinions I have formed to date. I reserve the right to revise, supplement, and/or amend my opinions stated herein based on newly obtained information or evidence received during the course of this proceeding, based on any new positions or declarations made by or on behalf of Patent Owner, Brook & Whittle Limited ("Patent Owner" or "Brook and Whittle"), or based on my continuing analysis of the materials already provided.

II. LEGAL STANDARDS FOR PATENTABILITY

12. I am not a lawyer and am not providing any legal opinions. In providing my opinions in this declaration, I am relying upon certain basic legal principles that have been explained to me by counsel and which I am summarizing below.

13. First, I understand that for an invention claimed in a patent to be found patentable, it must be, among other things, new and not obvious from what was known before the invention was made.

14. I understand the information that is used to evaluate whether an invention is new and not obvious is generally referred to as "prior art" and generally includes patents and printed publications (e.g., books, journal publications, articles on websites, product manuals, etc.).

15. I understand that in this proceeding the Petitioner has the burden of proving that the claims are obvious from the prior art by a preponderance of the evidence. I understand that "a preponderance of the evidence" is evidence sufficient to show that a fact is more likely to be true than not to be true.

16. I understand that in this proceeding, the claims should be given their ordinary and customary meaning as understood by one of ordinary skill in the art in view of the patent and its file history. The claims after being construed in this manner are then to be compared to the information in the prior art.

17. I understand that in this proceeding, the information that may be

evaluated is limited to patents and printed publications. My analysis below compares the claims to patents and printed publications that are prior art to the claims.

18. I understand that the prior art can be shown to have made a patent claim "obvious" to a person of ordinary skill in the art. My understanding of the legal standards for obviousness is set forth below, and I have applied these standards in my evaluation.

19. I understand that a claimed invention is not patentable if it would have been obvious to a person of ordinary skill in the field of the invention at the time the invention was made.

20. I understand that the obviousness standard is defined in the patent statute, 35 U.S.C. § 103, as follows:

> 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. I understand that to find a claim in a patent obvious, one must make certain findings regarding the claimed invention and the prior art. Specifically, I understand that the obviousness question requires consideration of four factors (although not necessarily in the following order):

- The scope and content of the prior art;
- The differences between the prior art and the claims at issue;
- The knowledge of a person of ordinary skill in the pertinent art; and
- Whatever objective factors indicating obviousness or non-obviousness may be present in any particular case.

22. In addition, I understand that the obviousness inquiry should not be done in hindsight, but must be done using the perspective of a person of ordinary skill in the relevant art as of the effective filing date of the patent claim.

23. I understand the objective factors indicating obviousness or non-obviousness may include: commercial success of products covered by the patent claims; a long-felt need for the invention; failed attempts by others to make the invention; copying of the invention by others in the field; unexpected results achieved by the invention; praise of the invention by those in the field; the taking of licenses under the patent by others; expressions of surprise by experts and those skilled in the art at the making of the invention; and the patentee proceeded contrary to the accepted wisdom of the prior art. I also understand that any of this evidence must be specifically connected to the invention rather than being associated with the prior art or with marketing or other efforts to promote an invention. I am not presently aware of any evidence of "objective factors" suggesting the claimed shrink labels (claims 1-13, 16-19) and related articles (claims 14-15) are not obvious, and

respectfully request the opportunity to address any such evidence if it is identified in the future.

24. I understand the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. I understand that when the prior art does not expressly disclose a claim limitation, inherency may also supply a missing claim limitation in an obviousness analysis. I understand that inherency is established in the context of obviousness when the limitation at issue necessarily must be present, or is the natural result of the combination of elements explicitly disclosed by the prior art. I also understand that an example of a solution in one field of endeavor may make that solution obvious in another related field. I also understand that market demands or design considerations may prompt variations of a prior art system or process, either in the same field or a different one, and that these variations will ordinarily be considered obvious variations of what has been described in the prior art.

25. I also understand that if a person of ordinary skill can implement a predictable variation, that variation would have been considered obvious. I understand that for similar reasons, if a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using that technique to improve the other device would have been obvious unless its actual application yields unexpected

results or challenges in implementation.

26. I understand that the obviousness analysis need not seek out precise teachings directed to the specific subject matter of the challenged claim, but instead can take account of the "ordinary innovation" and experimentation that does no more than yield predictable results, which are inferences and creative steps that a person of ordinary skill in the art would employ.

27. I understand that sometimes it will be necessary to look to interrelated teachings of multiple patents/publications from the same field of endeavor, or which seek to solve the same problem, as the subject patent, the effects of demands known to the design community or present in the marketplace, and the background knowledge and skill possessed by a person having ordinary skill in the art. I understand that all these issues may be considered to determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue.

28. I understand that the obviousness analysis cannot be confined by a formalistic conception of the words "teaching, suggestion, and motivation." I understand that in 2007, the Supreme Court issued its decision in *KSR Int'l Co. v. Teleflex, Inc.*, 550 U.S. 398 (2007), where the Supreme Court rejected the previous requirement of an explicit "teaching, suggestion, or motivation to combine" known elements of prior art as a precondition for finding obviousness. It is my

understanding that *KSR* confirms that any motivation that would have been known to a person of skill in the art, including common sense, or derived from the nature of the problem to be solved, is sufficient to explain why references would have been combined.

29. I understand that a person of ordinary skill attempting to solve a problem will not be led only to those elements of prior art designed to solve the same problem. I understand that under the *KSR* standard, steps suggested by common sense are important and should be considered. Common sense teaches that familiar items may have obvious uses beyond the particular application being described in a reference, that if something can be done once it is obvious to do it multiple times, and in many cases a person of ordinary skill will be able to fit the teachings of multiple patents/publications together like pieces of a puzzle. As such, the prior art considered can be directed to any need or problem known in the field of endeavor and can provide a reason for combining the elements of the prior art in the manner claimed. In other words, the prior art does not need to be directed towards solving the same problem that is addressed in the patent. Further, the individual prior art references themselves need not all be directed towards solving the same problem, provided that they come from the same field of endeavor as the claimed invention.

30. I understand that obviousness does not require that the features of a secondary reference be bodily incorporated into the structure of the primary

reference. Rather, the test is what the combined teachings of those references would have suggested to a person of ordinary skill in the art. The disclosures of the prior art references need not be physically combinable; combining the teachings of references should be the focus of the analysis.

31. I understand that an invention that might be considered an obvious variation or modification of the prior art may be considered non-obvious if one or more prior art references discourages or leads away from the line of inquiry disclosed in the reference(s). A reference does not "teach away" from an invention simply because the reference suggests that another embodiment of the invention is better or preferred. My understanding of the doctrine of teaching away requires a clear indication that the combination should not be attempted (e.g., because it would not work or explicit statements saying the combination should not be made).

32. I understand that a person of ordinary skill is also a person of ordinary creativity.

33. I further understand that in many fields, it may be that there is little discussion of obvious techniques or combinations, and it often may be the case that market demand, rather than scientific literature or knowledge, will drive design trends. When there is such a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within their technical grasp. If

this leads to the anticipated success, it is likely the product not of innovation but of ordinary skill and common sense. In that instance, the fact that a combination was obvious to try might show that it was obvious. The fact that a particular combination of prior art elements was "obvious to try" may indicate that the combination was obvious even if no one attempted the combination. If the combination was obvious to try (regardless of whether it was actually tried) and leads to anticipated success, then it is likely the result of ordinary skill and common sense rather than innovation.

34. I understand that with respect to claimed ranges, a "prima facie case" of obviousness (meaning, obviousness on its face) may exist when the ranges of a claimed composition overlap with ranges disclosed in the prior art. I understand that this is particularly so when the prior art range teaches toward the claimed range or the claimed range is within or overlaps with what would have been considered a conventional or optimal range by one of ordinary skill in the art.

35. I also understand that claim limitations that only describe a function or an intended use of a known structure or composition, without defining specific structural or compositional differences, may not, by themselves, make a claim non-obvious over prior art that discloses that structure or composition.

III. THE '422 PATENT

A. <u>The Person of Ordinary Skill in the Art ("POSITA")</u>

36. I have reviewed the '422 Patent specification, its claims, and

prosecution history. Based on my experience in the field and the information disclosed in the '422 Patent that I discuss in this declaration, it is my opinion that a POSITA would have a bachelor's degree in chemistry, chemical engineering, polymer science, or related field, and two years' experience in designing, manufacturing, or evaluating heat shrink film used for packaging or labeling containers.

37. It is also my opinion that additional education could compensate for lack of experience in the field and additional experience in the field could compensate for less education, such that a POSITA could have an educational level higher than a bachelor's degree but have less than two years' experience in the field or have less education than a bachelor's degree but have greater than two years' experience in the field. In any case, I am a POSITA under this definition.

B. '422 Patent's Effective Filing Date

38. The application for the '422 Patent (EX-1001), titled "Recyclable Heat Shrink Film for Recyclable Container," was filed on January 30, 2023. Based on information on the face of the '422 Patent, it was a continuation of an application filed on May 13, 2022, which claims priority to a provisional application filed on May 14, 2021. For the purposes of my opinions herein, I have been asked by Petitioner's counsel to assume that the '422 Patent's effective filing date is May 14, 2021.

C. <u>The '422 Patent's Specification</u>

39. The specification identifies a need in the packaging industry, particularly for products like dairy, food, and nutraceuticals packaged in clear polyethylene terephthalate ("PET") containers, for labels that provide effective protection against light degradation while also being compatible with established PET recycling streams. (*Id.*, 1:15-28). The patent asserts that prior solutions, such as using color-impregnated PET bottles or traditional shrink labels with certain light-blocking materials or constructions, often hinder recyclability. (*Id.*).

40. In an attempt to address these asserted needs, the '422 Patent describes a multi-layer recyclable heat shrink label designed for application to containers, particularly PET containers. (*Id.*, Abstract; 1:37-2:44). The core structure comprises a heat shrink film base, identified as preferably comprising PET, and a light blocking layer disposed adjacent to one surface of the film (typically the surface facing the container, termed the "first surface"). (*Id.*, Abstract; 6:33-57, 9:15-18).

41. The specification details several key features and components:

- ***Heat Shrink Film***: The base film is a heat-shrinkable polymer film, preferably consisting of PET or comprising PET or related polyesters. (*Id.*, 9:15-18). It is described as having a thickness typically in the range of 15 µm to 100 µm (*Id.*, 8:12-14) and exhibiting shrinkage (e.g., 1% to 90%) when heated to temperatures like 100°C (*Id.*, 9:24-30). The patent notes the importance of PET for recyclability. (*Id.*, 1:15-16; 2:45-61). The film inherently has a first and second surface.

- ***Light Blocking Layer***: Disposed adjacent to the film's first surface, this layer contains a "light blocking component" and is constructed to block at least 80% of incident light across a broad spectrum from 200 nm (ultraviolet, or "UV") to 900 nm (near-infrared, or "NIR"). (*Id.*, 1:39-45; 2:40-44; 6:58-61; 13:24-28; 19:63-67; 20:28-32). The light blocking component is described as comprising particulates, such as metal particles (Al, Zn, Cu, Ag, etc.), metal oxides (TiO_2), carbon black, mica, or reflective pigments. (*Id.*, 2:13-17). A particle size range of 0.1 μm to 100 μm is specified for these components. (*Id.*, 2:12-13). The amount of the layer or the component within the layer can be specified in terms of pounds per ream ("ppr"). (*Id.*, 2:17-21).
- ***Optional High Opacity Layer***: Some embodiments include a distinct high opacity layer, typically comprising a white pigment, e.g., TiO_2, precipitated calcium carbonate (PCC), aluminum oxide, aluminum silicate, coated mica), often disposed between the light blocking layer and an optional indicia layer. (*Id.*, Abstract; 2:35-44; 6:33-57; 11:57-64.). This layer provides a white background and contributes to obscuring underlying layers or the container.

- ***Optional Indicia Layer***: The label may include an indicia layer, comprising inks applied via standard printing methods, to convey graphical or textual information. (*Id.*, Abstract; 1:46-47; 15:54-67; 16:45-67). The patent describes configurations where this layer is effectively protected, such as by being adjacent to the container surface (reverse printing).
- ***Recyclability***: A key aspect emphasized is that the label is "recyclable with a PET container." (*Id.*, 9:10-18; 11:29-53; 28:36-37; 30:18-19). The specification describes that during standard PET recycling processes (e.g., caustic wash), the inks and coating layers (including the light blocking and opacity layers) are intended to separate cleanly from the PET base film, allowing the PET film to be recovered and processed with the container material without significant contamination or discoloration. (*Id.*, 9:10-18; 11:29-53).

42. The '422 Patent attempts to contrast its approach with prior art methods that allegedly incorporated light-blocking materials into the film itself, hindering recyclability, asserting that its layered approach with washable functional layers facilitates recycling compatibility. (Compare Background 1:26-28 with Summary/Detailed Description, e.g., 20:3-21).

D. The '422 Patent's Claims

43. I understand that Petitioner is challenging claims 1-19 of the '422 Patent. These claims are reproduced below:

Limitation	Claim Language
[1-PRE]	A recyclable shrink label comprising:
[1-1]	a heat shrink film comprising polyethylene terephthalate (PET) and having a first surface and a second surface opposite of the first surface,
[1-2]	the heat shrink film having a thickness from 15µm to 100µm; and
[1-3]	a light blocking layer disposed adjacent the first surface and comprising a light blocking component,
[1-4]	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 200nm to 900nm,
[1-5]	wherein the light blocking component comprises a particulate having a particle size of 0.1µm to 100µm,
[1-6]	wherein the particulate comprises metal, metal oxide, a reflective pigment, carbon black, mica, or a combination thereof, and
[1-7]	wherein the recyclable shrink label is recyclable with a PET container.
[2]	The recyclable shrink label of claim 1 further comprising an indicia layer.

Limitation	Claim Language
[3]	The recyclable shrink label of claim 1 further comprising a high opacity layer 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 of claim 1, wherein the heat shrink film consists of polyethylene terephthalate (PET).
[6]	The recyclable shrink label according to claim 1, wherein the recyclable shrink label is in a form of a sleeve or tube.
[7]	The recyclable shrink label according to claim 6, wherein the heat shrink film comprises a seam.
[8]	The recyclable shrink label according to claim 1, wherein when heated to 100°C., the heat shrink film contracts or shrinks by about 1% to about 90%.
[9]	The recyclable shrink label according to claim 1, wherein when heated to 100°C, the entire recyclable shrink label contracts or shrinks by about 1% to about 90%.
[10]	The recyclable shrink label according to 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.

Limitation	Claim Language
[11]	The recyclable shrink label according to 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.
[12]	The recyclable shrink label according to claim 1, wherein the light blocking layer is present in an amount of 0.5 ppr to 25 ppr relative to the recyclable shrink label.
[13]	The recyclable shrink label according to claim 1, wherein the light blocking layer comprises from 0.1 ppr to 10 ppr of the light blocking component.
[14-PRE]	An article comprising:
[14-1]	a container comprising polyethylene terephthalate (PET) and defining an external surface; and
[14-2]	the recyclable shrink label of claim 1 disposed on the container.
[15]	The article according to claim 14, wherein the first surface of the heat shrink film faces the external surface of the container.
[16]	The recyclable shrink label according to claim 2, wherein the indicia layer is disposed on the first surface.
[17]	The recyclable shrink label according to claim 8, wherein the heat shrink film contracts or shrinks by about 1% to 90% in a transverse direction.
[18]	The recyclable shrink label according to claim 1, wherein the heat shrink film comprises crystallizable polyethylene terephthalate (PET).
[19-PRE]	A recyclable shrink label comprising:

Limitation	Claim Language
[19-1]	a heat shrink film comprising polyethylene terephthalate (PET) and having a first surface and a second surface opposite of the first surface,
[19-2]	the heat shrink film having a thickness from 15μm to 100μm;
[19-3]	a light blocking layer disposed adjacent the first surface and comprising a light blocking component,
[19-4]	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, and
[19-5]	a high opacity layer comprising a white pigment,
[19-6]	wherein the recyclable shrink label is recyclable with a PET container.

E. '422 Patent's Prosecution History

44. As mentioned above, I have also reviewed the prosecution history of the '422 Patent (EX-1002, EX-1003). I did so, in part, to understand the context of the examination, including the prior art considered by the USPTO Examiner and the arguments presented by the Patent Owner that led to the allowance of the claims. My summary of these events is presented below.

45. In the first Office Action, the Examiner rejected original claims 1-11 and 13-18 primarily based on U.S. Patent Pub. 2017/0223879 ("Mitchell I"). (EX-1002, 224-22). The Examiner concluded that Mitchell I disclosed the structural features of original claim 1. Regarding the term "recyclable," the Examiner initially

considered it functional language related to intended use or found that Mitchell I's disclosed structure would inherently be recyclable. (*Id.*, 225). The Examiner also issued rejections over U.S. Patent Pub. 2009/0233067 ("Doornheim") and combinations involving U.S. Patent Pub. 2016/0136934 ("Mitchell II"), Mitchell I, and Japanese Patent Pub. No. 2004114498 ("Hashimoto"). (*Id.*, 228, 232; EX-1003, 3). Notably, original claim 19, which required PET film, was not rejected over Mitchell I or Mitchell II as the Examiner found these references did not disclose PET heat shrink film. (EX-1002, 63, 224).

46. To overcome these rejections, the Applicants amended claim 1 to explicitly require that the heat shrink film comprise PET and that the label be "recyclable with a PET container." (EX-1003, 83, 90, 94). The Applicants argued that the cited references failed to teach a PET heat shrink film. Furthermore, the Applicants contended that the "recyclable with a PET container" limitation was structural, not merely functional, attempting to distinguish its invention from the cited art. Applicants asserted that prior art labels achieving light blocking did so by incorporating light-blocking materials within the shrink film itself, rendering them non-recyclable due to contamination potential in the PET recycling stream. In contrast, Applicants argued their invention utilized a separate, adjacent light-blocking layer applied to the PET film, which can be separated (e.g., by caustic wash) from the latter during recycling. (*Id.*, 90-94).

47. In a subsequent Office Action, the Examiner introduced Japanese Patent Pub. JP2009-214535A ("Sasaki") and issued new rejections. The Examiner found Sasaki anticipated or rendered obvious many claims, including the amended version of claim 1. (EX-1003, 114, 116, 119, 121). The Examiner found Sasaki disclosed the structural features and described its labels as recyclable, considering the added limitation "recyclable with a PET container" to be functional language describing an intended use, or inherently met by Sasaki's structure. (*Id.*, 114-115).

48. In response, the Applicants maintained their position that "recyclable with a PET container" imparted structural limitations, though specific structural differences were not clearly identified. Applicants argued Sasaki actually taught away from the invention because Sasaki allegedly achieved light blocking using void spaces within the film, rather than the claimed particulates in an adjacent layer. Applicants further argued Sasaki taught away from using a separate opacity layer. (*Id.*, 184-185). Concurrently, Applicants further amended claim 1 to incorporate limitations from original dependent claims 12 and 13, specifying the particulate nature, particle size range (0.1μm to 100μm), and composition (metal, metal oxide, reflective pigment, carbon black, mica, or combination) of the light blocking component. (*Id.*, 177-178). Applicants also added claim 27 (which later issued as claim 19), reciting a high-opacity layer instead of specific light-blocking particulates. (*Id.*, 180; 185).

49. Ultimately, the Examiner allowed the claims. (EX-1003, 197). Based on the record, it appears the Examiner accepted the Applicants' arguments distinguishing Sasaki, likely based on the combination of features, i.e., a PET heat shrink film, a separate adjacent layer containing specific light blocking particles (or a separate opacity layer), and the asserted capability of being "recyclable with a PET container." The Examiner seemed satisfied that the prior art of record did not teach this specific combination.

F. Known Technologies That the Examiner Did Not Consider

50. Based on my review of the prior art available to a POSITA before May 14, 2021, this specific combination of features was, in fact, taught or rendered obvious by technologies that the Examiner may not have considered or fully appreciated.

51. Specifically, the prior art references upon which I rely in my unpatentability analyses, each of which fall within the same field of heat shrink films as the subject patent —namely Schurr (EX-1006) for Ground 1, and the combination of Kitano (EX-1007) with Lee (EX-1010) for Ground 2—provide, in my opinion, clear teachings or strong suggestions of this very combination of elements when viewed through the eyes of a POSITA and considering the state of the art at the time. I will briefly outline how these references address these key features below, and will provide a more detailed analysis in the subsequent Grounds sections of this

declaration.

52. The Schurr reference (EX-1006), for instance, describes a multi-layer heat-shrinkable film explicitly taught as suitable for wrapping applications and being "recycled easily." (EX-1006, Abstract; 8:32-36). From a POSITA's perspective, Schurr's teachings align directly with the features the Examiner seemingly found to be distinguishing. Schurr teaches that its film is polyester-based, specifically including PET as a suitable material (EX-1006, 2:50-55; 3:4-6). The film structure comprises a first polymer ply (Ply A) containing dark pigments such as fine metal particles or carbon black, which are light-blocking particulates, and which is adjacent to a second polymer ply (Ply B) containing white pigment, serving as an opacity layer. (EX-1006, Abstract; 2:20-24; 6:18-51; 7: 8-12). Schurr further teaches that the film structure may also comprise an additional ply consisting of one or more polymers, including polyesters, which contains neither a dark pigment nor a white pigment. (EX-1005, 5:14-34). This clear ply represents the base shrink film, which would be recyclable with the bottle after removal of the pigmented plies (Ply A, Ply B, and optional indicia ply) during caustic washing. Schurr further explicitly discusses that its film is designed for recyclability, including separation from transparent objects like PET containers based on differing densities, a known PET recycling technique. (EX-1006, 15:54-63). Thus, Schurr, on its own, provides a strong teaching of a PET-based heat shrink film with separate, adjacent layers

containing light-blocking particles and/or an opacity layer, which is also disclosed as being recyclable.

53. Similarly, the teachings of Kitano (EX-1007) and Lee (EX-1010) also address this combination of features. Kitano discloses a heat-shrinkable laminate label that preferably uses a PET substrate film (EX-1007, [0012], [0014]). This label includes separate, adjacent printed layers: a light-shielding layer containing aluminum particles (light-blocking particulates) and/or a white ink "shielding layer" (an opacity layer). (EX-1007, Abstract, [0007]-[0008], [0011], [0018]). Thus, Kitano itself provides teachings of a PET-based heat shrink film with separate, adjacent layers for light blocking or opacity. Concurrently, the Lee reference (EX-1010) is specifically directed to solving the technical problem of achieving integrated recyclability for PET-based shrink labels with PET containers. Lee teaches formulating PET/copolyester blends with controlled crystallizability such that the label "can be reused while attached to a PET container" and processed within standard PET recycling streams without issues like fusion. (EX-1010, Abstract, [0004], [0010], [0020]).

54. Therefore, from a technical perspective, the collective teachings available from Kitano (regarding the PET film structure with separate light-modifying layers) and Lee (regarding the specific material science for achieving PET co-recyclability for such films) provide a clear pathway to a PET-based heat shrink

label featuring separate, adjacent light-blocking and/or opacity layers that is specifically engineered to be recyclable with a PET container. As I will explain in detail in my analysis for Ground 2, a POSITA would have found it obvious to integrate these compatible teachings.

55. In any case, it is my opinion that these combined teachings present the very combination of features the Examiner appeared to find lacking in the art of record when allowing the '422 Patent claims, and thus these references and combinations are highly pertinent to the assessment of patentability.

IV. CLAIM CONSTRUCTION

56. For purposes of my opinions, I have applied each claim term's ordinary and customary meaning as it would be understood by a POSITA at the time of the invention, read in the context of the entire '422 Patent, including the specification and its prosecution history.

57. For the term "adjacent" as used in independent claims 1 and 19 (e.g., "a light blocking layer disposed adjacent the first surface"), I have applied the definition provided in the '422 Patent specification. The '422 Patent explains the term "adjacent" as follows: "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." (EX-1001, 6:51-54).

58. For the term "ppr" as used in dependent claims 12 and 13, I have

likewise applied the definition provided in the '422 Patent specification. The '422 Patent explains the term "ppr" as follows: "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)." (EX-1001, 5:44-47).

59. I understand and have been informed that the phrase, "recyclable shrink label is recyclable with a PET container," as used in independent claims 1 and 19, describes an intended use of the label and should not be given patentable weight. Nevertheless, I have been asked to assume the phrase will be given patentable weight and to provide my understanding of the phrase as understood by a POSITA. Such an understanding is compatible with established PET container recycling streams, and, specifically, I apply an understanding that this phrase means the label is capable of entering a PET recycling stream simultaneously with a PET container and can undergo the recycling process alongside the container. This process would typically involve steps such as grinding, washing (often a caustic wash), and separation, ultimately aiming to produce a PET product or PET constituent materials (like ethylene glycol and terephthalic acid) where the label components either separate cleanly, do not unduly contaminate the recycled PET, or are otherwise managed in a way that is considered acceptable within standard PET recycling practices. This understanding is consistent with the goal of ensuring that the label does not hinder

the recyclability of the PET container with which it is associated.

60. I also understand that certain "transitional" words and phrases in patent claims have established meanings in patent law, and I have applied these meanings in providing my opinions. Specifically:

- I understand the terms "comprising" and "comprises" are open-ended, meaning they are synonymous with "including," "containing," or "characterized by," and do not exclude additional, unrecited elements or steps.
- I understand the transitional phrases "consisting of" and "consists of" are closed-ended, meaning they ordinarily exclude any element, step, or ingredient not specified in the claim. But I also understand that when "consisting of" modifies a particular component or aspect of a claim (e.g., the polymeric composition of a film), it does not necessarily exclude other types of materials (e.g., non-polymeric additives like pigments) that are not part of that specifically defined component or aspect, if the claim as a whole, read in light of the specification, permits such an interpretation.

V. STATE OF THE ART / TECHNICAL BACKGROUND

61. In May 2021, a POSITA working on packaging solutions, particularly for light-sensitive products in PET containers, would have been operating within a

well-established technical landscape. Key aspects of this landscape, forming part of the POSITA's general knowledge, included the widespread use of PET, the known challenges of product degradation due to light exposure, the significant drive towards enhanced recyclability of all packaging components, and the existing technologies and approaches to address these issues.

62. PET was a dominant material for beverage and food containers due to its optical clarity, strength, and good barrier properties. However, the transparency of standard PET, while often desirable for product visibility, posed a significant challenge for light-sensitive contents. It was well understood that exposure to light, particularly in the UV-visible spectrum, could lead to the degradation of packaged products, such as milk, resulting in undesirable sensory changes (e.g., "sunlight flavor") and loss of nutritional value. (EX-1014, Abstract, lines 50-53, 68-70, 397-399, 453-456; see also '422 Patent, 1:16-25). Limbo (EX-1014), for example, specifically discusses photo-oxidation in milk packaged in clear PET bottles and notes that "when milk is exposed to light at wavelengths in the UV-visible range... [it] can activate complex photo-degradative reactions" (EX-1014, lines 51-53). Consequently, a POSITA would recognize a persistent need for effective light-blocking solutions for PET packaging to preserve product quality and extend shelf life. (EX-1014, lines 68-76, 448-451).

63. Simultaneously, there was immense industry and regulatory pressure to

improve the sustainability and recyclability of plastic packaging, with a strong focus on PET due to its high volume in the waste stream. (EX-1012, p.1-2, "1. Introduction"; EX-1013, p. 5376, col. 1; EX-1011). The concept of a "circular economy" for plastics was a major driver, aiming to keep materials in use for as long as possible and to minimize waste. (EX-1012, p.1-2). A POSITA would have been aware that labels, as integral components of packaging, needed to be compatible with established PET recycling streams to avoid contamination of the recycled PET (rPET) flake and to support closed-loop recycling. (EX-1012, p. 4, "Contamination of recycled material contributes to the decrease in quality and increase in variability of the regenerated polymer"; EX-1013, p. 5377, col. 1, "Especially for the more complex PET waste streams such as PET trays, mechanical recycling is even hardly possible...").

64. Mechanical recycling was the predominant method for PET, but it faced challenges, particularly with colored or multilayer PET structures, and with contaminants like inks and adhesives from labels that could diminish the quality of rPET. (EX-1012, p. 4, "Contamination of recycled material contributes to the decrease in quality and increase in variability of the regenerated polymer", p. 7, "3. Mechanical Recycling of Poly(ethylene terephthalate)"; EX-1013, p. 5376, col. 2, p. 5377, col. 1). These limitations in mechanical recycling underscored the ongoing need for robust chemical recycling pathways for certain PET waste streams or to

achieve higher purity recyclate. Chemical recycling methods, such as alkaline hydrolysis, were also known and being developed as a complementary approach to handle more complex PET waste streams and to recover high-purity monomers. (EX-1013, p. 5377, col. 1-2, "The hydrolysis of PET..."). Critically, Ügdüler (EX-1013) demonstrates that even challenging components, such as carbon black in PET, could be successfully removed from the hydrolysate during alkaline hydrolysis, yielding pure monomers. (EX-1013, Abstract, p. 5387, col. 1-2, "Scale-up assessment"). This established that the presence of common light-blocking pigments was not an insurmountable barrier to chemical recycling if the process was appropriately designed.

65. A POSITA would also have been familiar with standard techniques for imparting light-blocking properties to packaging films and labels. These included incorporating pigments such as carbon black, titanium dioxide (TiO_2), or metallic particles into one or more layers of the label structure. The use of such pigments in distinct layers, rather than being compounded into the bulk of the primary film material, was a common approach for manufacturing functional labels. (EX-1014, lines 69-70, 447-448, referencing light-protective additives and multilayer cartons).

66. Therefore, a POSITA in May 2021 would understand the dual critical needs: (1) to provide effective broad-spectrum light protection for products in PET containers, and (2) to ensure that any labeling solution was fully compatible with,

and did not hinder, the established and evolving PET recycling infrastructure, whether mechanical or chemical. Solutions that could address both needs simultaneously were highly desirable.

VI. OVERVIEW OF THE PRIOR ART

67. Heat shrink labels were well-known in the art before the '422 Patent. Indeed, in my opinion, the field of heat shrink labels for packaging, particularly those involving PET materials and addressing concerns of light protection and recyclability, was well-developed prior to May 14, 2021, the assumed effective filing date of the '422 Patent. Numerous prior art references described various aspects of such labels, including their material compositions, layered structures, functional properties, and manufacturing methods. For instance, Schurr (EX-1006), which I discuss in detail below, discloses a multi-layer, light-blocking, polyester-based heat shrink film explicitly stated to be recyclable. Furthermore, Kitano (EX-1007) describes PET-based heat shrink labels with specific light-shielding layers, and Lee (EX-1010) teaches PET-based heat shrink films engineered for enhanced co-recyclability with PET containers. As I explain below, a POSITA, equipped with the common knowledge in this field, would have found clear motivation and a reasonable expectation of success in applying the teachings of Schurr, or in combining the complementary teachings of Kitano and Lee, to arrive at the very subject matter of the Challenged Claims.

A. Prior Art Status

68. I understand from counsel for Petitioner that Schurr (EX-1006), Kitano (EX-1007), and Lee (EX-1010) each qualifies as prior art, and I have been asked to assume them to be so.

B. Schurr: U.S. Patent No. 11,358,363 (EX-1006)

69. "Schurr" refers to U.S. Patent No. 11,358,363, titled "Light-Tight Shrink Wrapping Film" (EX-1006).

70. In my opinion, Schurr is directed to solving the problem of providing a heat-shrinkable polymer film that offers effective light protection for packaged goods, particularly foodstuffs, while also being easily printable and recyclable. (EX-1006, 1:3-10, 1:60-63, 2:3-11, 7:59-8:15, 8:32-33). Schurr notes that prior attempts to achieve light-impermeability, such as by printing with black ink, had limitations including insufficient light blocking, post-processing costs, and potential defects after wrapping. (EX-1006,1:43-59). To address this, Schurr discloses a multi-layer film structure, preferably uniaxially stretched. (EX-1006, 2:20-21).

71. The core structure taught by Schurr comprises a "first polymer ply A which comprises at least one dark pigment, and also comprising a second polymer ply B, which comprises at least one white pigment." (EX-1006, Abstract, 2: 21-24). Schurr teaches that both plies are preferably polyester based, explicitly including PET as a suitable polyester. (EX-1006, 2:50-55, 3:3-5, 3:56-64). The dark pigment

in Ply A (e.g., fine metal particles or carbon black, including "soot and/or carbon black" with specific particle size ranges mentioned, 6:18-54) provides the primary light blocking, while the white pigment in Ply B (e.g., titanium dioxide TiO_2, 7:8-12) provides a white, printable surface that obscures the dark Ply A, ensuring Ply B "actually appears white." (EX-1006, 8:41-55). Schurr states its film achieves low light transmission (e.g., "not more than 12%," and potentially much lower, across 360-750 nm) and has a typical thickness of 20 µm to 100 µm. (EX-1006, Abstract; 2:24-27, 8:2-9).

72. Importantly, Schurr emphasizes the recyclability of its film, stating "the film overall can be recycled easily" and that "waste material can easily be added back to the material provided for the production of the first polymer ply A." (EX-1006, 8:32-39). Schurr also describes how, when the wrapped object is recycled, "the material of the films or hoses can be separated from the material of the transparent object by processes known in the art, for example on the basis of differing densities." (EX-1006, 15-54-63). Schurr further teaches that its film exhibits significant shrinkage (e.g., 20% to 85% in a 95°C water bath) and can be formed into a "hose" or sleeve by joining its edges, suitable for wrapping bottles. (EX-1006, Abstract; 2:29-35; 15:11-43).

C. <u>Kitano: JP 2017-114041 A (EX-1007)</u>

73. "Kitano" refers to the certified English translation of Japanese

Unexamined Patent Application Publication No. JP 2017-114041 A (EX-1007).

74. In my opinion, Kitano is directed to providing a "reflective light shielding laminate" for packaging that imparts light shielding properties without requiring conventional multi-step lamination or vapor deposition processes, while also offering excellent whiteness, brightness, and the ability to be back printed. (EX-1007, Abstract, [0006]-[0008], [0012], [0028]-[0031], [0034]-[0038]). Kitano aims to solve problems associated with prior art light shielding films, such as insufficient whiteness/brightness when using black/gray inks, or limitations on back printing. (EX-1007, [0003]-[0004]).

75. The laminate structure taught by Kitano fundamentally comprises a "substrate layer (1)," a "shielding layer (2)" composed of one or more layers of white ink, and a "light shielding layer (3)" printed on the shielding layer (2) and composed of light shielding ink containing binder resin and aluminum particles. (EX-1007, Abstract, [0007]-[0008], [0011], Fig. 1). Kitano teaches that the substrate layer can be a heat-shrinkable resin film, with PET film being "preferable because high transparency is obtained," particularly for back printing applications where an indicia layer (4) can be printed between the substrate (1) and the white ink shielding layer (2). (EX-1007, [0011], [0012], [0014], Fig. 2).

76. The light shielding layer with aluminum particles is key to Kitano's invention, providing "excellent light shielding properties" by reflection, and,

importantly, Kitano notes that these properties can be significantly enhanced when a heat-shrinkable substrate is used, as the "light shielding layer composed of aluminum particles takes on a dense surface shape after heat shrinkage." (EX-1007, [0009], [0019]). Kitano aims for low light transmittance, for example, "10% or less and furthermore 3% or less over a region of visible light having a wavelength of 500 to 600 nm." (EX-1007, [0020]). The white ink "shielding layer" provides opacity and a bright background. (EX-1007, [0015]-[0017]). Kitano also explicitly describes forming its laminate into a "cylindrical shrink label" by overlapping and bonding end portions, which may be in the form of a tube, for application to containers. (EX-1007, [0028], Fig. 6).

D. Lee: U.S. Pat. Pub. No. 2022/0389214 (EX-1010)

77. "Lee" refers to U.S. Pat. Pub. No. 2022/0389214 (EX-1010).

78. In my opinion, Lee is directed to a polyester resin blend and films made therefrom, specifically for heat-shrinkable labels that are compatible with PET container recycling streams. Lee explicitly addresses the problem that conventional heat-shrinkable labels, particularly amorphous polyester films, can cause "a fusion phenomenon that sticks to the container in the process of drying the container after washing in the recycle process of the polyethylene terephthalate container," thereby making recycling impossible. (EX-1010, [0004]). Lee also notes the demand for recyclable polyester films for PET containers that have superior shrinkage properties

compared to conventional polyester resins. (EX-1010, [0005]).

79. To solve these problems, Lee discloses a polyester resin blend comprising PET (which can be virgin or recycled PET) (EX-1010, Abstract, [0010], [0031]) and a specific copolyester resin. This copolyester resin is engineered with particular comonomers, including a diol moiety derived from a comonomer containing cyclohexanedimethanol, 4-(hydroxymethyl)cyclohexymethyl 4-(hydroxymethyl)cyclohexanecarboxylate and 4-(4-(hydroxymethyl)cyclohexylmethoxymethyl)cyclohexylmethanol and specific diacid-derived moieties, designed to control the film's crystallization behavior. (EX-1010, [0008]-[0009], [0013]-[0014], [0017]-[0018]). Lee teaches that this blend provides a heat-shrinkable label that is transparent and has "excellent shrinkage." (EX-1010, Abstract, [0010]).

80. A key teaching of Lee, highly relevant to its purpose, is that its heat-shrinkable label "can be reused while attached to a PET container, etc., and is expected to be useful for providing continuously usable plastics that have been recently attracting attention." (EX-1010, Abstract, [0010]). Lee explains that its label, due to its controlled crystallization properties, "can be supplied to the recycle stream of the PET container while being attached to the PET container," thus avoiding the "troublesome process of separating the label from the container." (EX-1010, [0003], [0020]). Lee highlights that its film can be crystallized even at high

drying temperatures typical in PET recycling, preventing fusion. (EX-1010, [0020]). Lee also describes its film as having "excellent shrinkage properties," for example, maximum shrinkage of 55% or more, or even 75% or more, at 95°C. (EX-1010, [0079], Table 3).

VII. THE CHALLENGED CLAIMS ARE OBVIOUS

A. Schurr Would Have Rendered CLAIMS 1-19 Obvious

81. In my opinion, Schurr (EX-1006), when viewed in combination with the knowledge and ordinary skill possessed by a POSITA at the time of the alleged invention (May 14, 2021), would have rendered claims 1-19 obvious and therefore unpatentable.

82. As discussed, Schurr (EX-1006) discloses a multi-layer, light-blocking heat-shrinkable film comprising polyester layers, including a first ply with a dark pigment and a second ply with a white pigment, designed to provide an effective light barrier for packaging applications. (EX-1006, Abstract; Claim 1). And Schurr further explicitly teaches that its film "can be recycled easily." (EX-1006, 8:32-36).

83. Schurr teaches or suggests nearly all limitations of claims 1-19. The knowledge of a POSITA is invoked primarily to bridge any minimal gaps related to achieving specific quantitative performance metrics (e.g., the precise light blocking percentage over the claimed 200-900 nm range, specific shrinkage values at 100°C, and coating amounts expressed in "ppr") through well-known, routine optimization

and characterization techniques. POSITA knowledge is also relevant to confirming or selecting specific material choices (e.g., ensuring the film consists of PET or possesses sufficient crystallizability) to ensure compatibility with standard PET container recycling streams, a well-understood industry objective. As detailed below, a POSITA would have been motivated to apply this knowledge to Schurr's teachings to arrive at the claimed invention with a reasonable expectation of success.

1. Motivation to Apply POSITA knowledge to Schurr and Reasonable Expectation of Success

84. Based on my decades of experience in polymer science, including the synthesis, characterization, and application of polymeric materials in areas such as films and coatings, it is my opinion that a POSITA, around May 2021, when tasked with developing improved shrink labels for PET bottles—particularly for light-sensitive contents—would have found clear and logical motivation to apply his or her ordinary skill and fundamental knowledge of polymer science and material properties to the teachings found in the Schurr reference (EX-1006). This motivation arises from the need to address concurrent technical challenges recognized in the art before the '422 Patent's effective filing date: protecting light-sensitive products and ensuring label compatibility with PET recycling streams. As I will explain, combining Schurr's disclosures with established scientific principles, known solutions to recycling challenges (e.g., EX-1012; EX-1013), and routine

optimization techniques common in materials development would have directly led such a POSITA to the invention recited in claims 1-19 of the '422 Patent.

85. The Schurr reference provides a highly pertinent and logical starting point for a POSITA. Schurr explicitly describes a heat-shrinkable film specifically designed for packaging applications. This film incorporates multiple polymer layers based on polyesters and utilizes pigments to achieve light-blocking properties. Again, and importantly, Schurr's inventors themselves note that this film can be "recycled easily" (EX-1006, Abstract; 8:32-36). From a materials science perspective, this combination of features—a polyester-based, light-blocking, heat-shrinkable, and ostensibly recyclable label film—directly addresses core technical challenges in developing protective labels for light-sensitive products intended for use with PET containers, issues well understood by a POSITA in May 2021.

86. In my opinion, the motivations for a POSITA to build upon Schurr's foundational disclosure are readily apparent and stem not from hindsight but from the logical application of known scientific principles within the fields of physical chemistry, physics, and polymer science, the well-understood demands of the packaging industry, and the utilization of standard material development and characterization techniques. This approach is fully consistent with my understanding of the flexible and common-sense framework for assessing obviousness articulated by the Supreme Court in *KSR*.

87. Indeed, the broader context before May 2021 included significant industry and societal drivers. Initiatives such as the European Green Deal, unveiled in late 2019 with the goal of achieving carbon neutrality by 2050 (EX-1011), intensified the existing pressure on the packaging industry to enhance the recyclability of all components. PET bottle waste was a widely recognized environmental concern, and transitioning to a circular economy for plastics like PET was seen as essential. (EX-1012, p.1-2, discussing the linear plastics economy and the need for recycling to reduce environmental impact and improve resource efficiency; *see also* EX-1013, p. 5376, col. 1, highlighting the "pressing need for efficient recycling processes"). Consequently, there was a strong impetus to develop label solutions that would not hinder, and ideally would facilitate, the efficient and clean recycling of PET materials.

88. Furthermore, based on my understanding of the state of the art in polymer coatings and printing for packaging applications as of May 2021, the concept of formulating inks and coating layers to be removable from film substrates during a caustic wash was a known area of technical development and a desirable characteristic, particularly in the context of recycling. The PET recycling process, both mechanical and as a precursor to chemical methods like alkaline hydrolysis, commonly employs a hot caustic wash step precisely for the purpose of cleaning PET flakes and removing contaminants, including certain types of inks, adhesives,

and label materials. (EX-1012, p. 3, discussing extrusion and melt blending which often follow wash steps; EX-1013, p. 5377, describing alkaline hydrolysis conditions).

89. Therefore, a POSITA would have been aware that efforts were ongoing in the industry to develop label systems, including the inks and coatings applied to them, that would detach or de-ink cleanly during this wash phase, thereby preventing contamination of the recycled PET. For instance, the art before the effective filing date of the '422 patent, as exemplified by Ügdüler (EX-1013), recognized that recycling PET even with challenging additives, such as carbon black, using alkaline hydrolysis (a tertiary recycling process) was entirely workable. Ügdüler (EX-1013) describes that "by using the optimized alkaline hydrolysis with further cleaning processes different types of colours, including carbon black are removed from the hydrolysate successfully." (EX-1013, Abstract; *see also* p. 5387, "Scale-up assessment," discussing separation of carbon black). A POSITA would understand that such principles would apply to layered label constructions where light-blocking pigments are present in distinct layers.

90. Consequently, a POSITA, leveraging his or her understanding of polymer chemistry, material interactions, and common industry objectives, would have been motivated by several key factors when considering Schurr's teachings:

- **The Need for PET Recycling Compatibility**: By May 2021, it was a fundamental understanding in the packaging and polymer industries that the massive scale of PET container usage created immense market and regulatory pressure for sustainable recycling solutions. (EX-1012, p. 1-2; EX-1013, p. 5376, col. 1). This necessitated that all packaging components, particularly labels, be fully compatible with established PET recycling infrastructure to prevent contamination of the recycled PET flake, which was a known and significant technical and economic problem. (EX-1012, p. 4, "Contamination of recycled material contributes to the decrease in quality and increase in variability of the regenerated polymer," p. 5, "Waste Sorting for Recycling"; EX-1013, p. 5376, col. 2, discussing complexities hindering recycling of PET trays and films). Given Schurr's disclosure of a polyester-based film that is "easily recycled," a POSITA would be strongly motivated to rigorously confirm and, if necessary, optimize this compatibility with PET bottle recycling. The goal would be to ensure the label could be co-recycled with PET bottles without causing detrimental effects during the recycling process, such as issues during the caustic wash or melt reprocessing stages. (EX-1012, p. 7-8, discussing PET degradation mechanisms during reprocessing).

- **The Need for Broad-Spectrum Light Protection**: While Schurr demonstrates substantial light blocking (≥88% transmission reduction) within the 360-750 nm range, a POSITA would be well aware that protecting a diverse array of products (such as beverages, foods, and pharmaceuticals) commonly packaged in PET often requires shielding from a broader spectrum of light. This includes UV radiation (200-400 nm), a primary driver of photodegradation, and potentially NIR radiation (750-900 nm), which can contribute to undesirable heating of the product. Light exposure, particularly in the UV-visible range, is known to cause spoilage or affect flavors of packaged contents. (EX-1014, Abstract, lines 51-53, "when milk is exposed to light at wavelengths in the UV-visible range... [it] can activate complex photo-degradative reactions," lines 68-70, discussing prevention of light-induced defects via packaging materials). This fundamental need for comprehensive light protection provides a direct and compelling technical motivation to ensure that a Schurr-based label design would effectively block light across the broader 200-900 nm range specified in the '422 Patent claims. A POSITA would know from basic principles of physical chemistry and materials science that achieving the target light blockage (e.g., ≥80%) across this wider UV-visible-NIR spectrum, using pigments taught by Schurr like carbon black (known for its exceptional broadband absorption capabilities), or other standard light-blocking particulates, would be a matter of routine formulation and process optimization. (EX-1014, lines 69-70, 447-448, discussing use of color pigments, UV absorbers, and light-protective additives like TiO_2).

- **Application of Standard Industry Practices and Material Characterization**: A routine aspect of product development in the field of polymeric films and labels involves the thorough characterization of materials and final products using standard industry test methodologies and units of measurement. For example, a POSITA developing a shrink label based on Schurr's disclosures would, as a standard part of the development process, evaluate its thermal shrinkage properties under conditions representative of industrial use, such as at 100°C, a common temperature for steam or hot water shrink tunnels (directly relevant to the performance specified in '422 Patent claims 8, 9, and 17). This characterization is a typical procedure for performance validation. Similarly, quantifying the amount of functional coatings or their active components—like a light-blocking layer or its pigments—using standard industry units such as ppr (as recited in claims 12 and 13 of the '422 Patent) is a routine practice in material specification, coating formulation, and quality control in the converting and packaging industries. It is a standard way to define coating weights and would be well within the ordinary skill of a POSITA.

- **Consideration of Known Design Alternatives for Functional Benefit**: In the design and manufacture of labels, various structural configurations are commonly employed to achieve specific functional benefits, such as print protection or enhanced adhesion. For instance, regarding the placement of printed indicia (as in '422 Patent Claim 16), a POSITA would be thoroughly familiar with reverse printing. This technique, where ink is applied to the film's inner surface (which becomes the first surface, facing the container, upon application) prior to any subsequent lamination or processing, is a very common and well-established alternative to conventional surface printing (i.e., printing on the film's outer, exposed surface). The technical motivation for selecting reverse printing is strong and widely understood: it effectively protects the printed graphics (indicia) from abrasion, scuffing, and various environmental factors during shipping, handling, and consumer use, because the ink layer is shielded by the transparent base film through which it is viewed. Therefore, selecting reverse printing represents an obvious and established design choice, frequently made by label designers to enhance product durability and appearance based on specific end-use requirements.

91. Furthermore, in my opinion, a POSITA viewing Schurr's disclosure would have possessed a strong and reasonable expectation of success in applying these routine optimizations and known techniques to Schurr's foundational work. This expectation stems from Schurr's use of a PET-based film and common light-blocking pigments, materials generally understood by a POSITA to be manageable within, or adaptable to, PET recycling paradigms, especially when applied in distinct layers as Schurr teaches. Schurr itself clearly demonstrates the fundamental feasibility of creating a light-blocking, polyester-based shrink film structure. The subsequent steps to achieve the specific performance metrics and material compositions of the '422 Patent claims, as I will detail, involve the application of well-understood principles, and would not have required more than the ordinary skill of a POSITA to achieve the claimed results.

92. The path from Schurr's teachings to the specific limitations of the '422 Patent claims would, in my view, involve the application of well-understood scientific and engineering principles common in the fields of polymer science, material formulation, and label manufacturing, leading to predictable outcomes. For example:

- **Light Absorption and Transmission**: The broadband light absorption properties of common pigments like carbon black (known for its effectiveness across UV, visible, and NIR spectra) are fundamental concepts in physics and materials science and are extensively documented in technical literature. A POSITA would understand that adjusting the concentration of such pigments or the thickness of the layer in which they are dispersed, in order to modify light transmission, follows predictable physical laws, such as the Beer-Lambert law. Achieving a specific level of light blockage across a broad spectrum like 200-900nm using such known broadband absorbers is thus a matter of routine formulation and characterization.

- **Thermal Shrinkage of Polyester Films**: The thermal shrinkage behavior of oriented polyester films like PET is a well-studied and well-characterized phenomenon in polymer processing. A POSITA would know that minor adjustments to processing conditions during film orientation, or testing thermal shrinkage at slightly different standard temperatures (such as 100°C versus Schurr's 95°C, both common in evaluating shrink films), would yield predictable trends in shrinkage behavior. Achieving shrinkage within the broad ranges claimed in the '422 Patent would not involve unexpected results but rather predictable material responses based on these established principles.

- **Inherent Properties of PET**: Key inherent properties of PET, including its fundamental crystallizability, are well-established in the polymer field and would be part of a POSITA's general knowledge. The selection of specific grades of PET to achieve desired processing characteristics or end-use properties, such as optimized crystallizability for recycling compatibility (as highlighted by EX-1010), or confirming such properties through standard analytical techniques, is standard practice in polymer materials engineering.
- **Conversion of Performance Metrics**: Converting performance metrics from one set of units to another, such as from weight percent of a component in a film to an areal density unit like ppr, is a routine calculation in materials science and engineering. Such conversions are based on straightforward relationships involving material density, layer thickness, and area (e.g., a standard ream area of 3000 sq ft as per EX-1001, 5:44-47), and would have been a routine calculation well within the ordinary skill of a POSITA, not requiring any contribution beyond such skill.
- **Label Manufacturing Techniques**: The various techniques involved in label manufacturing, such as multi-layer film coextrusion, applying coatings, printing (both surface and reverse methods), and forming

seams to create sleeves, are all established industrial processes. A POSITA would be familiar with these standard manufacturing capabilities and how to employ them to create multi-layered label structures with specific functionalities.

93. Therefore, it is my opinion that combining Schurr's effective starting point—a multi-layer, light-blocking, polyester-based film stated to be "recycled easily"—with the clear motivations driven by known industry needs (such as achieving full PET recycling compatibility and ensuring broad-spectrum light protection for sensitive products) through the application of a POSITA's ordinary skill, utilizing standard and predictable optimization techniques, common material characterization methods, and recognized design alternatives, provides a clear and direct path to the subject matter of claims 1-19 of the '422 Patent. A POSITA would have reasonably expected success in achieving this outcome because each step involves leveraging known materials, established scientific principles, and standard industry practices to meet well-defined performance targets. There is no indication that such a combination would have presented any unexpected technical hurdles or required skill beyond that of a POSITA systematically addressing known problems with known solutions.

94. Now, turning to the claims of the '422 Patent, I will analyze them in this context.

2. Independent Claims 1 and 19

95. As an initial matter, claims 1 and 19 are substantially similar, differing primarily in that claim 1 recites specific particulate requirements for the light blocking component ([1-5], [1-6]) while claim 19 instead requires a high opacity layer comprising a white pigment ([19-5]). Schurr, alone or with POSITA input where noted, renders both claims obvious.

a. Preambles [1-PRE], [19-PRE]

96. I understand the preambles recite "[a] recyclable shrink label." While counsel has advised me that such language stating an intended use might not be strictly limiting if the claim body fully defines the invention, I note that Schurr clearly discloses the subject matter even if the preambles are considered limiting. Schurr describes a "heat-shrinkable film" (EX-1006, Abstract; 1:3-5) explicitly designed for wrapping objects like bottles (EX-1006, 1:6-8). This film is also described as suitable for printing indicia (EX-1006, 1:9-11; 1:49-54), which is characteristic of a shrink label used in packaging. And Schurr explicitly states that "the film overall can be recycled easily." (EX-1006, 8:32-36). From a technical perspective, Schurr's disclosed film is therefore accurately described as a recyclable shrink label.

b. Heat Shrink Film [1-1]/[19-1], [1-2]/[19-2]

97. In my opinion, Schurr discloses a heat shrink film consistent with limitations [1-1]/[19-1] and [1-2]/[19-2].

98. Schurr identifies the film as "heat-shrinkable" and composed of "polyesters." (EX-1006, Abstract; 2:59-3:6). Schurr further clarifies that these polyesters include those derived from standard monomers like "terephthalic acid" and "1,2-ethanediol" (ethylene glycol) (EX-1006, 2:59-3:12), which are the monomers that form PET. Schurr's film structure comprises at least two plies, Ply A and Ply B, which inherently possess opposing first and second surfaces (EX-1006, Claim 3). Thus, Schurr describes a heat shrink film comprising PET and having opposed surfaces.

99. Schurr also discloses a film thickness range that renders the claimed range of 15μm to 100μm obvious. Schurr explicitly teaches that "the film has a thickness of 20 μm bis [to] 100 μm," a range also recited in Schurr's claim 1 (EX-1006, Abstract, 7:47–58). This range (20-100 μm) taught by Schurr substantially overlaps and encompasses almost the entirety of the claimed range (15-100 μm). From a technical perspective, selecting a film thickness is a routine design parameter often dictated by the desired balance of properties like strength, flexibility, cost, and shrinkage performance for a given application. There is typically no sharp change in properties or unexpected result obtained by operating just outside a disclosed

preferred range like Schurr's (e.g., between 15μm and 20μm). A POSITA would readily understand that a film thickness slightly below Schurr's explicit lower value of 20μm, such as 15μm, would be technically feasible and would provide similar performance characteristics, making the claimed range an obvious extension or selection within conventional shrink film parameters.

c. Light Blocking Layer [1-3]/[19-3]

100. Schurr also discloses a light blocking layer disposed adjacent the first surface and comprising a light blocking component, as required by [1-3] and [19-3].

101. Schurr's film structure comprises a "first polymer ply A which comprises at least one dark pigment" layered with a "second polymer ply B, which comprises at least one white pigment." (EX-1006, Abstract; 2:20-24). Ply A, containing dark pigments such as "fine metal particles" or "carbon black" (EX-1006, 6:18-30), serves as the "light blocking layer comprising a light blocking component." In typical application of a shrink label, the outer surface of the container constitutes the "first surface" relative to the label. Schurr describes Ply A as facing the object being wrapped (EX-1006, 15:64-67). Therefore, Ply A is disposed adjacent to the first surface. I note the '422 Patent defines "adjacent" as meaning the surface or side of the label to which the layer is closer, while allowing for intervening layers (EX-1001, 6:51-57), which is consistent with standard multilayer film structures where layers are contiguous.

d. Light Blocking Performance [1-4]/[19-4]

102. In my opinion, Schurr's teachings, particularly when combined with the knowledge of a POSITA, render the light blocking performance limitations [1-4] and [19-4] obvious. These limitations require the light blocking layer to block at least 80% of incident light across the 200nm to 900nm wavelength range.

103. Schurr explicitly discloses that its film achieves high light blocking, specifying a light transmission of "not more than 12%" (which corresponds to ≥88% blocking) measured over the wavelength range of 360-750nm (EX-1006, Abstract; 7:62-66; 8:4-10). Schurr achieves this, in part, by incorporating "soot and/or carbon black" as the dark pigment in Ply A (EX-1006, 6:28-30; 7:33-38). It is fundamental knowledge in physical chemistry and materials science, well understood by a POSITA, that carbon black is an exceptionally strong broadband absorber, effective across the ultraviolet (UV, <400nm), visible (400-700nm), and near-infrared (NIR, >700nm) portions of the spectrum. Therefore, a film constructed according to Schurr using carbon black that already demonstrates ≥88% blocking in the 360-750nm range would necessarily, inherently exhibit very strong blocking (well exceeding the 80% threshold) across the broader 200-900nm range claimed in the '422 patent, simply due to the inherent, well-known optical absorption characteristics of carbon black pigment.

104. Even if not considered inherent, achieving this performance based on

Schurr would have been obvious to a POSITA. Schurr clearly establishes the objective of creating a "light-tight" film (EX-1006, Title) and demonstrates substantial success (≥88% blocking). A POSITA would recognize that for many applications involving light-sensitive products, protection across the full UV-visible-NIR spectrum (200-900nm) is often required or desirable. Motivated by this need, a POSITA would find it straightforward to verify and, if necessary, optimize Schurr's formulation to meet the ≥80% blocking target across 200-900nm. This involves only routine experimentation, such as adjusting the concentration of the carbon black (or other taught dark pigments like metal particles) within Ply A, or slightly modifying the thickness of Ply A. The relationship between pigment concentration, layer thickness, and light transmission is governed by well-established principles (like the Beer-Lambert law), making such adjustments predictable and well within the ordinary skill. Confirming the broadband blocking capability of carbon black or achieving the specific ≥80% target over the 200-900nm range based on Schurr's effective light-blocking structure and pigments involves only routine optimization and characterization, not invention.

e. Particulate Nature and Size [1-5]

105. Schurr discloses a light blocking component comprising a particulate with a particle size falling within the claimed range of 0.1µm to 100µm. Schurr explicitly identifies the dark pigments used in Ply A as particulates. These include

"fine metal particles...with a diameter of up to not more than a few micrometres" (EX-1006, 6:18-22). "A few micrometres" clearly overlaps with and suggests sizes within the 0.1µm to 100µm range. Schurr also teaches using "soot and/or carbon black" with a preferred average particle diameter "within a range of 20 nm [0.02 µm] to 100 nm [0.1 µm]" (EX-1006, 6:47-50). This range explicitly meets the lower bound (0.1µm) of the claimed range. Given that Schurr discloses particle sizes up to "a few micrometres" for metals and down to 0.02 µm (with a preferred upper bound of 0.1µm) for carbon black, Schurr's teachings substantially overlap and suggest the claimed range of 0.1µm to 100µm. Selecting a specific size within this broad range disclosed or suggested by Schurr constitutes obviousness, particularly as particle size selection is a routine parameter in pigment formulation.

f. Particulate Composition [1-6]

106. Schurr teaches the particulate composition recited in limitation [1-6].

107. As noted above, Schurr explicitly discloses that the dark pigment particulate in Ply A may comprise "fine metal particles," metal oxides (such as "iron oxide brown or iron oxide black," and "spinel black"), and "soot, in particular carbon black." (EX-1006, 6:18-30). These specific examples taught by Schurr directly meet the claimed options of metal, metal oxide, and carbon black.

g. High Opacity Layer [19-5]

108. Schurr discloses the high opacity layer comprising a white pigment

recited in claim 19.

109. Schurr's film structure explicitly includes a "second polymer ply B, which comprises at least one white pigment." (EX-1006, Abstract; 2:20-24; Claim 1). Schurr explains that this layer contributes significantly to the film's low light transmission (EX-1006, Abstract; 7:1-4) and functions to prevent the dark pigment in Ply A from showing through, ensuring that Ply B "actually appears white" (EX-1006, 8:48-58). This function of masking the underlying layer and providing a white appearance is the definition of a high opacity layer containing a white pigment.

h. Recyclability with PET Container [1-7]/[19-6]

110. In my opinion, the Schurr reference (EX-1006), when viewed through the eyes of a POSITA, teaches or renders obvious that its heat shrink label is "recyclable with a PET container" as this phrase would be understood in the context of PET recycling practices prevalent in May 2021 and consistent with my understanding of this phrase as discussed in the claim construction section above.

111. As an initial matter, in my experience, a POSITA in May 2021 would have been aware that the term "recyclable with PET" in the context of labels for PET containers was not an abstract concept but was informed by established industry practices and guidelines aimed at ensuring that labels did not impede or contaminate the PET recycling process. Organizations such as the Association of Plastic Recyclers in North America, and similar bodies like Petcore Europe, publish design

guidelines and testing protocols that define criteria for the compatibility of labels with PET recycling. These guidelines often address factors such as the label material itself, adhesives, ink washability in caustic solutions, and separability from PET flake (see, e.g., EX-1012, generally discussing recycling compatibility issues). A POSITA would understand that achieving "recyclable with PET" status, particularly for widespread commercial use, generally involves meeting such industry-recognized benchmarks to ensure the label contributes to, rather than detracts from, the circular economy of PET.

112. With respect to Schurr, it makes the explicit statement that "the film overall can be recycled easily" (EX-1006, 8:32-36). Schurr then explains one mechanism for achieving this, particularly with transparent containers like PET bottles, by stating: "When the object is recycled, the material of the films or hoses can be separated from the material of the transparent object by processes known in the art, for example on the basis of differing densities..." (EX-1006, 15:54-63). While density separation is one common method, a POSITA would understand "recyclable easily" in the broader context of compatibility with PET recycling, including behavior during caustic wash steps. The overall goal, as understood by a POSITA, is to ensure the label does not unacceptably contaminate the PET recycle stream, regardless of the precise removal or compatibility mechanism.

113. It is important to consider the full context of PET recycling, including

the arguments made during the prosecution of the '422 Patent. The Applicants argued that some prior art labels with ***embedded*** light-blocking materials (i.e., pigments compounded directly into the polymer matrix of the film itself) were not "recyclable with a PET container" due to contamination from non-removable materials during a caustic wash. This argument, however, does not apply to Schurr's layered construction. Schurr's film, with its distinct polymer plies (Ply A containing dark pigments, and Ply B containing white pigments) and any printed indicia, involves light-blocking pigments that are present in ***discrete layers*** rather than being homogenously embedded throughout the entire film bulk. (EX-1006, Abstract; 2:18-24; 6:18-30). A POSITA would understand that such layered constructions, where functional pigments are concentrated in specific plies or applied as coatings/inks, are fundamentally different from integrally pigmented films, primarily because the pigments in layered constructions are not dispersed throughout the entire polymer matrix of the base film, making them potentially more accessible for removal or separation during recycling processes like caustic washing or delamination. The art, such as Ügdüler (EX-1013), demonstrated that even challenging additives ***within*** PET, like carbon black, could be successfully removed from the PET hydrolysate via alkaline hydrolysis and subsequent separation processes, for example, filtration and/or centrifugation. (EX-1013, Abstract; p. 5387). It would be evident to a POSITA that pigments confined to distinct layers, as in Schurr, would be at least as, if not more, amenable to separation or management during recycling processes (including caustic wash if the layers are designed for deinking or delamination, common goals in label design) than pigments dispersed throughout the entire polymer matrix.

114. Even if Schurr's primary described separation method (density difference) were considered distinct from a scenario where label inks or pigmented layers are washed off (a key aspect of the caustic wash step in PET recycling), a POSITA would still find it obvious to ensure that a label based on Schurr's PET-based film was "recyclable with a PET container" in a co-mingled stream. Given Schurr's explicit teaching that its film is PET-based (EX-1006, 2:50-55, 3:4-6, 3:57-62) and "can be recycled easily" (EX-1006, 8:32-36), and knowing from sources like Ügdüler (EX-1013) that PET containing carbon black can be chemically recycled with successful removal of the colorant (EX-1013, Abstract), a POSITA would be motivated to ensure Schurr's layered PET film with its PET-compatible pigments (like carbon black) could be processed in standard PET recycling streams. This would involve ensuring that the layers (Ply A, Ply B, optional unpigmented layers, and optional print layers) either separate cleanly during the caustic wash (a common design goal for recyclable labels) or, if the film itself is intended to be co-recycled, that its components do not unduly contaminate the rPET. The distinct, layered nature of Schurr’s construction, as opposed to pigments embedded throughout the film

bulk, makes it more amenable to such compatibility.

115. Schurr also acknowledges conventional recycling scenarios where the container itself might be opaque or where recycled material might lose transparency due to mixing (EX-1006, 15:46-54). However, the claim limitations [1-7] and [19-6] simply require that the label itself be "recyclable with a PET container." In my opinion, a POSITA would understand this to mean that the label, when processed along with PET containers in a standard PET recycling stream, does not unacceptably contaminate the resulting recycled PET or unduly hinder the recycling process. Schurr's teachings of an "easily recycled" PET-based film, particularly when considering its layered structure amenable to component removal or compatibility during washing, support this understanding. The claims do not impose specific requirements on the ultimate purity or optical properties of the recycled PET material itself, beyond what is generally acceptable in the industry for recycled PET.

3. Dependent Claim 2: Indicia Layer

116. Claim 2 depends from claim 1 and further requires "an indicia layer." In my opinion, Schurr discloses this limitation.

117. Functionally, Schurr clearly intends for its films to carry printed information. It states "it should be possible to print on them, to indicate the contents of the wrapped object, for example." (EX-1006, 1:9–11). Schurr also discusses various "printing motifs" that could be applied (EX-1006, 12:66–13:5). From a

functional perspective, this printed information indicating the contents serves as the claimed "indicia layer."

118. Structurally, Schurr's own description implies the presence of such a layer. Claim 1 of Schurr recites the film includes "at least one pigment ply consisting of pigments applied to the second polymer ply B." (EX-1006, Claim 1). Read in the context of Schurr's discussion of printing information onto the film (EX-1006, 1:9-11), this defined "pigment ply" applied to the outer-facing Ply B represents the layer where graphical or textual indicia would be printed. Thus, Schurr's disclosure encompasses the indicia layer recited in claim 2.

4. Dependent Claim 3: High Opacity Layer

119. Claim 3 depends from claim 1 and adds the requirement of "a high opacity layer comprising a white pigment." Schurr clearly discloses this feature.

120. As discussed previously, Schurr explicitly teaches that its film includes "a second polymer ply B, which comprises at least one white pigment." (EX-1006, Abstract; 2:21–22; Claim 1). Schurr further explains the function of this white pigment-containing layer (Ply B) is to obscure the underlying dark layer (Ply A) so that Ply B "actually appears white." (EX-1006, 8:46–58). This obscuring function is the hallmark of a high opacity layer. The effectiveness of this layer is also supported by Schurr's disclosure of the film's overall low light transmission (e.g., "not more than 12%"). (EX-1006, 2:23-27). Therefore, Schurr's Ply B constitutes the claimed

high opacity layer comprising a white pigment.

5. Dependent Claim 4: Arrangement of Layers

121. Claim 4 depends from claim 3 and requires the label to comprise an indicia layer, with the high opacity layer disposed between the indicia layer and the light blocking layer. Schurr teaches this specific arrangement. As discussed, Schurr's claim 1 teaches the indicia layer (as the "pigment ply" applied to Ply B). Schurr also specifies the film's orientation when applied to an object: Ply A (the light blocking layer) faces the object, while Ply B (the high opacity layer) faces outward and is the surface that "can be printed on." (EX-1006, 15:64–16:10). In this configuration, the indicia layer (printed on Ply B) is outermost, the high opacity layer (Ply B) is underneath it, and the light blocking layer (Ply A) is innermost, facing the container. This places the high opacity layer (Ply B) directly ***between*** the externally applied indicia layer and the internal light blocking layer (Ply A), exactly as recited in claim 4.

6. Dependent Claim 5: Film Consists of PET

122. Claim 5 depends from claim 1 and requires "wherein the heat shrink film consists of polyethylene terephthalate (PET)." Based on Schurr's disclosure, this limitation is met or, alternatively, rendered obvious.

123. Schurr's film is described as being fundamentally "polyester-based." (EX-1006, 2:59-3:6). Schurr explicitly defines the term "polyesters" to include

polymers resulting from the esterification of "terephthalic acid" and "1,2-ethanediol" (EX-1006, 2:62-64, 3:6-12), which are the constituent monomers of PET. Both Ply A and Ply B are described as comprising these polyesters (EX-1006, 2:20-24; 3:1-6; 3:22-27). Therefore, the primary polymeric component forming Schurr's heat shrink film is, in fact, PET. I understand the term "consists of," when applied to the "heat shrink film" in the context of its polymeric identity, means the polymer used ***is*** PET. It does not exclude the other explicitly required components of Schurr's film structure, namely the non-polymeric dark pigments in Ply A and white pigments in Ply B, which are essential to its disclosed function.

124. Even if Schurr were interpreted more broadly to allow for combinations or copolymers of polyesters beyond just PET, selecting PET as the sole polymer would have been an obvious design choice for a POSITA. As discussed previously, maximizing compatibility with PET container recycling streams was a significant driver in this field. Schurr explicitly mentions the film is "recycled easily" (EX-1006, 8:32-36) and describes separation based on density (EX-1006, 15:54-63), highlighting the relevance of recycling.

125. A POSITA in May 2021, tasked with developing a recyclable shrink label compatible with PET recycling streams, would understand that one of the most straightforward and effective ways to ensure optimal compatibility and minimize potential contamination issues during co-recycling with PET bottles is to use a shrink

film made entirely, in terms of its polymer content, of PET. While other polyesters or polymer blends might exhibit some degree of technical compatibility, utilizing 100% PET for the label film eliminates concerns about introducing dissimilar polymer types into the PET recycling stream, thereby ensuring maximum material homogeneity. This is a fundamental principle in designing for recyclability—minimizing foreign material contamination. Given that Schurr already teaches the use of PET as a suitable polyester for its film layers, a POSITA motivated by the strong industry push for recyclability would logically and obviously select PET as the sole polymeric component for both Ply A and Ply B. This would be a clear path to achieving the best possible integration with PET recycling processes, fully utilizing a material explicitly contemplated and taught by Schurr for its intended purpose.

7. Dependent Claim 6: Sleeve or Tube Form

126. Claim 6 depends from claim 1 and requires the label to be "in a form of a sleeve or tube." Schurr clearly discloses this configuration. Schurr describes achieving its objective through a "hose which comprises a heat-shrinkable film as described above." It further explains, "[t]he hose can be produced using a procedure known in the art, in which two edges of a heat-shrinkable film are joined to each other." (EX-1006, 15:11–15). Schurr explicitly notes this "hose" is suitable for wrapping objects such as bottles (EX-1006, 15:40-43). In the context of shrink labels

for bottles, a "hose" formed by joining the edges of a film is synonymous with the claimed "sleeve or tube" form factor.

8. Dependent Claim 7: Seam

127. Claim 7 depends from claim 6 and requires "wherein the heat shrink film comprises a seam." Schurr's disclosure of the sleeve/tube form inherently includes a seam.

128. As discussed regarding claim 6, Schurr teaches forming the hose (sleeve/tube) by joining "two edges of a heat-shrinkable film," using methods such as "heat sealing or solution sealing." (EX-1006, 15:12–18). The physical process of joining two edges of a flat film to create a tube necessarily results in a seam where those edges meet and are bonded. Therefore, the seam is an inherent structural feature resulting directly from Schurr's described method of producing the sleeve or tube form.

9. Dependent Claims 8 and 9: Shrinkage at 100°C

129. Claim 8 requires that the heat shrink film contract or shrink by about 1% to 90% when heated to 100°C. Claim 9 requires the same shrinkage range for the "entire recyclable shrink label." In my opinion, these limitations are rendered obvious by Schurr's teachings combined with the knowledge of a POSITA.

130. Schurr explicitly discloses that its heat-shrinkable film possesses significant shrinkage properties. Specifically, Schurr states that "the film after 15

seconds in a water bath at 95° C. exhibits shrinkage in the range of 20% to 85%" in its primary shrinking direction (EX-1006, Abstract; 2:26-35). Although Schurr provides this shrinkage data at 95°C, it does not explicitly report the shrinkage value at the slightly higher temperature of 100°C recited in the claims.

131. In my opinion, however, determining the film's shrinkage at 100°C would have been a routine and straightforward task for a POSITA. Characterizing the thermal shrinkage behavior of polymer films across various standard temperatures is a fundamental part of material evaluation and product development in the packaging industry. A temperature of 100°C is particularly relevant as it represents conditions commonly encountered in industrial shrink tunnels using steam or hot water, a standard application method for such labels. A POSITA would understand the general principle from their knowledge of polymer science that for oriented polyester films like those described by Schurr, shrinkage typically increases or, at a minimum, remains high as the temperature increases slightly above a point where significant shrinkage already occurs, such as the 95°C point provided by Schurr. Indeed, a POSITA would expect the shrinkage at 95°C and 100°C to be nearly the same, or for the 100°C shrinkage to be slightly greater, but certainly not significantly less under these conditions.

132. Given Schurr's disclosure of substantial shrinkage (20-85%) at 95°C, a POSITA would reasonably and confidently expect the film to exhibit comparable, if

not slightly greater, shrinkage when tested at 100°C. This expectation is based on the typical thermal behavior of oriented polyester films. Critically, the claimed shrinkage range of "about 1% to about 90%" is exceptionally broad and encompasses virtually all commercially relevant shrinkage levels for such films. Therefore, this expected shrinkage value at 100°C would certainly fall well within this extremely broad claimed range; it would be difficult for a functional shrink film of this type to fall outside such a wide range. Confirming the precise shrinkage percentage at 100°C would involve nothing more than standard, routine laboratory testing, such as immersing a sample in a 100°C water bath for a set time and measuring the dimensional change. This is a procedure well within the capabilities of any POSITA working with shrink films. Thus, characterizing film shrinkage at 100°C is routine, and based on Schurr's 95°C data and the general knowledge of polyester shrink films, achieving a shrinkage value well within the 1-90% range at 100°C is the reasonably expected and predictable outcome.

133. Regarding claim 9, which addresses the shrinkage of the "entire recyclable shrink label," a POSITA would understand from fundamental principles of composite materials and thin film mechanics that the overall dimensional change of a multilayer label during heating is overwhelmingly governed by the properties of the base heat shrink film itself. This is especially true when the additional layers, such as inks or functional coatings, are relatively thin, as is typical for printed labels.

134. The additional layers described by Schurr, such as the pigment-containing Ply A and Ply B, and any potential printed indicia layers, are generally designed to adhere well to the base film and are typically significantly thinner than the base PET film (e.g., Schurr Inventive Example 3 describes an 8µm Ply A and a 32µm Ply B, both of which may be utilized as adjuncts to an underlying PET base film, though Schurr's examples primarily describe the plies themselves as polyester, and thus would exhibit the same shrinkage as the base film anyway). A POSITA would understand that because these additional functional layers are significantly thinner and are formulated to contract with the substrate, they would not substantially impede or alter the inherent shrinkage behavior dictated by the much thicker base heat shrink film. The thinner these adjunct layers are relative to the base film, the more closely the shrinkage of the entire multi-layer label will mirror that of the base shrink film component when considered in isolation. Therefore, it is technically reasonable and predictable to expect the entire label structure disclosed by Schurr to exhibit essentially the same shrinkage percentage as its base heat shrink film. Since the base film's shrinkage at 100°C is expected to fall within the broad 1-90% range, as discussed for claim 8, the entire label's shrinkage would consequently also be expected to fall well within this same broad range without yielding an unexpected result.

10. Dependent Claim 10: High Opacity Layer Pigment Composition

135. Claim 10 depends from claim 3 and further specifies the pigment in the high opacity layer, requiring selection from titanium dioxide, precipitated calcium carbonate, aluminum silicate, aluminum oxide ("alumina"), certain mica-based pigments, or combinations thereof. Schurr's explicit teachings render this limitation obvious.

136. As discussed regarding claim 3, Schurr's Ply B functions as the high opacity layer comprising a white pigment. Schurr provides "[n]on-limiting examples of inorganic white pigments" suitable for this layer, specifically listing "barium sulphate, calcium carbonate, titanium dioxide, zinc oxide, zinc sulphide or mixtures of two or more representatives thereof." (EX-1006, 7:8–11). This list expressly includes "titanium dioxide" (TiO_2) and "calcium carbonate." Precipitated calcium carbonate (PCC) is a well-known and common form of calcium carbonate used as a pigment and filler. Thus, Schurr explicitly discloses at least two members (TiO_2 and $CaCO_3$/PCC) of the group recited in claim 10 as suitable white pigments for its high opacity layer. This disclosure of specific species within the claimed group is sufficient to render the selection obvious under established patent law principles.

137. Furthermore, other options listed in claim 10 for the high opacity layer pigment, such as aluminum silicate and aluminum oxide, were well-known and

common white pigments and fillers extensively used in the field of polymer films and coatings at the time of the alleged invention. These materials are frequently employed, often in conjunction with titanium dioxide (TiO_2), to modify and optimize properties such as opacity, brightness, processability, and cost of the final formulation. Their use and effects would be familiar to a POSITA.

138. A POSITA formulating a white opacity layer, as generally taught by Schurr's Ply B, would have readily recognized aluminum silicate and alumina as standard, obvious choices to consider as alternatives or as co-pigments/fillers alongside the TiO_2 and calcium carbonate ($CaCO_3$) explicitly mentioned by Schurr. Aluminum silicates, commonly known as clays, are widely used as extender pigments in coatings. Similarly, alumina is another major category of white pigment/filler. Therefore, selecting from this known palette of common white pigments and fillers to achieve desired levels of opacity, brightness, or other functional properties in a white polymer layer does not involve invention but rather routine formulation based on established material science. Coated mica, also listed in claim 10, is typically regarded by a POSITA as an interference or pearlescent pigment; its selection would be an obvious choice if unique optical effects were desired for the label in addition to opacity.

11. Dependent Claim 11: Light Blocking Component Composition

139. Claim 11 depends from claim 1 and requires the light blocking component to comprise materials selected from a specified group (including various metals, metal oxides, carbon black, mica, reflective pigments, etc.). In my view, Schurr discloses sufficient options within this group to render the claim obvious.

140. Schurr identifies several materials suitable for the dark pigment in Ply A, which functions as the light blocking component. These include "fine metal particles," various metal oxides like "iron oxide brown or iron oxide black" and "spinel black," and "soot, in particular carbon black." (EX-1006, 6:18–30). Schurr also mentions light blocking white pigments, particularly "titanium dioxide" and "zinc oxide." (EX-1006, 7:8-11).

141. Schurr's disclosure directly teaches multiple members or categories recited in the group of claim 11. "Fine metal particles" encompass claimed metals like aluminum, zinc, copper, or silver. Schurr's specific iron oxides and spinel black fall under the claimed "metal oxide" category. "Carbon black" is explicitly listed in both Schurr and the claim. "Titanium dioxide" is also explicitly listed in both. By teaching metal particles, metal oxides, carbon black, and titanium dioxide as suitable pigments for its film layers, Schurr discloses multiple species within the claimed group, rendering the selection required by claim 11 obvious.

142. Additionally, other broad categories listed in claim 11 for the light blocking component, such as "reflective pigment," "a polymer capable of blocking light," or "a mineral capable of blocking light," represent functional descriptions of material properties rather than specific chemical compositions.

143. A POSITA would understand that many of the materials explicitly taught by Schurr, or otherwise well-known in the art for achieving light blocking, would inherently fall into these functional categories. For example, Schurr's "fine metal particles," which would include materials like aluminum flake pigments, are inherently "reflective pigments"; aluminum flake pigments are available in leafing grades that orient at the film surface to provide a reflective barrier, a well-known characteristic. Carbon black, also taught by Schurr, is a pigment and a mineral capable of blocking light very effectively via absorption across a broad spectrum. Titanium dioxide (TiO_2) and other metal oxides mentioned by Schurr are minerals capable of blocking light via scattering and absorption. Other common particulate materials known to a POSITA to contribute to light blocking or opacity, such as mica (often used as a filler or as a substrate for pearlescent pigments), would also be recognized as "a mineral capable of blocking light." Furthermore, a POSITA would be aware of certain polymers that inherently possess light blocking (e.g., UV absorbing) characteristics or could be rendered so by incorporation of absorbing chromophores, thus qualifying as "a polymer capable of blocking light." Therefore,

selecting materials possessing these known light-blocking functions, including those explicitly taught by Schurr or readily available alternatives, would have been an obvious approach for a POSITA tasked with designing the light-blocking layer.

12. Dependent Claims 12 and 13: Component Amounts in ppr

144. Claim 12 requires the light blocking layer to be present in an amount of 0.5 to 25 ppr, while claim 13 requires the light blocking component within that layer to comprise 0.1 to 10 ppr. In my opinion, achieving amounts within these ranges would have been obvious to a POSITA implementing Schurr's teachings.

145. Schurr discloses the concentration of dark pigments (the light blocking component) in Ply A (the light blocking layer) in terms of weight percent relative to the total film, providing ranges such as "0.05 wt% to 3.0 wt%" (EX-1006, 6:54-7:7). Schurr does not explicitly state these amounts using the areal density unit "ppr," which is defined in the '422 Patent as pounds per ream (specifically, 3000 sq ft) ('422 Patent, 5:44-47).

146. However, expressing coating or layer amounts in terms of areal density, such as ppr or its metric equivalent grams per square meter (g/m^2), is a standard and widely adopted practice in the coating, film, label, and paper industries. This method of specification is favored because it allows for consistent and comparable values regardless of variations in material density or precise layer thickness. A POSITA, having determined the necessary layer thickness and pigment concentration (e.g., in

weight percent, wt%) to achieve the desired light blocking performance (as discussed previously for limitation [1-4]/[19-4]) based on Schurr's teachings, would find it a routine and elementary matter to calculate and express the resulting amount of the light-blocking layer, or the active pigment component within that layer, in standard areal density units like ppr; such a calculation would be well within the ordinary skill of a POSITA.

147. This conversion from thickness and concentration to areal density (ppr) involves straightforward calculations. These calculations utilize the layer's thickness (which can be determined or estimated from Schurr's disclosed total film thickness range of 20-100μm and the typical relative thickness of a functional ply like Ply A, e.g., 5-50% of the total film thickness), the known or easily measured material densities for common polymers and pigments, the pigment concentration within the layer (wt%), and the standard definition of a paper or film ream (typically 3000 sq ft, as noted in the '422 Patent).

148. Whether the specific amount of light blocking material is determined by direct experimentation (for instance, by preparing a series of samples with varying coating weights and measuring their light transmission until the target of ≥80% blockage is achieved) or by calculation based on Schurr's disclosed wt% ranges for pigments and typical layer structures, arriving at an effective amount for the light blocking layer and for the active component within that layer that falls

within the broad ranges recited in claims 12 (0.5-25 ppr for the layer) and 13 (0.1-10 ppr for the component) would be the reasonably expected outcome for a POSITA. These claimed ppr ranges encompass typical areal densities for functional ink or coating layers commonly applied to thin films in the packaging industry. In fact, my own analysis of Schurr's Inventive Example 1, based on reasonable assumptions for material densities and layer compositions consistent with Schurr's disclosure, indicates that Schurr's teachings directly anticipate or, at a minimum, render obvious these ppr ranges. For instance, I calculate that the areal density of the light blocking layer (Ply A) in Schurr's Example 1 (40 µm total film thickness, with Ply A being 20% of that, i.e., 8 µm) is approximately 6.4 ppr, which falls squarely within the 0.5-25 ppr range of claim 12. Correspondingly, the light blocking component itself (carbon black, formulated at 3 wt% loading within Ply A of Example 1) would be approximately 0.19 ppr, which falls within the 0.1-10 ppr range of claim 13. (For these calculations, the density of Ply A in Schurr's Example 1 was calculated to be 1.294 g/cm^3. This calculation was performed by applying an algorithm for Density of Mixed Materials, available online at Material Calculator - Density of Mixed Materials, to the composition of Ply A explicitly recited by Schurr.) Thus, determining the required amount of light blocking layer or active component within that layer, expressed in ppr, to meet a target light-blocking specification based on Schurr's disclosed materials and structures involves only standard calculations and/or routine experimentation.

13. Dependent Claim 14

149. Claim 14 recites "[a]n article comprising: [a] a container comprising polyethylene terephthalate (PET) and defining an external surface; and [b] the recyclable shrink label of claim 1 disposed on the container." Schurr discloses or renders obvious such an article.

a. [14-PRE] and [14-1] The Article Comprising a PET Container

150. The preamble recites "[a]n article," and the first limitation requires "a container comprising polyethylene terephthalate (PET) and defining an external surface." Schurr (EX-1006) explicitly states that the intended application for its heat-shrinkable films is to wrap objects such as "bottles, tubs or boxes for storage," which commonly include plastic containers (EX-1006, 1:6-9). As previously discussed (see, e.g., my analysis of Claim 5 above), Schurr's film comprises polyester, specifically PET. Given that PET containers are the predominant type used for beverages and foodstuffs, often requiring shrink labels like Schurr's, applying Schurr's PET-containing film to a PET container is a directly contemplated and obvious application context.

151. Moreover, as discussed in the motivation section, a POSITA seeking to utilize Schurr's "recyclable" film technology would naturally target the largest

relevant market, which is PET containers. The compatibility issues associated with recycling labeled PET containers were a well-known industry concern.

152. Therefore, confirming that PET containers represent a primary and obvious application for polyester-based heat shrink labels like the one described in Schurr is consistent with the well-understood market realities and technical focus of the packaging field in May 2021. Applying Schurr's PET-containing film to a PET container represents not only an intended application but also the most logical and significant commercial use for such a label, given the prevalence of PET in beverage and food packaging.

b. [14-2] The Label Disposed on the Container

153. Limitation [14-2] requires "the recyclable shrink label of claim 1 disposed on the container." Schurr discloses this arrangement.

154. Having taught the label of claim 1 and its application to containers like PET bottles, Schurr further clarifies how the label is applied. Schurr explains that "[t]he film or the hose preferably at least partially wraps the object, for example a bottle or can." (EX-1006, 15:40-42). This act of wrapping the container necessarily places, or "disposes," the label onto the container. Schurr also confirms the label's orientation during use, stating that "the first polyester ply A [the dark, light-blocking layer] facing the object." (EX-1006, 15:64–67), confirming physical placement on the container surface.

14. Dependent Claim 15: Label Orientation on Container

155. Claim 15 depends from claim 14 and requires "wherein the first surface of the heat shrink film faces the external surface of the container." Schurr discloses this orientation.

156. As noted above, Schurr explicitly states that when its film/hose is applied to an object like a bottle, "the first polyester ply A [is] facing the object..." (EX-1006, 15:64-67). Since Ply A (the dark, light-blocking layer) is located adjacent to what is defined as the "first surface" of the heat shrink film (see analysis for [1-3]), Schurr directly teaches the orientation where the first surface faces inward, towards the external surface of the container.

15. Dependent Claim 16: Indicia Layer on First Surface

157. Claim 16 depends from claim 2 (which requires an indicia layer) and adds the requirement "wherein the indicia layer is disposed on the first surface." While Schurr suggests printing on the second (outer) surface, the arrangement of Claim 16 represents an obvious design alternative. Schurr teaches the film is intended for printing indicia (EX-1006, 1:9-11) and identifies the outer white surface of Ply B (the second surface) as suitable "for printing purposes." (EX-1006, 7:1-4).

158. While Schurr suggests printing on the second (outer) surface of Ply B, a POSITA would readily understand that placing the printed indicia layer on the first surface of the heat shrink film (i.e., the surface that faces the container) is a well-

known and standard alternative configuration in the field of shrink label manufacturing. This technique is commonly referred to as "reverse printing." Indeed, Schurr's teaching of an optional unpigmented ply (EX-1006, 5:35-51, 7:51-55), which can serve as a clear outermost base film when the label is constructed with Ply A and Ply B as inner layers, is particularly amenable to reverse printing. In such a configuration, the indicia would be printed on the inner side of this clear base film, protected by the film itself, and viewed through it, while the light-blocking Ply A and opacifying Ply B would be located behind the indicia layer relative to the viewer. The technical motivation for choosing reverse printing is clear and compelling: it inherently protects the ink layer (indicia) from scratching, scuffing, abrasion, and exposure to various external elements during handling, transport, and end-use, because the printed graphics are viewed through the transparent base film itself. A POSITA designing a shrink label based on Schurr's film, particularly for applications requiring durable and high-quality graphics, would readily recognize reverse printing onto the first surface as a standard and obvious design choice to achieve enhanced print protection. For many applications, particularly those where the label is expected to endure rubbing or exposure to moisture, reverse printing is the preferred method to maintain graphic integrity. For print protection, reverse printing directly onto the first surface of the primary PET film is a common and effective solution. The selection between surface printing (as an option suggested by Schurr for Ply B) and reverse printing (as recited in claim 16) is a routine design decision based on the specific application's requirements for print durability versus other manufacturing or cost factors. In summary, reverse printing the indicia layer on the first surface of a shrink film was a known and obvious alternative configuration in the art.

16. Dependent Claim 17: Transverse Direction Shrinkage

159. Claim 17 depends from claim 8 (requiring 1-90% shrinkage at 100°C) and further requires this shrinkage occur "in a transverse direction." Schurr's teachings, combined with POSITA knowledge, render this limitation obvious.

160. Schurr explicitly states that its film is preferably oriented to shrink primarily in the transverse direction. Schurr teaches, "[t]o achieve heat-shrinkability, the heat-shrinkable film is stretched in one direction... Stretching is possible in particular in a transverse direction... so that the main shrinking direction is also the transverse direction..." (EX-1006, 2:30-39). This transverse direction orientation is standard for shrink sleeve labels intended to conform circumferentially around containers like bottles. As discussed with respect to claim 8, Schurr discloses substantial shrinkage (20-85%) at 95°C.

161. As I discussed previously with respect to claim 8, determining the shrinkage of a film like Schurr's at 100°C is a routine characterization task for a POSITA. Given Schurr's explicit disclosure that its film is oriented for primary

shrinkage in the transverse direction and that it exhibits high shrinkage (20-85%) at 95°C, a POSITA would reasonably expect that the substantial shrinkage observed at 100°C (which, as established, would fall within the broad 1-90% range of claim 8) would indeed occur primarily in the intended transverse direction. This transverse direction orientation is standard for shrink sleeve labels designed to conform circumferentially around containers. Confirming the transverse direction shrinkage value at 100°C is a standard test, and based on Schurr's explicit teaching of transverse direction orientation and its 95°C shrinkage data, achieving significant transverse direction shrinkage (within the 1-90% range) at 100°C is the reasonably expected outcome for this type of film and its intended application.

17. Dependent Claim 18: Crystallizable PET

162. Claim 18 depends from claim 1 and requires "wherein the heat shrink film comprises crystallizable polyethylene terephthalate (PET)." In my opinion, Schurr discloses this limitation either inherently or by clear implication, rendering it obvious.

163. As discussed with respect to claim 5, Schurr teaches that its heat shrink film comprises PET, identifying the constituent monomers as terephthalic acid and 1,2-ethanediol (EX-1006, 2:59–3:12). PET, as synthesized from these standard monomers, is inherently a semi-crystalline polymer. This means it possesses the fundamental molecular structure and capability to form crystalline regions under

appropriate thermal or processing conditions; it is inherently "crystallizable." This is a basic material property well-known in the field of polymer science and would certainly be known to a POSITA. Because Schurr discloses the use of standard PET, it necessarily discloses the use of a material that is inherently crystallizable.

164. Furthermore, Schurr's own specification reinforces the understanding that the PET being used is crystallizable. Schurr explicitly discusses selecting polyester materials based on their "crystallisation half-time," specifically referring to polymers having a "long crystallisation half-time" (EX-1006, 9:10–32). The very discussion of crystallization half-times or rates inherently implies that the material under discussion is capable of crystallizing. One cannot meaningfully discuss the rate or half-time of crystallization for a material that is purely amorphous and incapable of forming crystalline structures. Therefore, by disclosing PET as a component and by discussing the control of its crystallization properties, Schurr makes it clear that the PET comprised by its heat shrink film is, in fact, a crystallizable material, thereby teaching the limitation of claim 18. While PET is inherently crystallizable, its rate of crystallization is notoriously slow compared to some other common polymers. For certain applications, particularly injection molding of thick parts where rapid cycle times are desired, this slow crystallization can be problematic. However, for films, especially shrink films, different crystallization characteristics might be targeted. The term "crystallizable PET" as

used in the claim, in my opinion as a POSITA, refers to PET that possesses this inherent ability to crystallize, even if that crystallization is controlled, modified, or occurs at a specific rate suitable for its application. Schurr's PET fits this definition.

B. Kitano in View of Lee Would Have Rendered Claims 1-19 Obvious

165. It is also my opinion that claims 1-19 of the '422 Patent would have been obvious to a POSITA as of May 14, 2021, based upon the combined teachings of Kitano (EX-1007) and Lee (EX-1010), viewed in conjunction with the general knowledge and ordinary skill possessed by such a person at the time.

166. As discussed above, Kitano teaches a multi-layer laminate suitable for use as a shrink label, which includes a PET substrate layer (EX-1007, [0012]), a white ink shielding layer (EX-1007, [0011], [0016]), and a light-shielding layer composed of aluminum particles (EX-1007, Abstract, [0007], [0018], [0034]). Kitano also discloses, in a comparative example, the use of a mixture of TiO_2 and carbon black pigments for a light-shielding ink (EX-1007, [0041]).

167. Lee, on the other hand, specifically addresses the challenge of recycling PET shrink labels together with PET containers. Lee teaches formulating heat-shrinkable labels using specific PET/polyester blends engineered with controlled crystallizability such that the label can be "reused while attached to a PET container" and "supplied to the recycle stream of the PET container while being attached to the PET container," thereby avoiding problematic separation steps (Lee, Abstract;

[0010]; [0020]; [0034]).

168. In my analysis, the combination of Kitano and Lee teaches or suggests nearly all limitations recited in claims 1-19 of the '422 Patent. Kitano provides the foundational light-blocking structure and suitable pigment options, while Lee provides the critical technology for achieving integrated PET recycling compatibility through material design. As explained below, achieving the specific quantitative performance metrics detailed in certain dependent claims (e.g., the exact light blocking percentage, shrinkage values at 100°C, or coating amounts in ppr) represents routine optimization or confirmation well within the ordinary skill of a POSITA building upon this combined disclosure. A POSITA would have been clearly motivated to combine these complementary teachings and would have had a reasonable expectation of success in doing so.

1. Motivation to Combine Kitano and Lee and Reasonable Expectation of Success

169. In my opinion, at the time of the alleged invention (May 2021), a POSITA in the field of packaging for products such as beverages and foodstuffs in PET containers would have been well aware of two significant and concurrent technical demands that would motivate combining the teachings of Kitano and Lee.

170. Firstly, there was the persistent and long-standing need to protect light-sensitive contents from degradation caused by exposure to UV and visible light (as

evidenced, for example, by the problems addressed in prior art like Kitano, EX-1007, [0002] and Ohta, EX-1008, [0005]).

171. Secondly, driven by increasing environmental awareness, regulatory pressures, and logistical challenges in waste management (EX-1012, p. 1-2, "1. Introduction"), there was strong and growing industry pressure to develop packaging components, particularly shrink labels, that were fully compatible with established PET bottle recycling streams. (EX-1013, p. 5376, col. 1, noting the "pressing need for efficient recycling processes"). This compatibility was essential to facilitate a circular economy for PET and to avoid contamination of the recycled PET material, a concern highlighted in references like Lee (EX-1010, [0004], [0010], discussing label fusion issues) and generally in reviews like Schyns (EX-1012, p. 4, "Contamination of recycled material"). Kitano itself acknowledges general recycling considerations. (EX-1007, [0009]).

172. The art, before the earliest priority date of the '422 patent, was replete with a recognized need for improvements to recycling PET materials, especially when those materials or associated labels contained additives like pigments for light blocking, such as titanium dioxide or carbon black, as described in the '422 patent itself. (EX-1012, p.4, referencing pigments as contaminants; EX-1013, Abstract, p. 5376 col. 2, addressing colored PET waste). This need was particularly strong in Europe, following initiatives like the European Green Deal which aimed for carbon

neutrality by 2050. (EX-1011). PET waste was recognized at the time as a problem to be overcome (EX-1012, p.1-2), and transitioning to a circular economy for plastics like PET was seen as essential. (EX-1012, p.1-2; EX-1013, p. 5376, col.1). The desire for "recyclable polyester films such as [for] polyethylene terephthalate containers" was explicitly noted in the art. (EX-1010, [0005]).

173. Based on my experience in polymer science and materials for packaging applications, a POSITA working in this field in May 2021 would have been acutely aware of these dual requirements: achieving effective light shielding for product integrity and ensuring seamless PET recycling compatibility for environmental sustainability and regulatory compliance. Such a POSITA would have recognized that developing shrink labels capable of addressing both these needs simultaneously was a key objective, driven by prominent market forces and central design goals for advanced packaging solutions for PET containers. The broader industry context, including initiatives like the European Green Deal (EX-1011) and the well-documented problem of PET waste (EX-1012, at p.1-2, "1. Introduction"), would have further emphasized the importance of developing labels that did not hinder PET recycling.

174. Faced with this challenge of providing both light protection and PET recycling compatibility, a POSITA would naturally look to the available technical literature for solutions to each aspect of the problem. Kitano (EX-1007) provides a

well-defined solution for achieving light shielding in a shrink label format using printed layers on a substrate. Kitano teaches using metallic particles (like aluminum) in an ink layer to effectively block light (EX-1007, Abstract, [0018]-[0019]), demonstrating a known technique for imparting this functionality. Kitano also discloses, in a comparative example, the use of other pigments (like TiO_2/carbon black) in an ink layer (EX-1007, [0041]).

175. Kitano's disclosed method of using printed particulate layers, whether comprised of metal particles or other pigments, to create a light barrier on a film substrate represents a standard, well-understood, and commonly practiced approach in the art for achieving light shielding properties in packaging films and labels. A POSITA would recognize this as a conventional technique for imparting light-blocking functionality.

176. Concurrently, Lee (EX-1010) provides a specific and targeted solution to the PET recycling compatibility problem. Lee explicitly addresses issues like label fusion during the drying stage of PET recycling (EX-1010, [0004], [0020]) and teaches that these can be overcome by using specific PET/copolyester blends where the material's crystallizability is carefully controlled (EX-1010, [0034], [0112]). Lee clearly presents this as yielding a heat-shrinkable label designed to be recycled with the PET container (EX-1010, Abstract; [0010]; [0020]).

177. Lee's disclosure, in my opinion, offers a specialized PET-based

substrate material meticulously engineered to address the known shortcomings of conventional shrink labels in integrated PET recycling streams. Lee particularly focuses on managing the crystallization behavior of the PET-based film to prevent undesirable phenomena such as label fusion with PET container flake during the drying stages of the recycling process, thereby enabling effective co-processing of the label with the container.

178. Presented with Kitano's effective light-blocking layer system and Lee's tailored solution for a recyclable PET film substrate, a POSITA exercising ordinary skill and creativity would have found it obvious to combine these teachings. This involves leveraging prior art elements according to their established functions, consistent with the principles discussed in *KSR*.

179. The motivation for this combination is straightforward: to create a single shrink label that incorporates both desired functionalities, meeting both market demands for product protection and recyclability. Specifically, the motivation would be to replace Kitano's potentially generic substrate film with Lee's specialized, recycling-compatible PET film blend, while retaining Kitano's effective light-shielding layer structure (using, for example, aluminum, TiO_2, or carbon black particles) applied onto that improved substrate.

180. This represents a logical integration of solutions addressing distinct but concurrent problems in the target application (PET container labels). It involves

modifying a known component (Kitano's substrate) using a known technique specifically designed to improve a relevant property (Lee's recyclable blend) while maintaining another desired function (Kitano's light blocking). This approach aligns with standard engineering practice, leveraging prior art elements according to their established functions, as discussed in *KSR*.

181. Substituting Lee's specialized, recyclable PET film for Kitano's substrate is an obvious modification aimed at gaining the specific, recognized benefit taught by Lee—improved recyclability integrated with the PET container. Applying Kitano's light-blocking ink layers onto Lee's PET-based film is simply applying a known functional coating technique onto a suitable substrate.

182. Combining these distinct but complementary teachings from Kitano (for light blocking) and Lee (for a recyclable PET film substrate) would have been a predictable and logical step for a POSITA. A POSITA, motivated to create a label that is both light-blocking and recyclable with PET containers, would find it obvious to apply established functional layers, such as the light-blocking ink layers taught by Kitano, onto an improved substrate specifically designed for recyclability, like the film taught by Lee. The outcome of such a combination—a light-blocking, recyclable PET label—would be the expected result of bringing together these known elements according to their respective, well-understood intended functions: Kitano's layers for light-blocking and Lee's substrate for integrated PET

recyclability. This involves simply the application of standard formulation and material combination practices.

183. The inherent transparency of Lee’s shrink film represents another motivation to combine with Kitano and would be viewed as an advantage by a POSITA. This transparency signifies that the base film itself does not inherently contain pigments, meaning it would not introduce such colorant contaminants into the rPET stream when co-recycled. Moreover, a transparent base film is ideally suited for reverse printing, where indicia are printed on the inner surface and protected by the film. Lee's primary technical contribution, as I understand it, is the engineering of the PET film's composition and crystallizability to ensure its compatibility with PET container recycling streams. This addresses a critical need separate from the optical properties of the final label. A POSITA would recognize that Lee's film provides an excellent, highly recyclable ***substrate***. The subsequent application of Kitano's light-blocking system, which inherently involves opaque or pigmented layers (such as those containing aluminum particles, titanium dioxide, or carbon black), would then impart the desired light-shielding functionality to the overall label construction. The transparency of Lee's base film, in this context, is an advantageous starting point, as it does not interfere with the optical performance of the subsequently applied opaque light-blocking and, if desired, high-opacity white layers taught by Kitano. The goal of the combination is to achieve ***both*** recyclability

(from Lee) ***and*** light-blocking (from Kitano); the final opacity of the label would be determined by Kitano's layers, not by Lee's transparent substrate.

184. A POSITA would also have possessed a reasonable expectation of success in making this combination.

185. Applying ink or coating layers onto polymer film substrates, which would be necessary to add Kitano's functional light-blocking layers onto Lee's specialized PET film, is a fundamental and entirely routine practice within the label and packaging industry. A POSITA would be intimately familiar with standard industrial printing and coating techniques such as gravure, flexographic, offset, or screen printing, any of which could be employed for this purpose depending on desired quality, speed, and cost. This step presents no technical novelty.

186. Furthermore, both Kitano and Lee utilize PET-based polymer chemistry for their respective components (substrate/film and materials for light-blocking layers, or the film itself in Lee's case). This shared chemical basis strongly suggests good material compatibility and adhesion between Lee's film and Kitano's ink layers, minimizing the likelihood of unexpected interfacial problems and supporting a reasonable expectation of success when combining these technologies.

187. Consequently, the combined label structure—Lee's recyclable PET film serving as the substrate for Kitano's light-blocking layer system—would reasonably be expected by a POSITA to function predictably and effectively. Such a label would

logically exhibit the light-shielding properties derived from Kitano's established layer design and material choices (e.g., metallic particles, carbon black), coupled with the enhanced recyclability and appropriate crystallizability imparted by Lee's specialized film composition. A POSITA would not anticipate significant negative interference between these compatible PET-based components that would prevent the combined structure from achieving both desired functionalities.

188. Therefore, in my opinion, a POSITA would have been clearly motivated to combine the core technical contributions of Kitano (light-blocking layers) and Lee (recyclable PET film) with a reasonable expectation of successfully producing a light-blocking, recyclable PET shrink label.

189. Achieving the specific quantitative performance metrics recited in certain dependent claims of the '422 Patent—such as attaining a specific light blocking percentage over the full 200-900nm range (as in limitation [1-4]/[19-4]), specific thermal shrinkage values at 100°C (as in claims 8, 9, and 17), or particular coating amounts expressed in ppr (as in claims 12 and 13)—would then, in my opinion, be a matter of routine optimization and characterization for a POSITA. Once the basic, logical combination of Kitano's light-blocking layers with Lee's recyclable film substrate is conceived, fine-tuning these performance parameters using standard experimental techniques (like adjusting coating thickness or pigment loading) and relying on known material property relationships (such as Beer-

Lambert Law for light absorption or known shrinkage behavior of oriented polyesters) falls squarely within the ordinary skill in the art of film and label development.

2. Independent Claims 1 and 19

190. As with the analysis for Ground 1, independent claims 1 and 19 define substantially similar recyclable PET shrink labels possessing light blocking capabilities. They differ primarily in how the light blocking functionality is achieved: Claim 1 requires specific particulates ([1-5], [1-6]), while claim 19 adds the requirement of a distinct high opacity layer containing a white pigment ([19-5]) in addition to the general light blocking layer and component ([19-3], [19-4]). In my opinion, the combination of Kitano and Lee, viewed with the knowledge of a POSITA, renders both claims obvious.

a. Preambles [1-PRE], [19-PRE]

191. The preambles recite "[a] recyclable shrink label." Even if considered limiting, the combination of Kitano and Lee clearly teaches this subject matter. Kitano discloses laminates formed from heat-shrinkable films intended for use as "shrink label[s]," including forming them into a "cylindrical shrink label" (EX-1007, Abstract, [0009], [0028]-[0029], [0036]). Lee explicitly teaches formulating a "heat shrinkable label" designed specifically to be "recyclable" and which "can be reused while attached to a PET container" during standard recycling processes (EX-1010,

Abstract, [0010], [0020]). As discussed in the motivation section, a POSITA seeking PET-compatible recycling solutions would be motivated to integrate Lee's recyclable film technology into Kitano's label structure. This combination directly results in a "recyclable shrink label" as recited in the preambles.

b. Heat Shrink Film [1-1]/[19-1], [1-2]/[19-2]

192. Limitations [1-1]/[19-1] require a heat shrink film comprising PET with opposed first and second surfaces. Limitations [1-2]/[19-2] require this film to have a thickness between 15μm and 100μm. The combination of Kitano and Lee teaches these features.

193. Kitano teaches using a "heat-shrinkable stretching film" as the substrate layer (1), identifying PET film as a preferred material (EX-1007, [0012], [0014], [0035]). Kitano's figures clearly depict films having first and second opposed surfaces (EX-1007, Figs. 1-5). Lee likewise discloses heat shrinkable labels based on PET and polyester blends (EX-1010, Abstract, [0010], [0013]). The combination, motivated by Lee's focus on recyclability, thus utilizes a heat shrink film comprising PET with opposed surfaces.

194. Regarding thickness, both Kitano and Lee disclose ranges that overlap with or suggest the claimed 15μm to 100μm range. Kitano teaches a preferred substrate thickness of 5-90 μm (more preferably 9-70 μm) and provides an example using a 30 μm PET film (EX-1007, [0014], [0035]). Lee discloses film thicknesses

generally from 3 μm to 350 μm (EX-1010, [0098]). Kitano's preferred range significantly overlaps the claimed range.

195. Furthermore, the claimed thickness range of 15μm to 100μm for the heat shrink film represents a standard, conventional range widely used for such films in labeling applications. A POSITA would understand that factors like desired label strength for application and handling, flexibility during the shrinking process, conformability to the container geometry, overall material cost, and converting line speed all influence the specific thickness chosen for a particular product. Selecting a film thickness within this conventional range, which is also consistent with and suggested by the overlapping thickness ranges disclosed in Kitano (e.g., 30μm example, preferred 9-70μm) and Lee (3μm to 350μm general disclosure), would be a matter of routine optimization and straightforward design choice for a POSITA developing a particular label product.

196. There is no indication that selecting a thickness within the specific 15-100μm range, particularly where it overlaps with Kitano's preferred range, yields any unexpected results compared to thicknesses slightly outside this range but still taught by the prior art.

197. Thus, the combination of Kitano and Lee, supplemented by the routine knowledge of a POSITA regarding standard film thicknesses, renders limitations [1-1]/[19-1] and [1-2]/[19-2] obvious.

c. Light Blocking Layer [1-3]/[19-3]

198. Limitations [1-3]/[19-3] require "a light blocking layer disposed adjacent the first surface and comprising a light blocking component." Kitano teaches this feature.

199. Kitano explicitly discloses a "light shielding layer (3)" which comprises a "light shielding ink containing binder resin and aluminum particles" (EX-1007, [0007]-[0008], [0018]). The aluminum particles in this ink serve as the "light blocking component." Kitano's Figure 1 illustrates this light shielding layer (3) applied over another ink layer (2, the white ink shielding layer), which in turn is on the substrate (1). In a typical label configuration where the substrate (1) is the outermost layer of the label once applied to a container, the light shielding layer (3) would thus be adjacent to the inner "first surface" of the film (i.e., the surface of the substrate film facing the container). This arrangement is consistent with the '422 Patent's definition of "adjacent," which allows for intervening layers between the light blocking layer and the first surface of the heat shrink film itself (EX-1001, 6:51-57), as would be the case here with the white ink layer (2) potentially between the substrate's first surface (1) and the light blocking layer (3). The motivated combination of Kitano's layer structure with Lee's film thus includes this limitation.

d. Light Blocking Performance [1-4]/[19-4]

200. Limitations [1-4]/[19-4] require the light blocking layer to block at least

80% of incident light between 200 nm and 900 nm. The combination of Kitano and Lee, viewed with POSITA knowledge, renders this performance obvious.

201. Kitano teaches that its light shielding layer provides "excellent light shielding properties" (EX-1007, [0019]) and aims for low light transmittance (e.g., ≤10% or even ≤3% in the 500-600 nm visible light range) (EX-1007, [0020]). Kitano achieves effective light shielding using materials such as aluminum particles (EX-1007, [0018], [0034]). Kitano also describes, in a comparative example, a mixture of TiO_2 and carbon black used for a light-shielding ink (EX-1007, [0041]).

202. A POSITA would know from general knowledge in physical chemistry and materials science, as well as from disclosures like Kitano, that the materials taught therein are effective light blockers across a broad spectrum. For instance, flaked aluminum particles, as taught by Kitano for its light shielding ink, are well known to be highly reflective and opaque across the UV, visible, and NIR regions, providing excellent light barrier properties. Titanium dioxide, which Kitano also mentions, is a strong scatterer and absorber of light, particularly effective in the UV and visible ranges. Carbon black, another option disclosed by Kitano (e.g., in a gray ink with TiO_2 at [0041]) and discussed previously, is an exceptionally potent broadband absorber covering the entire 200-900 nm range.

203. Although Kitano does not explicitly quantify blocking across the full 200-900 nm range or guarantee ≥80%, achieving this specific, quantitative

performance target would have been obvious through routine optimization. A POSITA, motivated to use Kitano's light-blocking approach on Lee's recyclable film, would understand that the level of light blocking is a predictable function of the type of light-blocking agent used (e.g., Al, TiO_2, CB), its concentration in the ink, and the thickness of the applied ink layer. Optimizing these known parameters—which are standard variables controlled during ink formulation and printing—to meet a specific blocking requirement (like ≥80% across 200-900 nm) is a routine task involving standard experimental procedures (e.g., preparing samples with varying ink formulations/thicknesses and measuring spectral transmittance) or calculations based on known material optical properties.

204. Therefore, achieving at least 80% light blocking over the 200-900 nm spectrum using Kitano's highly effective light-blocking components, such as aluminum particles or carbon black, would be a predictable outcome of routine optimization well within the skill of a POSITA. This would involve standard formulation adjustments, such as modifying the concentration of these pigments in the ink and/or adjusting the applied thickness of the light-blocking layer, until the desired quantitative performance target was met. There is no evidence to suggest that this level of performance represents an unexpected result for these well-characterized materials or that achieving it would require anything beyond ordinary skill.

205. Therefore, the combination of Kitano and Lee, as routinely optimized by a POSITA, renders the performance limitations [1-4] and [19-4] obvious.

e. Particulate Nature and Size [1-5]

206. Limitation [1-5] requires the light blocking component to be a particulate with a particle size of 0.1μm to 100μm.

207. In my review of Kitano, I note that it explicitly teaches using "flaked aluminum particles" as the light blocking component. Kitano further specifies that these particles have an "average particle size of 7 μm" (EX-1007, [0034]). This 7 μm size falls squarely within the claimed range of 0.1 μm to 100 μm. Thus, in my opinion, Kitano directly teaches this limitation.

f. Particulate Composition [1-6]

208. Limitation [1-6] requires the particulate to comprise metal, metal oxide, reflective pigment, carbon black, mica, or a combination.

209. In my opinion, Kitano directly teaches the use of particulates meeting several of the options specified in limitation [1-6]. Kitano explicitly teaches using "aluminum particles." Aluminum is a metal and, particularly in the flaked form taught by Kitano (which mentions "luster" at [0019]), functions as a "reflective pigment." Kitano also explicitly discloses, in a comparative example, a gray ink containing a mixture of "titanium dioxide" (which is a "metal oxide") and "carbon black" (EX-1007, [0041]). Thus, Kitano directly teaches the use of particulates that

satisfy the "metal," "metal oxide," "reflective pigment," and "carbon black" options recited in the claim, thereby rendering this limitation obvious from Kitano alone.

g. High Opacity Layer [19-5]

210. Limitation [19-5] requires "a high opacity layer comprising a white pigment."

211. Kitano, in my opinion, explicitly discloses the option of including a "shielding layer" (labeled as layer 2 in Fig. 1 or layer 5 in Fig. 3) made from "white ink" (EX-1007, [0011]). Kitano clarifies that this "white ink" contains a "white pigment," preferably titanium dioxide (TiO_2) (EX-1007, [0016]). The described function of this white ink layer includes providing opacity and a white background for printing (EX-1007, [0011], [0015]). This directly corresponds to the claimed "high opacity layer comprising a white pigment."

h. Recyclability with PET Container [1-7]/[19-6]

212. Limitations [1-7] and [19-6] require the label to be "recyclable with a PET container." In my opinion, the combination of Kitano and Lee clearly teaches or renders obvious this limitation.

213. While Kitano (EX-1007) applies its label to a PET bottle ([0037]) and mentions that separability of label from container might be advantageous ([0009]), it does not explicitly detail the mechanism of *integrated* recyclability with the PET container in the way the '422 Patent appears to envision (i.e., where the label itself

is processed through the PET recycling stream). However, Kitano uses materials and configurations (a PET film with a separate, light-blocking layer adjacent to it) that a POSITA would recognize as potentially compatible with such integrated recycling. Kitano expressly describes that "The light shielding layer may be formed by printing on an entire surface… by a conventional printing method…" (EX-1007, [0018]). This is the same type of printing described in the '422 patent for its light blocking composition ('422 Patent, 14:37-55). Therefore, a POSITA would expect similar recyclability between Kitano's labels and the claimed labels.

214. During prosecution of the '422 Patent, the Applicants argued that prior art labels with embedded light-blocking materials were unrecyclable due to contamination in a caustic wash. However, as discussed for Schurr and equally applicable here, this argument is flawed when applied to Kitano's structure. Kitano teaches applying its light-shielding layer (e.g., aluminum particles, or a mixture including carbon black and titanium dioxide) as described in its example inks, (EX-1007, Abstract, [0007]-[0008], [0018], [0034], [0041]) as a ***printed layer*** on the substrate, typically with a binder. This is fundamentally different from pigments compounded directly and homogenously into the polymer matrix of the film itself. A POSITA would understand that such distinct printed layers are generally more amenable to removal or management during recycling processes, including potential de-inking in a caustic wash if the ink formulations were so designed—a known

objective in the art for recyclable labels. Moreover, the art before the '422 Patent's effective filing date, such as Ügdüler (EX-1013), demonstrated that PET with challenging additives, including carbon black, could be successfully chemically recycled using optimized alkaline hydrolysis to remove such colorants from the monomers (EX-1013, Abstract, p. 5387). Given that Kitano's light-blocking layer is a printed coating, and that methods like alkaline hydrolysis (as shown by Ügdüler) were known to handle PET containing even difficult-to-remove pigments like carbon black, a POSITA would have reasonably expected that Kitano's printed light-blocking layers—particularly those utilizing common pigments like carbon black or other inert particulate opacifiers like titanium dioxide if present in a printed layer—could be rendered compatible with established or emerging PET recycling streams, either through effective separation of the label/ink or by processing the depolymerized monomers.

215. Lee's disclosure (EX-1010), in contrast to Kitano's general statements on label application, is directly focused on solving this exact problem of integrated recyclability for PET-based shrink films. Lee's central teaching is the provision of a PET-based shrink film specifically engineered (through careful control of blend composition and resulting crystallizability) so that the label "can be reused while attached to a PET container" ([0010]) and successfully processed within standard PET container recycling streams ([0020]). As discussed in the motivation section, a

POSITA seeking to create a state-of-the-art label that is both light-blocking (drawing from Kitano's teachings of printed light-blocking layers) and fully recyclable with PET containers (addressing the need solved by Lee's engineered substrate) would be strongly motivated to incorporate Lee's specific technological solution for the film substrate into a Kitano-like label structure featuring printed functional layers. Lee's teaching thus provides the explicit disclosure for achieving integrated recyclability of the PET film base. Combining Kitano's printed light-shielding layers with Lee's recyclable film technology, therefore, directly teaches or renders obvious a label that is "recyclable with a PET container." A POSITA would understand that the combination of a recyclable substrate (from Lee) with functional printed layers (from Kitano), which are inherently more separable or treatable in recycling than pigments embedded in the film matrix, presents a clear path to a fully recyclable light-blocking label.

3. Dependent Claim 2: Indicia Layer

216. Claim 2 depends from claim 1 and requires the label to further comprise "an indicia layer." The combination of Kitano and Lee renders this claim obvious.

217. In my opinion, Kitano explicitly describes incorporating layers for printed graphics into its laminate structures, which directly correspond to the claimed "indicia layer." Kitano teaches, for instance, that "a pattern printing layer 4 may be provided between the substrate layer 1 and the shielding layer 2," or, as an

alternative, "a pattern printing layer 6 may be provided on an opposite side (outer surface side)" (EX-1007, [0011], Figs. 2-3). Kitano further explains that these layers are composed of printing ink depicting items such as "characters or figures" ([0023]). While Lee's disclosure primarily focuses on the film substrate's recyclability, its description of providing a "heat shrinkable label" (EX-1010, [0010]) inherently implies its intended use in commerce, where labels virtually always include printed indicia for branding, information, or decoration.

218. Since Kitano, which provides the foundational teachings for the label's layered structure in this ground, explicitly discloses incorporating such an indicia layer, adding this standard and nearly universal feature to the obvious base structure established by combining Kitano's light-blocking technology with Lee's recyclable film would be straightforward and entirely obvious to a POSITA.

4. Dependent Claim 3: High Opacity Layer

219. Claim 3 depends from claim 1 and requires "further comprising a high opacity layer comprising a white pigment." The combination of Kitano and Lee renders this claim obvious, primarily based on Kitano's teachings.

220. As I discussed previously when analyzing claim 19 in the context of the Schurr reference, Kitano explicitly discloses adding an optional "shielding layer" (identified as layer 2 in EX-1007's Figure 1; or layer 5 in EX-1007's Figure 3). This layer is made from "white ink" which Kitano clarifies contains a "white pigment,"

with titanium dioxide (TiO_2) being a preferred example (EX-1007, [0011], [0016]). Kitano explains that this white ink layer serves functions such as providing opacity and a white background for subsequent printing or for the overall label appearance (*Id.* at [0011], [0015]). This disclosure directly corresponds to the claimed "high opacity layer comprising a white pigment."

221. Because Kitano explicitly teaches the inclusion and function of this high opacity white pigment layer as part of its disclosed laminate structures, incorporating it into the label rendered obvious by the combination of Kitano's light-blocking system with Lee's recyclable film substrate is merely the adoption of a feature expressly taught by Kitano, the primary reference for the label's optical and structural layers. It would be an obvious element for a POSITA to include if opacity or a white background were desired.

5. Dependent Claim 4: Arrangement of Layers

222. Claim 4 depends from claim 3 and requires a specific arrangement: the indicia layer, the high opacity layer disposed between the indicia layer and the light blocking layer. The combination of Kitano and Lee renders this arrangement obvious, as it is explicitly shown in Kitano.

223. This claim requires the specific relative positioning of the indicia layer (analyzed for claim 2), the high opacity layer (analyzed for claim 3), and the light blocking layer (analyzed for claim 1).

224. Kitano's Figure 2 embodiment, in my opinion, illustrates precisely the arrangement of layers recited in claim 4. This figure depicts a substrate (1), upon which an indicia layer (pattern printing layer 4) is back-printed. Printed over this indicia layer (4) is a high opacity layer (the white ink "shielding layer" 2). Finally, Kitano teaches printing the light blocking layer (light shielding layer 3) onto this high opacity shielding layer (2) (EX-1007, [0011], [0018], Fig. 2). In this specific configuration shown by Kitano, the high opacity layer (2) is physically located directly between the indicia layer (4) and the light blocking layer (3), thereby fulfilling the spatial requirement of claim 4.

225. Since Kitano explicitly discloses this specific layer configuration as one of its preferred embodiments for constructing a multi-layer label, adopting this well-defined arrangement in the context of the obvious combination of Kitano's layered optical system with Lee's recyclable film substrate would have been an obvious design choice for a POSITA seeking to implement Kitano's teachings.

6. Dependent Claim 5: Film Consists of PET

226. Claim 5 depends from claim 1 and requires "wherein the heat shrink film consists of polyethylene terephthalate (PET)." Kitano's teachings render this limitation obvious.

227. Kitano identifies PET as a suitable resin for its substrate layer (EX-1007, [0012]) and notes that PET film is preferable for back-printing applications

due to its transparency (EX-1007, [0014]). Critically, after listing PET among other potential resins, Kitano states, "These may be used ***alone***, two or more resins may be blended, or a multilayer film [...] may also be used." (EX-1007, [0012] (emphasis added)).

228. This explicit teaching that PET "may be used alone" directly corresponds to the claim limitation requiring the heat shrink film to "consist of" PET (in terms of its polymeric component, as discussed for Ground 1). Kitano further reinforces this by using standard commercial PET films as the substrate in its working examples (e.g., Example 1 uses a 30 µm PET film, Example 2 uses a 12 µm PET film) (EX-1007, [0035], [0039]).

229. While Kitano also mentions laminated films as an alternative ([0013]), the explicit disclosure and preference for PET, combined with the express statement that it can be used "alone," makes selecting a film consisting solely of PET an obvious choice directly taught by Kitano.

230. Based on Kitano's explicit preference for PET as a substrate material, its express teaching that PET "may be used alone" ([0012]), and its consistent use of standard commercial PET films in its working examples ([0035], [0039]), selecting a heat shrink film consisting solely of PET (in terms of its polymeric content) as taught by Kitano would have been obvious to a POSITA. While the combination with Lee further reinforces the choice of PET for recyclability, Kitano's own

disclosure provides a sufficient basis for finding this limitation obvious. Therefore, a heat shrink film consisting of PET would have been obvious from Kitano itself, without necessarily requiring the teachings of Lee for this specific "consists of PET" limitation, although Lee's teachings strongly support the use of PET for achieving the overall goal of a recyclable label.

7. Dependent Claim 6: Sleeve or Tube Form

231. Claim 6 depends from claim 1 and requires the label to be "in a form of a sleeve or tube." The combination of Kitano and Lee renders this obvious, based primarily on Kitano. Kitano explicitly describes forming its laminate into a "cylindrical shrink label" and states this label "may be in the form of a tube." (EX-1007, [0028], Fig. 6). This cylindrical tube form is technically synonymous with the claimed sleeve or tube. Lee also discusses providing a "heat shrinkable label" ([0010]), a term commonly understood in the field to include sleeve labels for containers.

232. Since Kitano, the primary reference defining the label's structure and application, explicitly discloses the claimed sleeve or tube form, the combination inherently includes this feature.

8. Dependent Claim 7: Seam

233. Claim 7 depends from claim 6 and requires "wherein the heat shrink film comprises a seam." Kitano's disclosure renders this feature obvious.

234. As discussed in connection with claim 6, Kitano teaches forming its label into a "cylindrical shrink label," which is a sleeve or tube. Kitano describes that this process involves overlapping the end portions (designated 7a, 7b in its Figure 6) of the flat film and then bonding these overlapped portions. Kitano suggests suitable bonding methods include "thermal bonding or adhesive, or a seal portion may be formed by a solvent seal" (EX-1007, [0028], Fig. 6). Indeed, Kitano's Example 1 specifically describes using a solvent seal on such overlapped portions to form the cylindrical label ([0036]). In my technical understanding, this described process of overlapping and then bonding or sealing the longitudinal edges of a flat film to create a tube inherently and necessarily results in the formation of a seam where these edges meet and are joined.

235. Therefore, because the seam is an inherent and unavoidable structural consequence of Kitano's disclosed method for forming the sleeve or tube (as recited in claim 6), claim 7, which requires that the heat shrink film comprises such a seam, would have been obvious from the teachings of Kitano.

9. Dependent Claim 8: Shrinkage at 100°C

236. Claim 8 depends from claim 1 and requires that when the heat shrink film is heated to 100° C., it "contracts or shrinks by about 1% to about 90%."

237. The combination of Kitano and Lee, viewed with the knowledge of a POSITA, renders this limitation obvious. Both references disclose the use of heat-

shrinkable films based on PET designed to exhibit substantial shrinkage when heated. Kitano provides an example using a PET film that showed 62% shrinkage after 10 seconds at 90°C and also discusses the possibility of films achieving 50% to 90% transverse direction shrinkage under similar conditions (EX-1007, [0013], [0035]). Lee teaches formulating PET blends to achieve "excellent shrinkage," providing examples with maximum shrinkage values exceeding 55%, and up to 75% or more, when tested at 95°C (EX-1010, [0010], [0079], Table 3).

238. Although neither Kitano nor Lee explicitly reports shrinkage data for their PET-based films measured precisely at 100°C, a POSITA would understand from fundamental polymer science that the shrinkage of oriented polymer films is a temperature-dependent property.

239. It is well understood in polymer science, and would be known to a POSITA, that heat-shrinkable PET films, such as those taught by Kitano and Lee which demonstrate significant shrinkage at temperatures of 90-95°C, will continue to exhibit substantial, and often slightly increased, shrinkage at the moderately higher temperature of 100°C. This latter temperature is highly relevant as it is commonly used in commercial shrink tunnel operations (e.g., employing steam or hot water) and is therefore a standard temperature for characterizing the performance of shrink films intended for such applications. A POSITA would expect shrinkage rates at 90-95°C to be very close to, or slightly less than, shrinkage rates at 100°C

for these types of oriented films.

240. Characterizing the precise shrinkage percentage at 100°C involves standard, routine laboratory procedures familiar to anyone working with shrink films (e.g., immersing a measured sample in a controlled 100°C bath for a specified time and remeasuring its dimensions).

241. Confirming the precise shrinkage behavior of a given film at 100°C is therefore a routine characterization step for a POSITA. It involves standard laboratory procedures, such as immersing a film sample in a controlled 100°C bath for a specified time and then remeasuring its dimensions.

242. The claimed shrinkage range in the '422 Patent of "about 1% to about 90%" at 100°C is exceptionally broad. In my experience, this range encompasses almost all practical and commercially relevant levels of shrinkage for heat shrink films used in packaging. Given the high shrinkage values already disclosed by Kitano (contemplating up to 90% transverse direction shrinkage, albeit measured at 90°C) and Lee (reporting up to 75% or more shrinkage at 95°C), a POSITA would reasonably and confidently expect that the shrinkage of a combined film based on these teachings, when tested at 100°C, would predictably fall well within this expansive 1-90% range. There is no technical basis or scientific principle that would lead a POSITA to expect a significant deviation or an unexpected drop in shrinkage when moving from 95°C to 100°C that would place the result outside this very broad

claimed range. It would, in fact, be difficult for a functional shrink film of this nature to *not* fall within such a wide range.

243. Therefore, based on the shrinkage properties explicitly disclosed in Kitano and Lee at temperatures very close to 100°C, combined with the routine ability of a POSITA to characterize shrinkage at standard industry temperatures, achieving a shrinkage value within the claimed 1-90% range at 100°C would have been obvious.

10. Dependent Claim 9: Shrinkage of Entire Label at 100°C

244. Claim 9 depends from claim 1 and requires that "when heated to 100° C., the entire recyclable shrink label contracts or shrinks by about 1% to about 90%."

245. This limitation is rendered obvious by the combination of Kitano and Lee for largely the same reasons as claim 8. Claim 9 simply extends the shrinkage requirement from the base "heat shrink film" (covered by claim 8) to the "entire" label structure.

246. As discussed above regarding claim 8, the base heat shrink film itself, drawing from the combined teachings of Kitano and Lee (particularly Lee's PET/copolyester blends engineered for recyclability), would be expected by a POSITA to shrink well within the broad 1-90% range when heated to 100°C.

247. The rationale establishing the obviousness of the base film shrinking 1-90% at 100°C, as detailed above for claim 8, applies directly to the "entire recyclable

shrink label" of claim 9. The expectation of achieving this level of shrinkage for the base film is clear and, in my opinion, easily met.

248. Kitano teaches applying various functional layers onto the base heat shrink film substrate. These include the white ink shielding layer, the light shielding layer (e.g., metallic or pigmented ink), an optional printed pattern layer, and an optional slipperiness layer (EX-1007, [0011], [0018], [0024], [0035]-[0036]). Kitano then describes shrinking this entire composite label structure onto a container (EX-1007, [0037]).

249. A POSITA would understand that these functional layers (inks, coatings) applied according to Kitano's teachings are typically very thin compared to the base substrate film. For instance, Kitano's Example 1 details a 30μm substrate film, a 2μm white ink layer, a 0.3μm aluminum ink layer, and a 0.5μm slipperiness layer (EX-1007, [0035]-[0036]). These thin layers are designed to adhere firmly to the substrate and conform to its dimensional changes during the heat shrinking process.

250. Because these additional functional layers (such as Kitano's white ink shielding layer, light shielding layer, optional pattern layer, and optional slipperiness layer) are typically very thin in comparison to the base substrate film and are formulated to adhere to and contract with the substrate, they would not substantially impede or alter the inherent shrinkage behavior dictated by the much thicker base

heat shrink film. From my understanding of material science and thin film behavior, the overall shrinkage percentage of such a multi-layer "entire recyclable shrink label" is therefore dominated by, and expected to be substantially the same as, the shrinkage percentage of the base film itself.

251. Since the base film's shrinkage at 100°C is expected to fall within the 1-90% range (per claim 8 analysis), and the thin functional layers taught by Kitano shrink along with it without significant hindrance, the "entire recyclable shrink label" would likewise be expected to shrink within the same broad 1-90% range at 100°C. Thus, claim 9 is rendered obvious by the combination of Kitano and Lee, supplemented by the routine knowledge of a POSITA regarding the behavior of multilayer shrink films.

11. Dependent Claim 10: High Opacity Layer Pigment Composition

252. Claim 10 depends from claim 3 (requiring the high opacity layer) and further specifies the white pigment comprises TiO_2, PCC, aluminum silicate, alumina, coated mica, or combinations. Kitano renders this limitation obvious.

253. As discussed with claim 3, Kitano teaches the optional "shielding layer" (layer 2 or 5) made from "white ink" containing a white pigment (EX-1007, [0011], [0016]).

254. Claim 10 specifies the type of white pigment for the high opacity layer.

In my review, Kitano explicitly states that for its white ink, "conventional white ink may be used, in which a white pigment is added..." and lists examples including "titanium oxide, calcium carbonate, magnesium carbonate, and mixtures..." Kitano further notes that "titanium oxide, which is the most common pigment, is preferably used for cost reasons and the like" (EX-1007, [0016]). Titanium dioxide (TiO_2) and calcium carbonate (which includes common forms like precipitated calcium carbonate, PCC) are both explicitly recited members of the group in claim 10.

255. Therefore, because Kitano explicitly teaches the use of TiO_2 (which it identifies as preferred) and/or calcium carbonate (including forms like PCC) as suitable white pigments for its opacity-providing layer, and this layer is part of the combined Kitano/Lee structure, claim 10 would have been obvious based on Kitano's direct disclosure alone.

12. Dependent Claim 11: Light Blocking Component Composition

256. Claim 11 depends from claim 1 and requires the light blocking component to be selected from a specific group (including various metals, oxides, carbon black, etc.). Kitano renders this claim obvious.

257. As discussed for claim 1 of this ground, Kitano's light shielding layer (typically layer 3 in its embodiments) contains a light blocking component. Examples of such components disclosed by Kitano include aluminum particles or a

mixture of TiO_2 and carbon black. Claim 11 specifies the chemical composition of this light blocking component.

258. In my opinion, Kitano explicitly discloses using materials for its light blocking component that fall within the group recited in claim 11. Kitano's primary example for its light shielding ink utilizes "aluminum particles," which clearly meet the "metal" element of the group. Due to their described luster (EX-1007, [0019]) and inherent optical properties when flaked, these aluminum particles also function as a "reflective pigment" (Kitano, [0034]). Kitano further describes, in a comparative example, a gray ink formulation containing a mixture of "titanium dioxide" (a "metal oxide") and "carbon black" (EX-1007, [0041]).

259. Since Kitano explicitly teaches the use of aluminum (which is a metal and functions as a reflective pigment), titanium dioxide (a metal oxide), and carbon black as suitable light blocking components, all of which are directly recited members of the group in claim 11, the selection required by claim 11 would have been obvious from Kitano's teachings.

13. Dependent Claim 12: Light Blocking Layer Amount (0.5-25 ppr)

260. Claim 12 depends from claim 1 and requires the light blocking layer to be present in an amount of 0.5 ppr to 25 ppr. This limitation is rendered obvious by the combination of Kitano and Lee, viewed with POSITA knowledge.

261. As discussed, claim 1 requires a light blocking layer ([1-3]) that achieves a certain performance ([1-4]). Kitano teaches forming such a layer (e.g., layer 3) using materials like aluminum paste and provides typical layer thicknesses (e.g., 0.3 μm in Example 1, general range 0.1-10 μm, preferred 0.2-5 μm) (EX-1007, [0035], [0021], [0034]). Kitano does not express this amount in ppr units.

262. Achieving the functional light blocking performance required by claim 1 involves optimizing the layer's parameters, including the applied amount of the light blocking material. This applied amount is a direct function of the ink formulation (concentration of light blocker) and the thickness of the applied layer.

263. Again, the unit "ppr" is a standard unit of areal density commonly used in the coating, paper, and converting industries to express the coating weight or add-on amount of a layer. It is a routine calculation for a POSITA, familiar with film and coating specifications, to convert between layer thickness, material density, and areal density units like ppr or its metric equivalent, g/m^2.

264. A POSITA tasked with achieving the ≥80% light blocking required by claim 1 using Kitano's taught materials (like aluminum particles) would perform routine optimization of the ink formulation and applied thickness. This would result in a specific, necessary coating weight (areal density) for the light blocking layer.

265. The claimed range of 0.5 to 25 ppr for the light blocking layer is, in my experience, quite broad and readily encompasses typical coating weights for

functional ink or coating layers applied to thin films such as labels. Based on Kitano's teachings of effective light blocking materials (e.g., reflective aluminum flakes) and typical layer thicknesses (e.g., ranging from sub-micron to a few microns, with an example at 0.3 µm for an aluminum layer), it would be predictable that the optimized coating weight needed to achieve the ≥80% light blocking performance (required by claim 1) would fall within this conventional 0.5-25 ppr range. My analysis of Kitano's Example 1, assuming reasonable material densities for an aluminum-containing ink layer of 0.3 µm thickness, indicates an areal density for that light blocking layer of approximately 0.24 ppr. While this specific calculation (which requires some assumptions about pigment loading and binder density not explicitly detailed by Kitano for this exact layer) is slightly below the 0.5 ppr lower limit of claim 12, a POSITA would understand that minor, routine adjustments in coating thickness or formulation (e.g., slightly increasing the aluminum content or the applied thickness) to ensure robust ≥80% light blocking would easily result in a ppr value falling within the claimed 0.5-25 ppr range. Such adjustments are standard practice in coating formulation to meet performance targets. Arriving at a value within this range via routine optimization or standard calculation based on Kitano's effective materials would be well within the ordinary skill of a POSITA.

266. No evidence suggests that achieving light blocking requires an amount

outside this typical range or that operating within this range yields unexpected results.

267. Therefore, based on Kitano's teachings regarding the light blocking layer and its components, combined with the routine optimization and standard units used by a POSITA to meet the functional requirements of claim 1, claim 12 would have been obvious.

14. Dependent Claim 13: Light Blocking Component Amount (0.1-10 ppr)

268. Claim 13 depends from claim 1 and requires the light blocking ***component*** itself (e.g., the Al particles or TiO_2/CB pigment) to be present in an amount of 0.1 ppr to 10 ppr within the light blocking layer. This limitation is also rendered obvious.

269. This claim focuses on the amount of the active light-blocking material within the layer, rather than the total layer amount (covered by claim 12). As discussed for claim 12, a POSITA would determine the necessary total amount (ppr) of the light blocking layer via routine optimization to meet the performance required by claim 1.

270. Kitano provides guidance on the concentration of the light blocking component within the ink used to form the layer. For example, the aluminum paste in Example 1 contained "about 10% by mass" aluminum particles, and this paste

itself was used at 10% by mass in the final ink formulation (EX-1007, [0034]). The gray ink used a "mixed pigment composed of titanium dioxide and carbon black" ([0041]), implying these are the active components.

271. A POSITA, having determined the required total ppr for the light blocking layer (per claim 12 analysis) and knowing the concentration (e.g., wt%) of the active light blocking component (Al, TiO_2, CB, etc.) within the ink formulation as taught by Kitano, could easily calculate the specific ppr amount of the component itself.

272. This calculation—multiplying the total layer ppr (as determined for claim 12) by the known weight fraction (wt%) of the active light blocking component (e.g., aluminum particles, TiO_2, or carbon black) within the ink formulation—is a straightforward and routine calculation for anyone experienced in formulating or specifying coatings or inks.

273. The claimed range of 0.1 ppr to 10 ppr for the active component is broad and encompasses typical loading levels for effective pigments or metallic particles in functional thin layers. Achieving the ≥80% light blocking specified in claim 1 using Kitano's effective materials (like Al or CB) and standard ink formulations would predictably result in an amount of the active light blocking ***component*** falling within this conventional 0.1-10 ppr range.

274. Therefore, confirming that 0.1-10 ppr represents a predictable and

conventional range for the necessary amount of the active light blocking component within a functional light blocking layer, based on Kitano's taught materials (like aluminum or carbon black), their typical concentrations in inks, and the performance target of claim 1 (≥80% light blocking), is readily apparent to a POSITA. For instance, continuing with the analysis of Kitano's Example 1, if the 0.3 μm aluminum-containing layer (calculated above at approximately 0.24 ppr for the total layer, or adjusted to be within the 0.5-25 ppr range like, say, 1 ppr through routine optimization) contained aluminum particles at a typical loading for such reflective inks, for example, 10% to 50% by weight of the dried ink, the ppr for the aluminum component itself would clearly fall within or be readily optimized into the 0.1-10 ppr range of claim 13. An amount of 0.19 ppr for a carbon black component, as I previously calculated for a Schurr-like layer, also falls within this range.

275. There is no evidence suggesting that achieving the required blocking necessitates component amounts outside this range or yields unexpected results.

276. Consequently, based on Kitano's teachings regarding light blocking components and their typical concentrations in inks, combined with routine optimization and calculation performed by a POSITA, claim 13 would have been obvious.

15. Dependent Claim 14: Article Comprising PET Container and Label

277. Claim 14 depends from claim 1 and recites "[a]n article comprising: [a] a container comprising polyethylene terephthalate (PET) and defining an external surface; and [b] the recyclable shrink label of claim 1 disposed on the container." In my opinion, the combination of Kitano and Lee, viewed with the knowledge of a POSITA, renders this claim obvious.

278. Kitano (EX-1007) explicitly describes applying its heat-shrinkable film to wrap objects, providing the specific example of covering PET bottles (EX-1007, [0037]). This is the primary intended commercial application for such shrink labels. A PET bottle inherently comprises PET and defines an external surface, matching element [14-1].

279. Lee's teachings, as I understand them, are squarely focused on achieving functional compatibility between heat-shrinkable labels and existing PET container recycling streams (see, e.g., EX-1010, Abstract; [0010], [0099]). Lee specifically addresses the technical challenge of providing a label that "can be reused while attached to a PET container" and can be successfully processed within standard PET recycling protocols ([0010], [0020]).

280. Element [14-2] of claim 14 requires the label itself (which, as discussed in my analysis for claim 1 of this ground, is rendered obvious by the combination of

Kitano and Lee) to be "disposed on the container." Kitano's own description of shrinking its label onto the "outer surface of this PET bottle" (EX-1007, [0037]) directly teaches this physical placement. Furthermore, Lee's entire focus on integrated recycling, where the label is designed to remain attached to the PET container throughout the recycling process (EX-1010, [0010], [0020]), inherently reinforces that the label is indeed disposed on the container during its intended lifecycle, including its end-of-life processing.

281. Therefore, in my opinion, applying the light-blocking, recyclable PET label (rendered obvious by the combined teachings of Kitano and Lee) to a PET container represents a natural and intended application context that is explicitly taught or strongly suggested by both references. A POSITA, motivated by the industry need to create a label suitable for PET containers that addresses both light blocking (as taught by Kitano) and integrated recyclability (as taught by Lee), would inevitably and obviously arrive at the claimed article, which comprises such a label disposed on a PET container.

16. Dependent Claim 15: Label Orientation on Container

282. Claim 15 depends from claim 14 and further specifies the orientation: "wherein the first surface of the heat shrink film faces the external surface of the container." In my opinion, Kitano's disclosure renders this claim obvious.

283. This claim relates to how the multi-layer label is oriented when applied

to the container. Kitano (EX-1007) describes configurations for its cylindrical shrink label where the "substrate layer (outermost layer)" of the label is exposed to the environment, and the functional layers, such as the light shielding layer, are described as the "(innermost layer)" (Kitano, EX-1007, [0028]; see also Kitano, Fig. 6, showing substrate 1 as outermost).

284. Kitano's use of "back printed" layers in its Example 1 ([0035]) further supports this orientation. From the perspective of a POSITA in the field of film converting and labeling, "back printing" or "reverse printing" signifies printing on that surface of the film which will ultimately face inward toward the container once the label is formed and applied. This is a standard and widely practiced technique in shrink sleeve manufacturing. The primary technical motivation for employing reverse printing is to protect the printed ink layers (which constitute the indicia or other functional layers) from physical damage such as abrasion and scuffing, as well as from environmental factors, during shipping, handling, and consumer use, because the ink is viewed through the transparent outer substrate layer.

285. Because Kitano explicitly describes label configurations (e.g., in its Figure 6 and by its use of the term "back printed" in Example 1) that directly correspond to the claimed orientation where the first surface (bearing the functional layers) faces the container—a standard industry practice employed for print protection—claim 15 is, in my opinion, rendered obvious by Kitano's teachings.

17. Dependent Claim 16: Indicia Layer on First Surface

286. Claim 16 depends from claim 2 (which added an indicia layer) and requires "wherein the indicia layer is disposed on the first surface." In my opinion, Kitano renders this limitation obvious.

287. As discussed for claim 2, Kitano (EX-1007) teaches incorporating indicia layers (e.g., "pattern printing layer 4" or "pattern printing layer 6") into its label structure (EX-1007, [0011], [0023]). Claim 16 specifies the location of this indicia layer on the "first surface," meaning the surface facing the container.

288. Kitano's Figure 2 embodiment explicitly illustrates the precise arrangement recited in claim 16. This figure depicts "a pattern printing layer 4" (the indicia layer) provided between the substrate (1) and the shielding layer (2), with Kitano clarifying that the "printing ink is back printed on the substrate layer 1" (EX-1007, [0011]; Fig. 2). As I explained in my analysis for claim 15, a POSITA understands that "back printing" onto the substrate means applying the ink (which forms the indicia layer) to that surface of the substrate which will become the inner, first surface when the label is ultimately formed and applied to a container. Kitano's Figure 2 thus directly shows the indicia layer (4) disposed on the first surface of the heat shrink film substrate (1).

289. Since Kitano explicitly discloses this specific configuration in at least one of its illustrated embodiments, which represents a standard reverse-printing

technique for protecting indicia, placing the indicia layer on the first surface as required by claim 16 would have been an obvious implementation of Kitano's teachings.

18. Dependent Claim 17: Transverse Direction Shrinkage

290. Claim 17 depends from claim 8 (requiring 1-90% shrinkage at 100°C) and further requires this shrinkage occur "in a transverse direction." In my opinion, the combination of Kitano and Lee, viewed with POSITA knowledge, renders this limitation obvious.

291. As discussed in the analysis for claim 8, the combined teachings render it obvious that the heat shrink film would exhibit shrinkage within the broad 1-90% range when tested at 100°C. Claim 17 specifies the primary direction of this shrinkage.

292. Shrinkage predominantly in the transverse direction is the fundamental requirement and expected behavior for heat-shrinkable films intended for use as sleeve labels, which must conform circumferentially around containers. Kitano (EX-1007) explicitly recognizes this, teaching the adjustment of the heat shrinkage factor "in the TD [transverse direction] direction" using standard methods like tentering, and provides a target transverse direction shrinkage range of 50% to 90% (measured at 90°C) (EX-1007, [0013]). Kitano's Example 1 film, exhibiting 62% shrinkage at 90°C (EX-1007, [0035]) and used to form a cylindrical label shrunk onto a bottle

([0028], [0037]), would be understood by a POSITA to shrink primarily in the transverse direction to achieve this conformance.

293. Lee likewise discloses films for shrink labels (EX-1010, [0010]), which conventionally are oriented to shrink predominantly in the transverse direction.

294. Therefore, a POSITA combining Kitano's label structure (which includes teachings on transverse direction shrinkage for sleeve labels) with Lee's recyclable PET film technology for use as a sleeve label would fully and reasonably expect the resulting composite film to exhibit its primary shrinkage (discussed in my analysis for claim 8 as being predictably within the 1-90% range when tested at 100°C) in the transverse direction. This expectation is entirely consistent with Kitano's explicit teachings regarding the adjustment of transverse direction shrinkage (EX-1007, [0013]) and the standard, required functionality of shrink sleeve labels, which must shrink circumferentially to conform to containers. Achieving the claimed shrinkage magnitude specifically in the transverse direction at 100°C is the reasonably expected outcome for this type of film and its intended application, rendered obvious by the combination of these prior art teachings and the routine knowledge of a POSITA.

19. Dependent Claim 18: Crystallizable PET

295. Claim 18 depends from claim 1 and further recites "wherein the heat shrink film comprises crystallizable polyethylene terephthalate (PET)." In my

opinion, the combination of Kitano and Lee renders this claim obvious.

296. As discussed previously, the base heat shrink film in the combined Kitano/Lee disclosure comprises PET. Claim 18 requires this PET be "crystallizable."

297. Standard PET, such as that described by Kitano (EX-1007) for use as a substrate (EX-1007, [0014]), is inherently a semi-crystalline polymer. As a polymer scientist, I know that standard PET possesses the fundamental molecular structure capable of forming crystalline regions when subjected to appropriate thermal or processing conditions; it is, by its very nature, "crystallizable." While specific processing conditions, such as rapid quenching during film formation, can result in largely amorphous PET films, the material itself always retains this inherent capability to crystallize.

298. Lee provides the explicit motivation and technical context for utilizing this inherent property. Lee's entire approach to achieving integrated recyclability centers on controlling the crystallizability of PET/copolyester blends. Lee teaches formulating blends by considering the crystallization temperature of recycled PET (EX-1010, [0034]) and managing the crystallization rate (as indicated by crystallization half-time, EX-1010, [0097], [0112]) to prevent fusion during recycling (EX-1010, [0004], [0020]) while allowing the film to be crystallized during the PET container drying process (EX-1010, [0020]).

299. In my expert opinion, Lee's disclosure clearly teaches the relevance and, indeed, the necessity of controlling PET crystallizability to achieve the specific goal of integrated recycling for shrink labels used with PET containers. Lee's entire technical solution for preventing label fusion and enabling co-processing fundamentally relies on using PET formulations that are crystallizable, but whose crystallization behavior (e.g., rate and extent of crystallization) is carefully tailored for compatibility with the conditions encountered in the PET recycling process.

300. A POSITA motivated by Lee's teachings to create a recyclable label (see motivation section above) would necessarily incorporate Lee's solution, which involves using PET blends specifically designed to possess and control crystallizability relevant to recycling. Therefore, incorporating Lee's teachings into the combined label structure inherently results in a heat shrink film comprising PET that is, by design and necessity for the intended function, "crystallizable," rendering claim 18 obvious.

APPENDIX A

List of Exhibits Considered

No.	Description	Referred To As
1001	U.S. Patent No. 11,961,422	'422 Patent
1002	File History for '422 Patent (Part I)	'422 Patent File History
1003	File History for '422 Patent (Part II)	'422 Patent File History
1005	CV of Dr. Robson F. Storey, Ph.D.	Storey CV or EX-1005
1006	US 11,358,363 B2	Schurr or EX-1006
1007	JP 2017-114041 A	Kitano or EX-1007
1008	JP 2004-250040 A	Ohta or EX-1008
1009	U.S. Pat. Pub. No. 2016/0361939	Keulders or EX-1009
1010	U.S. Pat. Pub. No. 2022/0389214	Lee or EX-1010
1011	Tamma, Paola; Schaart, Eline; Gurzu, Anca (11 December 2019). "Europe's Green Deal plan unveiled". *POLITICO*.	Tamma or EX-1011
1012	Schyns, Zoé OG, and Michael P. Shaver. "Mechanical recycling of packaging plastics: a review." Macromolecular rapid communications 42.3 (2021): 2000415.	Schyns or EX-1012
1013	Ügdüler, Sibel, et al. "Towards closed-loop recycling of multilayer and coloured PET plastic waste by alkaline hydrolysis." Green chemistry 22.16 (2020): 5376-5394	Ügdüler or EX-1013

No.	Description	Referred To As
1014	Limbo, Sara, et al. "Storage of pasteurized milk in clear PET bottles combined with light exposure on a retail display case: A possible strategy to define the shelf life and support a recyclable packaging." *Food chemistry* 329 (2020): 127116.	Limbo or EX-1014
1015	JP 2017-114041A	Japanese Version Kitano
1016	JP 2004-250040 A	Japanese Version Ohta