I, Chan Wook Doh, am fluent in English and Korean. I hereby certify under penalty of perjury that I translated into English the following document: Korean Patent Application No. 10-2006-0126101, published on December 7, 2006, which is attached to this Affidavit. I further certify and verify under penalty of perjury that the attached document written in English is, to the best of my knowledge, a true and accurate English translation of Korean Patent Application No. 10-2006-0126101, published on December 7, 2006, which is written in Korean.

___________________________ (Signature of Translator/Verifier)

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(54) Hybrid Tire Cord and a Method for Manufacturing the Same

(57) Summary

The present invention relates to a hybrid tire cord and a method for manufacturing the same, and more particularly, to a hybrid tire cord in which nylon filaments and aramid filaments are combined at a weight ratio of 10:90 to 90:10 and then formed into 2 or 3 plies at a weight ratio of 2:1 to 1:2, and a method for manufacturing the same.

The above hybrid tire cord has uniform fineness, and its physical properties such as tensile strength are improved by using aramid filaments, and its production cost is reduced by using nylon filaments, so it is preferably applied as a cap ply of ultra-high performance automobile tires suitable for high-speed driving.

Representative Figure

FIG. 1

Scope of Claims

Claim 1.

A hybrid tire cord comprising nylon filaments and aramid filaments, wherein the nylon filaments and the aramid filaments are included at a weight ratio of 10:90 to 90:10.

Claim 2.

The hybrid tire cord according to Claim 1, which is composed of 2 or 3 plies of nylon filaments and aramid filaments at a weight ratio of 2:1 to 1:2.

Claim 3.

The hybrid tire cord according to Claim 1, which is applied for cap ply use.

Claim 4.

The hybrid tire cord according to Claim 1, wherein the nylon filament has a tensile strength of 8 g/d or more and an elongation at break of 17% or more.

Claim 5.

The hybrid tire cord according to Claim 1, wherein the aramid filament has a tensile strength of 20 g/d or more and an elongation at break of 3.0% or more.

Claim 6.

The hybrid tire cord according to Claim 1, which has the following physical properties:

(i) (i) Tensile strength of 8.0 to 15.0 g/d as measured by ASTM D885:

(ii) (ii) Elongation at break of 10 to 20 as measured by ASTM D885:

(iii) Dry heat shrinkage of 2.0 to 5.0 as measured at 180°C.

Claim 7.

A tire comprising a hybrid tire code selected from any one of Claims 1 to 6.

Claim 8.

a) a) A method for manufacturing a hybrid tire cord, comprising the steps of a) combining nylon filaments and aramid filaments and then twisting them to produce a z-twisted yarn;

b) twisting 2 to 3 strands of the z-twisted yarn to produce an s-twisted yarn;

c) immersing the s-twisted yarn in an adhesive solution and then drying and heat-treating it.

Claim 9.

a) A method for manufacturing a hybrid tire cord, comprising the steps of a) twisting nylon filaments and aramid filaments to produce a z-twisted yarn;

b) combining 2 to 3 strands of the z-twisted yarn to produce an s-twisted yarn;

c) immersing the s-twisted yarn in an adhesive solution and then drying and heat-treating it.

Specifications

Detailed Description of Invention

Purpose of the Invention

Technology to Which the Invention Belongs and Prior Art in That Field

[Technical Field]

The present invention relates to a hybrid tire cord including nylon filaments and aramid filaments, which have excellent physical properties and reduced production costs and can be applied to ultra-high performance tires, and a method for manufacturing the same.

[Prior Art]

As automobile performance and road conditions improve, driving speeds are gradually increasing. Research is being conducted on tire cords used as rubber reinforcing materials in tires to maintain the stability and durability of tires even during high-speed driving.

Tire cords are classified according to the parts and roles they are used in, and are divided into the carcass part that supports the entire tire, the belt part that supports the load and prevents deformation due to high-speed driving, and the cap ply part that prevents deformation of the belt part. Recently, as highway conditions have improved and the driving speed of automobiles has increased, problems such as deformation of the belt part of tires and deterioration of the ride quality of automobiles have occurred. Therefore, the importance of cap ply to prevent deformation of the belt part is increasing.

The main cap fly materials currently in use are nylon 66 and aramid. Among them, nylon 66 is used in most tire specifications because it shows a lower price compared to other materials, excellent adhesive performance, and adhesive performance after fatigue. In addition, it exhibits high shrinkage stress for belt cord support at high speeds required in cap ply, but has a weakness as a performance cap ply such as flat spot because the modulus is low and the change in modulus at room temperature and high temperature is large.

In addition to nylon 66 mentioned above, aramid, which is used as a cap ply material, exhibits lower shrinkage stress than nylon 66, but has excellent creep characteristics, and has very high modulus characteristics and little change in modulus at room temperature and high temperature, so there is almost no flat spot phenomenon in which the tire is deformed when the vehicle is parked for a long time. These aramid materials are mainly used in high-end tires where tire quality is very important, but because the price of the material itself is very high, it is almost impossible to apply it to general-purpose tires.

Technical Task the Invention Seeks to Accomplish

An object of the present invention to solve the above-mentioned problem is to provide a hybrid tire cord manufactured from a nylon filament having excellent shrinkage force and capable of preventing movement of a belt cord, and an aramid filament having high modulus characteristics, and a method for manufacturing the same.

Another object of the present invention is to provide a use of the hybrid tire cord for applying it to a cap ply of a tire, particularly a high-speed tire.

Composition of the Invention

To achieve the above object, the present invention provides a hybrid tire cord, wherein nylon filaments and aramid filaments are included at a weight ratio of 10:90 to 90:10.

Preferably, the nylon filaments and the aramid filaments are double- or triple-plied at a weight ratio of 2:1 to 1:2, and the hybrid tire cord obtained has a tensile strength of 8.0 to 15.0 g/d as measured by ASTM D885, an elongation at break of 10 to 20% as measured by ASTM D885, and a dry heat shrinkage of 2.0 to 5.0% at 180°C.

In addition, the present invention provides a use for applying the hybrid tire cord to a cap ply of a tire and a tire including the same.

In addition, the present invention provides a method for manufacturing a hybrid tire cord, comprising the steps of a) combining nylon filaments and aramid filaments and then twisting them to produce a z-twisted yarn, b) twisting 2 to 3 strands of the z-twisted yarn to produce an s-twisted yarn, and c) immersing the s-twisted yarn in an adhesive solution and then drying and heat-treating it.

In addition, the present invention provides a method for manufacturing a hybrid tire cord, comprising the steps of a) twisting nylon filaments and aramid filaments to manufacture a z-twisted yarn, b) combining 2 to 3 strands of the z-twisted yarn to manufacture an s-twisted yarn, and c) immersing the s-twisted yarn in an adhesive solution and then drying and heat-treating it.

The present invention is described in more detail below.

The tire cord according to the present invention is a hybrid type in which nylon filaments and aramid filaments having excellent adhesive strength and heat-resistant fatigue properties are mixed, whereby the low modulus of the nylon filaments is supplemented by the aramid filaments, and the low shrinkage force of the aramid filaments is supplemented by the nylon filaments, thereby lowering the price and enhancing the competitiveness of the product.

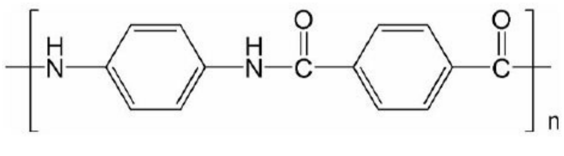
The cap ply of a tire is a special cord attached to a belt made of steel wire or fabric fiber to improve driving performance of a vehicle and prevent the belt from coming off. The hybrid tire cord of the present invention must take into consideration both material aspects, such as the physical properties of nylon and aramid filaments, and process aspects, such as the number of twists and the order of plying.

Nylon contains an amide group with angular polarity in the main chain and is crystalline due to its steric regularity and symmetry. The nylon filament used in manufacturing the tire cord is not particularly limited in the present invention, but it is preferable that it have physical properties suitable for use as a tire cord, that is, a tensile strength of 8 g/d or more and an elongation at break of 17% or more. However, if the above conditions are not met, a large amount of cord is used due to low strength, which increases the weight of the tire and causes problems in that the belt movement is not sufficiently prevented when the vehicle is driven. In addition, low elongation has the problem that significant strength loss occurs due to fatigue from repeated driving of the tire.

The usable nylon filament may be one filament selected from the group consisting of conventional nylon 6, nylon 66 and nylon 6.10, with nylon 66 being preferred.

Aramid is one of the nylon polymers mentioned above, and has a phenyl ring connected to all the main chains except the amide group, so it exhibits a modulus that is more than 10 times that of nylon. Aramid exists in para (p-) and meta (m-) form depending on the connection state of the phenyl ring, and poly(p-phenylene terephthalamide) (poly(p-phenylene terephthalate)) bonded in para form as represented by the following Chemical Formula 1 is preferably used.

Chemical Formula 1



In the above formula, n is determined according to the molecular weight of aramid and is not specifically limited in the present invention.

Aramid filaments having the structure of the above chemical formula 1 have high crystallinity, excellent heat stability, and very high modulus due to phenyl rings being laminated in a plate-like shape, and are mainly used as fibers. These aramid filaments are also preferably used as tire cords with a tensile strength of at least 20 g/d and an elongation at break of at least 3.0%, similar to nylon filaments. However, if the above conditions are not met, the tire cord cannot sufficiently provide support within the tire, which is its role, and thus the low strength of the nylon filament pursued in the present invention cannot be compensated for.

The physical properties of the hybrid tire cord according to the present invention can be achieved by adjusting the mixing ratio of the nylon filaments and the aramid filaments that constitute the cord, and at this time, the mixing ratio of each filament is used in an amount that can sufficiently compensate for the required level of properties and the shortcomings of each filament. In general, aramid filaments have a modulus about 10 times that of nylon filaments, so even if only 15% is used, it has a modulus about 2 to 3 times that of a single nylon material, so it is very useful in reducing the flat spot phenomenon. However, considering the properties and cost of the tire cord, 10 to 90 weight% of nylon filaments and 90 to 10 weight% of aramid filaments are used. If nylon filaments are used excessively, the resulting hybrid tire cord will follow the physical properties of the nylon filaments, resulting in a flat spot phenomenon. If aramid filaments are used excessively, the properties will improve, but the shrinkage will be low, making it difficult to effectively prevent the belt cord from moving as the car drives, and the cost will increase.

In addition, the hybrid tire cord selects an appropriate number of twists to maximize the physical properties of each filament. In general, as the twist count of fibers increases, the strength decreases but the fatigue performance increases, and conversely, as the twist count decreases, the strength increases but the fatigue performance decreases. Since the hybrid tire cord of the present invention has similar strength and fatigue performance according to twisting since the two types of filaments have similar structures, the twist count of the hybrid tire cord follows the fineness of nylon.

For example, when the total fineness of the nylon filament is 840 denier, the appropriate twist count is 470 TPM (Twist Per Meter), and when it is 1890 denier, the appropriate twist count is 300 TPM. Therefore, the hybrid tire cord according to the present invention has a twist count in the range of 300 to 500 TPM. At this time, it is desirable that the fineness of the aramid filament also has the same or similar range as that of the nylon filament.

Hereinafter, the manufacturing method of the hybrid tire cord having the above composition will be described in more detail.

The hybrid tire cord of the present invention comprises a step of performing a process of twisting nylon filaments and aramid filaments into a z-twist and an s-twist, immersing the twisted yarn obtained in an adhesive solution, and then drying and heat-treating it, and is characterized in that the nylon filament and the aramid filament are combined and then subjected to a z-twist process at the same time, or the z-twist process is performed after they are combined.

Figure 1 is a flow chart showing the manufacturing steps of a hybrid tire cord according to the present invention.

Referring to Fig. 1, a hybrid tire cord is manufactured by combining nylon filaments and aramid filaments and then twisting them to manufacture a z-twisted yarn (S1), twisting 2 to 3 strands of the z-twisted yarn to manufacture an s-twisted yarn (S2), and immersing the s-twisted yarn in an adhesive solution and then drying and heat-treating it (S3).

At this time, if the weight ratio of the nylon filament and the aramid filament is 1:1, it is acceptable to perform the process before the s-twist and after the z-twist as shown in Fig. 2.

Specifically, in S1, nylon filaments and aramid filaments are combined through a guide and then twisted to produce a z-twisted yarn.

The above twisting process is performed by devices commonly used in this field, such as spindles, rotors, and rollers, and performs S-twist (right-hand twist) and Z-twist (left-hand twist) depending on the direction. The extension of the fibers that occurs during this twisting process combines with the tension of the fibers to increase the pressure in the inward direction of the fibers, thereby increasing the friction between the fibers, and thus making it possible to manufacture a hybrid tire cord with a strong bond between the fibers.

In S2, a secondary twisting process is sequentially performed on the 2 to 3 strands of a z-twisted yarn obtained in S1 to manufacture an s-twisted yarn having the same fineness.

The twisting process of the present invention is significantly different from the conventional method of manufacturing a z-twisted yarn with each filament and then performing an s-twist process. In other words, if a z-twisted yarn is made with filaments of each material and then an s-twisted yarn is manufactured with these two z-twisted yarns, the ratio of the two materials must be maintained at 1:1. Otherwise, twisting defects will occur in the s-twisted yarn, making manufacturing impossible. Moreover, even if a 1:1 ratio is maintained, if materials with significantly different strength and modulus are used, the possibility of twisting defects increases again.

However, in the present invention, by performing the z-twist process after combining nylon filaments and aramid filaments through a combining process before or simultaneously with the z-twist process or performing the z-twist process simultaneously with the combining process, the z-twisted yarn obtained after the z-twisting process has the same fineness. Accordingly, the s-twisted yarns obtained by performing the s-twist process with the above z-twisted yarns also have the same fineness, and because each s-twisted yarn has the same physical properties, twisting defects do not occur. As a result, the properties of the final hybrid tire cord, such as strength and modulus, are greatly improved, and productivity is increased because twisting defects rarely occur. In addition, using this method, the final tire cord can be easily manufactured by adjusting the ratio according to the level of physical properties required for the final tire.

In S3, to improve the adhesiveness of the tire cord, the twisted yarn obtained in S2 is immersed in and passed through an adhesive solution, then dried and heat-treated to manufacture a tire cord.

The adhesive solution used as the above adhesive is not particularly limited in the present invention, and an RFL solution (Resorcinol Formaldehyde Latex), which is an impregnation solution for tire cords commonly used in this field, or an epoxy-based adhesive composition solution, etc. can be used. At this time, drying varies depending on the composition of the impregnation solution, but is usually performed at 70 to 200°C for 30 to 120 seconds.

The heat treatment process is typically performed at 200 to 250°C for 30 to 120 seconds, and through this heat treatment, the adhesive component of the impregnation solution attached in the previous step is coated on the surface of the tire cord, thereby increasing the adhesion with the rubber composition used in tire manufacturing in the subsequent process.

At this time, if nylon filaments and aramid filaments are used in a ratio of 1:1, the combining process may be performed before the s-twisting after the z-twisting as shown in Fig. 2, and the specific process conditions are the same as those described above.

The hybrid tire cord manufactured by the process described above has physical properties such as a tensile strength of 8.0 to 15.0 g/d as measured by ASTM D885, an elongation at break of 10 to 20%, and a dry heat shrinkage of 2.0 to 5.0% as measured at an initial load of 0.01 g/De' for 2 minutes at 180°C.

The above hybrid tire cord is preferably applied to the cap ply, especially among tire cords, to sufficiently prevent deformation of the tire belt that occurs when a car is driven at high speeds, thereby effectively improving the flat spot phenomenon that occurs in tires that employ conventional nylon-based tire cords.

In addition, the hybrid tire cord of the present invention can satisfy physical properties required for various types of tires by variously changing the ratio of nylon filaments and aramid filaments, total fineness, and impregnation process.

Furthermore, the hybrid tire cord uses a mixture of expensive aramid with excellent properties and inexpensive nylon filaments, so that it is less expensive than tire cords manufactured using a single aramid filament material, and the defect rate during the process is reduced, thereby improving productivity and increasing competitiveness as a product.

Hereinafter, preferred embodiments of the present invention are described. However, the following examples are only preferred embodiments of the present invention, and the present invention is not limited to the following examples.

[Embodiments]

Embodiment 1-4

Nylon 66 filaments and p-aramid (Kevlar) filaments having the properties shown in Table 1 below were passed through a guide, combined, and then twisted to produce a z-twisted yarn.

The above two strands of the z-twisted yarn were subjected to a twisting process so that the twist count became 360 TPM, thereby manufacturing the s-twisted yarn.

The s-twisted yarn obtained was passed through an RFL adhesive bath, and then dried and heat-treated at 150°C and 240°C for 60 seconds, respectively, to manufacture a hybrid tire cord.

[Table 1]

Category		Embodiment 1	Embodiment 2	Embodiment 3	Embodiment 4
Nylon/p-aramid (Weight%)		50/50	60/40	40/60	85/15
Twisting method		Combining before twisting	Combining before twisting	Combining before twisting	Combining before twisting
Nylon filament	Tensile strength (g/d)	9.1	9.1	9.1	9.1
	Elongation at break (%)	20.5	20.5	20.5	20.5
p-aramid filament	Tensile strength (g/d)	21	21	21	21
	Elongation at break (%)	3.5	3.5	3.5	3.5
Twist count (TPM)		360	360	360	360

Comparative Example 1

A tire cord was manufactured in the same manner as in the above embodiment, except that a nylon 66 filament having the properties shown in Table 2 below was used alone.

Comparative Example 2

A tire cord was manufactured in the same manner as in the above embodiment, except that a p-aramid filament having the properties shown in Table 2 below was used alone.

Comparative Examples 3 & 4

A tire cord was manufactured in the same manner as in the above embodiment, except that nylon 66 and p-aramid filaments having the properties shown in Table 2 below were subjected to a twisting process to manufacture nylon 66 z-twisted yarn and p-aramid z-twisted yarn, and then a combining process was performed.

Comparative Example 5

A tire cord was manufactured by following the process of the embodiment of performing a combining process before a twisting process, except that the content of nylon 66 and p-aramid filaments was 95/5.

Comparative Example 6

A tire cord was manufactured using the same method as in Comparative Example 5, except that the properties and contents of nylon 66 and p-aramid filaments were changed.

[Table 2]

Category		Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5	Comparative Example 6
Nylon/p-aramid (Weight%)		100/0	0/100	30/70	70/30	95/5	87/13
Twisting method		-	-	Combining after twisting	Combining after twisting	Combining after twisting	Combining after twisting
Nylon filament	Tensile strength (g/d)	9.1	-	9.1	9.1	9.1	7.6
	Elongation at break (%)	20.5	-	20.5	20.5	20.5	24.3
p-aramid filament	Tensile strength (g/d)	-	21	21	21	21	18.5
	Elongation at break (%)	-	3.5	3.5	3.5	3.5	3.8
Twist count (TPM)		360	360	360	360	360	360

Experimental Example 1

In order to manufacture the properties of the tire cords manufactured in the above embodiments and comparative examples, specimens were manufactured, respectively, and the tensile strength, elongation at break, and shrinkage were measured, and the twist state of the yarn was visually confirmed to determine the quality of the yarn. The results obtained are shown in Table 3 below, and the methods for measuring each property are as follows.

A: Tensile strength (g/d. Strength)

According to ASTM D885, measurements were made using an Instron low-speed extension tensile tester at a tensile speed of 300 mm/min, a sample length of 250 mm, an ambient temperature of 25°C, and 65%RH.

B: Elongation at break (%, Elongation at break, 50 mm/min)

The elongation at peak strength of the treated cord-applied filaments was measured according to ASTM D885.

C: Dry heat shrinkage (%, shrinkage)

After leaving for more than 24 hours under ambient conditions of 25°C and 65% relative humidity, measurements were made using a Testrite device at 180°C for 2 minutes under an initial load of 0.01 g/De.

D: Whether or not twisting defects occur and the quality of the yarn

After the twisting process, 5 m of the twisted yarn was collected and the twist condition was visually checked to determine whether there were any defects.

E: Quality of the yarn

Considering the above measured properties, the applicability as a tire cord was determined.

[Table 3]

	Tensile strength (g/d)	Elongation at break (%)	Dry heat shrinkage (%)	Whether twisting defects occur	Quality of the yarn
Embodiment 1	12.2	12.4	2.6	None	Satisfactory
Embodiment 2	11.5	13.4	3.0	None	Satisfactory
Embodiment 3	10.7	15.4	3.8	None	Satisfactory
Embodiment 4	8.8	19.2	4.8	None	Satisfactory
Comparative Example 1	7.8	22.4	7.3	None	Satisfactory
Comparative Example 2	18.4	4.3	0.7	None	Satisfactory
Comparative Example 3	Immeasurable	Immeasurable	Immeasurable	Occurrence	Defects
Comparative Example 4	Immeasurable	Immeasurable	Immeasurable	Occurrence	Defects
Comparative Example 5	8.6	21.3	6.6	None	Satisfactory
Comparative Example 6	7.8	18.5	4.9	None	Satisfactory

Referring to Table 3 above, it can be seen that the yarns of Embodiments 1 to 3, which were combined prior to the twisting process according to the present invention, have better quality than those of the comparative examples. In other words, it can be seen that by performing the z-twist process in a combined state, the stress applied to the z-twisted yarn during the s-twist process is uniformly distributed without causing a stress concentration phenomenon in which the stress is concentrated on one part, thereby improving the properties of the final hybrid tire cord obtained.

In the case of Comparative Example 1, when nylon filaments were used alone, no twisting defects occurred and the quality of the yarn was good, but it was found that the tensile strength was low and the elongation at break and shrinkage were high, which could cause a flat spot phenomenon.

The tire cord of Comparative Example 2 used p-aramid filaments alone, and, like Comparative Example 1, had good twisting performance, good yarn quality, and excellent tensile strength; however, the elongation at break and shrinkage were too low to effectively support the belt of the tire.

In particular, the tire cords of Comparative Examples 3 and 4 were manufactured by going through a z-twist process to produce nylon 66 twisted yarn and p-aramid z-twisted yarns, and then performing an s-twist process on the z-twisted yarns. It was observed that the above nylon 66 and p-aramid yarns each had isotonic twists due to differences in modulus and fineness, which resulted in a deterioration in the quality of the yarn and twisting defects.

The tire cord of Comparative Example 5 was combined before the twisting process, so there was no twisting defect and the quality of the yarn was excellent. However, the aramid content was too low, so it exhibited a tensile strength too low to be used as a tire cord for cap ply.

In addition, the tire cord of Comparative Example 6 was also subjected to a combining process prior to the twisting process, but the properties of the nylon 66 and p-aramid filaments used were low, and thus it did not secure sufficient properties to be used as a tire cord.

Effects of the Invention

As described above, by combining nylon filaments and aramid filaments and then z-twisting them according to the present invention, twisting defects do not occur in the subsequent s-twist process, and the fineness of the final yarn obtained is uniform. Accordingly, the hybrid tire cord according to the present invention not only prevents the flat spot phenomenon that occurs in existing tire cords made of nylon, but also has excellent physical properties and is inexpensive, so that it can be effectively applied to the cap ply of high-speed tires.

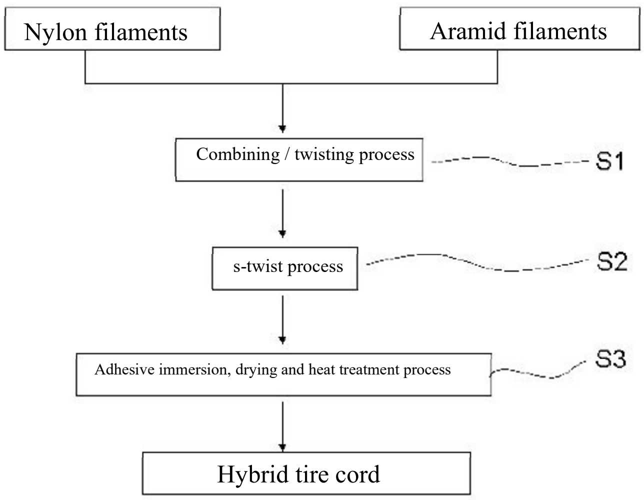
Brief Description of the Drawings

Figure 1 is a flow chart showing the manufacturing steps of a hybrid tire cord according to one embodiment of the present invention.

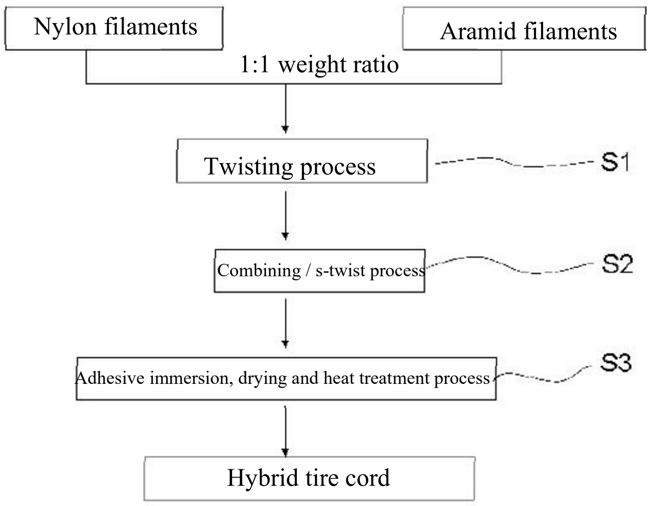
FIG. 2 is a flow chart showing the manufacturing steps of a hybrid tire cord according to another embodiment of the present invention.

Drawings

Drawing 1



Drawing 2


Nylon filaments
Aramid filaments
1:1 weight ratio
Twisting process
S1
Combining / s-twist process
S2
Adhesive immersion, drying and heat treatment process
S3
Hybrid tire cord