I, James Choi, 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. 10-1997-0048866, published on March 2, 2000, 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. 10-1997-0048866, published on March 2, 2000, which is written in Korean.

J. M. Choi (Signature of Translator/Verifier)

James Choi (Print Name)

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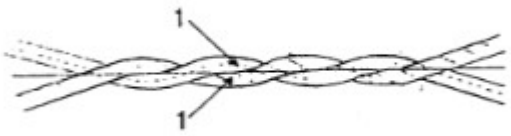
(54) Aramid-Nylon Complex Fiber Cord for Rubber Stiffner

Summary

The present invention relates to the fiber cord composed of aramid and nylon with excellent structural stability and adhesiveness which is used as stiffner of rubber, etc. for cable sheath as well as the carcass ply and cap ply of tire, and belt.

Master Drawing



SPECIFICATION

[Name of invention]

Aramid-Nylon Complex Fiber Cord for Rubber Stiffner

[Concise explanation of the drawings]

FIG. 1 is a perspective view illustrating the structure of the conventional fiber cord.
FIG. 1 is a perspective view illustrating the structure of the present invention.
FIG. 3 is the microstructure diagram of aramid cord.
FIG. 4 is the microstructure diagram of nylon cord.

* Explanation on the numbers marked for the major parts of the drawings

1: Aramid ply 2: Nylon ply
3: Crystal 4. Amorphous

[Detailed explanation of the invention]

The present invention relates to the fiber cord composed of aramid and nylon with excellent structural stability and adhesiveness which is used as stiffner of rubber, etc. for cable sheath as well as the carcass ply and cap ply of tire, and belt.

Recently, the high speed driving stability and high durability of tire is considered very important due to the high speed driving resulted from the upgrading of passenger cars. The general trend for low flatness ratio tire is to apply aramid cord with excellent structural stability and strength to carcass plies to assure high speed driving performance. However, even though aramid cord is excellent in high speed driving stability due to its excellent in structural stability and it is a cord which can improve durability performance by applying low cord density due to its excellent strength, it has a shortcoming of weak adhesive strength with rubber structurally, so it is not appropriate for tire which is used for a long period of time but is applied only to tires for short term driving such as car racing.

Therefore, this inventor conducted a research assiduously to supplement the shortcoming of weak adhesive strength of aramid cord which is used in carcass plies of tires of high speed running passenger cars, and as a result, the inventor found that weak adhesive strength, which is a shortcoming of aramid carcass tire, can be supplemented when applying aramid-nylon composite fiber cord composed of aramid with excellent structural stability and nylon with excellent adhesive performance to the carcass plies, so it can not only be applied to the tires of various specifications but also improve the risk of accidents caused by the decline in adhesive strength when driving vehicles for a long period of time, and thus the present invention has come to perfection,

The present invention is described in detail with reference to the attached drawings as follows:

The present invention has supplemented the weak adhesive strength of the conventional aramid cord (illustrated in FIG. 1) which is used in the carcass plies of tires for passenger cars, and as illustrated in FIG. 2, it relates to the aramid-nylon combined fiber cord which is a single cable (i.e. cord) formed by twisting nylon ply with excellent adhesive strength and aramid ply with excellent structural stability.

Aramid cord is composed of 95% or more crystal and 5% or less amorphous so it is very excellent in the structural stability against heat and tension, whereas since well-developed crystal is accounting for absolutely large portion, it is a cord which has a form very disadvantageous in the adhesion by physical difficult and a structure difficult to combine chemically so it is very disadvantageous in adhesion (Refer to FIG. 3).

On the other hand, nylon cord is very advantageous in chemical adhesion too since its molecule has polyamide structure, and though crystal and amorphous vary depending on the manufacturing process, they account for about 60% and 40% respectively, so it is a cord with a structure which is very advantageous with respect to the defect caused by physical diffusion (Refer to FIG. 4). Therefore, the fiber cord of the present invention can supplement the characteristics of the conventional two fiber cords as one cord is achieved by twisting the plies of the above two materials into one cord.

Poly(p-phenylene terephthalamide) of the following Structural Formula (I) is desirable for aramid used in the present invention, and Poly(ε-caprolactam) of the following Structural Formula (II) is desirable for nylon.

(I)

(II)

In the present invention, aramid ply of 500 to 2,000 denier and nylon ply of 500 to 2,000 denier can be applied, and the fiber cords of the present invention has a structure of two ply cord made by twisting one ply of aramid and one ply of nylon, three ply cord made by twisting one ply of aramid and two plies of nylon, or three ply cord made by twisting two plies of aramid and one ply of nylon. At this time, the desirable number of twists is 10 to 50 TPI (Twist Per Inch).

The present invention shall be explained in more detail through embodiments as follows:

[Embodiment 1]

1000D-840D composite fiber cord of the present invention which is made by twisting one aramid ply of 1000 denier and one nylon ply of 840 denier and the conventional 1000D/2P aramid cord have been tested for physical properties, and the results of the test are shown in Table 1.

[Table 1]

Category	100D/2P Aramid cord (twist per inch (TPI): 43)	100D – 840D composite fiber cord (twist per inch (TPI): 43)
Strength (kg)	35	24.5
Medium elongation (4.5 kg), %	0.75	1.8
Thermal shrinkage ratio (%) (177'CX2min, FREE)	0	1.0

Performance test was conducted with the tires manufactured by applying the aramid-nylon combined fiber cord and the aramid cord used in the above physical property test to carcass plies of the tires for passenger car of 195/50R15 specification respectively, and its results are shown in the following Table 2.

[Table 2]

Type of test		Tire 1	Tire 2
		100D/2P Aramid cord applied	100D – 840D composite fiber cord applied
Real car driving (Field Test)		Occurrence of an accident after running 40,000 km	Occurrence of an accident after running 60,000 km
High speed driving stability[1)]		6.0	5.8
Ride comfort[1)]		6.0	7.0
Adhesion[2)]	Before driving	14 kg/inch	18 kg/inch
	After driving	8 kg/inch	15 kg/inch

(Notes)

1) Index of people's feeling on the basis of the perfect score of 10 (A difference of 1 point or more is a difference at a level that can be felt by regular drivers, and a difference of 0.5 or more is a difference that can be felt by sensitive drivers).

2) Driving conditions: Before and after driving 140 km/hour – 500 km

[Embodiment 2]

1000D/2-840D composite fiber cord of the present invention which is made by twisting two aramid plies of 1000 denier and one nylon ply of 840 denier and the conventional 1000D/3P aramid cord have been tested for physical properties, and the results of the test are shown in Table 3.

[Table 3]

Category	1000D/3P Aramid cord (twist per inch (TPI): 35)	1000D/2P – 840D composite fiber cord (twist per inch (TPI): 35)
Strength (kg)	55	45
Medium elongation (6.8 kg), %	0.8	1.4
Thermal shrinkage ratio (%) (177'CX2min, FREE)	0.1	0.5

Performance test was conducted with the tires manufactured by applying the fiber cords used in the above physical property test to carcass plies of the tires for passenger car of 215/50R15 specification respectively, and its results are shown in the following Table 4.

[Table 4]

Type of test		Tire 3	Tire 4
		1000D/3P Aramid cord applied	1000D/2P – 840D composite fiber cord applied
Real car driving (Field Test)		Occurrence of an accident after running 35,000 km	Occurrence of an accident after running 56,000 km
High speed driving stability[1)]		5.8	5.8
Ride comfort[1)]		6.0	6.5
Adhesion[2)]	Before driving	13.5 kg/inch	168 kg/inch
	After driving	7.5 kg/inch	12.5 kg/inch
Note) 1) Number felt by people on the basis of the perfect score of 10 (A difference of 1 point or more is a difference at a level that can be felt by regular drivers, and a difference of 0.5 or more is a difference that can be felt by sensitive drivers). 2) Driving conditions: Before and after driving 140 km/hour – 500 km			

As we can see in the results summarized in the above Table 2 and Table 4, the tires made by applying the aramid-nylon combined fiber cord of the present invention to carcass plies is superior to the tires made by applying conventional aramid cord in durability performance, riding comfort and adhesion performance but there was no big difference in high speed driving stability.

In addition, the aramid-nylon combined fiber cord of the present invention show excellent structural stability as described above when it is applied to the cap ply of tire, belt and rubber for cable sheath.

(57) Scope of claims

Claim 1

A rubber reinforced material combined fiber cord manufactured by twisting aramid ply of 500 to 2000 denier and nylon ply of 500 to 2000 denier with each other.

Claim 2

The fiber cord of Claim 1, which is composed of one ply of the aramid and one ply of the nylon, one ply of the aramid and two plies of the nylon, or two plies of the aramid and one ply of the nylon.

Drawings

FIG. 1

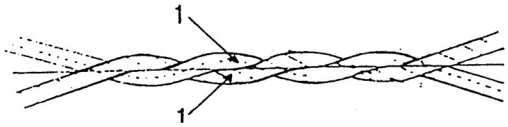


FIG. 2

FIG. 3

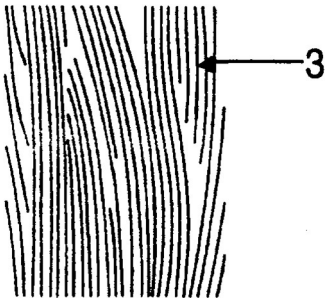


FIG. 4