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(54) **CORD COMPRISING BIO-BASED COMPONENT AND METHOD FOR PREPARING SAME**

(57) The present application relates to a hybrid cord including a bio-based nylon primarily twisted yarn. According to the present application, while including a primarily twisted yarn including bio-based nylon having a higher modulus compared to chemical-based nylon,

there is provided a hybrid cord and has elongation and fatigue resistance equivalent to or higher than commercially required levels (i.e., the level that the cord including a conventional chemical-based nylon primarily twisted yarn has).

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Description**[TECHNICAL FIELD]****CROSS-REFERENCE TO RELATED APPLICATION(S)**

[0001] This application claims the benefit of Korean Patent Application No. 10-2021-0056810 filed on April 30, 2021 and Korean Patent Application No. 10-2022-0051246 filed on April 26, 2022 in the Korean Intellectual Property Office, the contents of which are incorporated herein by reference in their entirety.

TECHNICAL FIELD

[0002] The present application relates to a cord including a bio-based component and a method for preparing the same. Specifically, the present application relates to a hybrid cord that includes a first primarily twisted yarn formed by imparting twist to a bio-nylon fiber, and a second primarily twisted yarn formed by imparting twist to a dissimilar resin fiber different from the bio-nylon, and a method for preparing the same.

[BACKGROUND ART]

[0003] A cord used as a rubber reinforcing material for automobile tires must satisfy the physical properties that can maintain the stability and durability of the tire in consideration of the driving conditions specific to the tire. For example, a tire cord must have excellent balance between physical properties such as strength, constant load elongation, elongation at break, dry heat shrinkage, and the like, and also must be able to provide excellent fatigue resistance characteristics. Particularly, since tire reinforcement materials receive relatively high loads in an environment where repeated tension and compression are applied, the strength retention rate is decreased if a cord with high modulus (i.e., relatively low elongation) is used in a fatigue environment as described above. Considering such fatigue resistance characteristics, it can be seen that on the assumption that the basic physical properties required for tire application are satisfied, having a modulus value as low as possible helps to improve the fatigue resistance performance of the cord, and consequently, it helps to improve the durability of the tire.

[0004] A cord for tire reinforcement can be prepared by twisting a component called a primarily twisted yarn, wherein the filament or fiber component included in the primarily twisted yarn can be selected in consideration of performance required for the use as a tire reinforcement material. For example, since an aramid fiber is high in modulus, and is small in the amount of change of modulus at room temperature and high temperature, it is mainly used for high-quality tires because it has an advantage in suppressing a flat spot phenomenon, which are deformed when parked for a long period of time. However, the aramid fiber is expensive and have poor fatigue resistance due to their high modulus properties. That is, in the case of a tire cord containing aramid primarily twisted yarn, it is excellent in the reinforcing properties, but there are disadvantages in that fatigue resistance or durability is not good. Therefore, a primarily twisted yarn containing nylon or polyester (e.g., PET), which has a relatively low modulus compared to aramid and is advantageous for securing fatigue resistance performance, is used together with the aramid primarily twisted yarn.

[0005] On the other hand, in the case of the primarily twisted yarn or filament used for preparing the cord, a chemical-based or artificial product generally is used. However, the chemical-based or artificial material s may cause interference with supply of raw materials when the supply and demand of the raw materials is unstable. And, with respect to the use of chemical-based or artificial materials, it has been pointed out that environmental pollution is greatly induced not only in the raw material acquisition process but also in the product (or material) preparation process.

[0006] Therefore, there is a need to develop a cord that is not only eco-friendly without being greatly affected by the supply and demand problem of synthetic raw materials, but can provide physical properties of the level equivalent to or higher than those of a conventional cord made from a chemical-based fiber.

[DETAILED DESCRIPTION OF THE INVENTION]**[Technical Problem]**

[0007] It is an object of the present application to provide an eco-friendly cord including a bio-based nylon fiber and a method for preparing the same.

[0008] It is another object of the present application to provide a cord that include a bio-based fiber and thus is not significantly affected by the supply and demand problems of synthetic raw materials.

[0009] It is yet another object of the present application to provide a cord that can provide physical properties of the level equivalent to or higher than those of a conventional cord including only chemical or synthetic fibers and a method

for preparing the same.

[0010] The above and other objects of the present application can be resolved by the inventions of the present application described in detail below.

[Technical Solution]

[0011] According to an embodiment of the present application, there is provided a cord that includes a primarily twisted yarn which is dissimilar fiber components different from each other, and one of the dissimilar fiber components is a bio-based nylon (or bio-nylon), and a method for preparing the same.

[0012] The hybrid cord of the present application can provide physical properties having commercially required level (i.e., physical properties of levels the cord including a conventional chemical-based nylon primarily twisted yarn has) in terms of properties such as strength, constant load elongation, elongation at break, dry heat shrinkage, adhesive strength, and/or fatigue resistance, etc. even while using a bio-based nylon.

[0013] Specifically, the inventor of the present application confirmed that when conventional chemical-based nylon fibers used in the preparation of hybrid tire cords are replaced with bio-nylon fibers, the bio-nylon fibers exhibit high modulus properties (i.e., low constant load elongation) as compared with chemical-based nylon fibers. When the initial modulus on the stress-strain curve pattern is high, the force received during tension and compression increases, and fatigue resistance deteriorates. Since the chemical-based nylon fiber has a lower modulus than other materials, it has an advantageous function in securing the fatigue resistance of cords and tires in a situation where tension and compression are repeated. However, when the chemical-based nylon is replaced with a bio-nylon having a relatively higher modulus, the increase in the modulus of the primarily twisted nylon yarn is disadvantageous for the hybrid cord to secure fatigue resistance characteristics. Therefore, the inventors of the present application have developed a hybrid cord that can solve the supply and demand problems of synthetic raw materials and the resulting price fluctuation problems, is eco-friendly, and can provide physical properties of the level equivalent to or higher than those of the conventional hybrid cord (including chemical-based nylon primarily twisted yarn), and completed the invention of the present application.

[0014] As used herein, the term "bio-based nylon or bio-nylon" may mean that a component used in the preparation of nylon is derived from natural resources, for example, vegetable resources. For example, the bio-based nylon may be or include PA56 or nylon 56. Although not particularly limited, the bio-based nylon can be formed, for example, by reacting with pentamethylenediamine, which is synthesized from an enzymatic reaction, a yeast reaction or a fermentation reaction from a bio-mass-based compound such as glucose or lysine, with a dicarboxylic acid.

[0015] Although not particularly limited, whether it is the bio-based nylon primarily twisted yarn may be confirmed by (radioactive) carbon dating. In the case of bio-nylon derived from bio-mass such as glucose or lysine, the half-life of the isotope is different from that of chemical-based nylon. Such measurement methods are standardized by countries or organizations around the world (e.g., ASTM (American Material Testing Association), CEN (European Standardization Commission)), and the like. In connection with the present application, in order to confirm that it is a bio-based nylon primarily twisted yarn, for example, the ASTM-D6866 method may be considered.

[0016] As used herein, the term "cord" may mean a hybrid cord including at least dissimilar fibers different from each other. For example, the cord may mean a hybrid cord including at least two or more primarily twisted yarns including dissimilar fibers different from each other. More specifically, the hybrid cord may mean that a coating agent such as an adhesive is coated onto a fiber component (plied twisted yarn), that is, a dipped cord. And, a cord including at least two dissimilar fibers in a state in which the coating agent is not coated onto the fiber component may be referred to as a raw cord. The cord or the raw cord has a plied twisted yarn structure in which at least a first primarily twisted yarn and a second primarily twisted yarn are secondarily twisted together (that is, prepared by twisting the primarily twisted yarns).

[0017] As used herein, the term "primarily twisting" means twisting a yarn or a filament in either direction, and the term "primarily twisted yarn" may mean a single ply yarn made by twisting yarn or filaments in one direction, that is, a single yarn. Although not particularly limited, the primary twisting may mean, for example, a clockwise or counterclockwise twisting.

[0018] Further, as used herein, "plied twisted yarn" may mean a yarn made by twisting two or more primarily twisted yarns together in one direction. The secondary twisting may mean twisting in a direction opposite to the twist in which the primary twisting is performed. For example, the secondary twisting may mean twisting in a counterclockwise or clockwise direction.

[0019] The primarily twisted yarn or plied twisted yarn prepared by imparting twist in any direction may have a predetermined number of twists. In this case, the "number of twists" means the number of twists per 1 m, and the unit may be TPM (Twist Per Meter).

[0020] Hereinafter, the hybrid cord of the present application and a method for preparing the same will be described in more detail.

[0021] In an embodiment according to the present application, there is provided an eco-friendly cord including a bio-based fiber. The bio-based fiber included in the cord may be referred to as a bio-based nylon fiber or a bio-nylon fiber,

and is included in the primarily twisted yarn constituting the cord.

[0022] The bio-nylon has different properties from chemical-based nylon. For example, as confirmed in Experiments described later (see Table 1), the bio-nylon has a higher modulus than the chemical-based nylon. Specifically, looking at Table 1, when the chemical-based PA66 and the bio-nylon PA56 have a fineness in the range of 700 to 1500 denier in common (in Table 1, about 845 denier), it is confirmed that the constant load elongation of the bio-nylon yarn is low. For example, within the fineness range described below, the bio-nylon yarn has a constant load elongation (4.7 Constant load elongation of cN/dtex) of 15% or less, 14% or less, or 13% or less, 12% or less, 11 % or less, 10% or less, or 9% or less as measured according to ASTM D885. The lower limit of the constant load elongation may be 5% or more, 6% or more, 7% or more, 8% or more, 9% or more, or 10% or more.

[0023] Compared to using a chemical-based nylon primarily twisted yarn in this way, use of the bio-nylon primarily twisted yarn with a relatively high modulus (low constant load elongation) is disadvantageous in securing tire fatigue resistance characteristics. In order to secure fatigue resistance characteristics of the level equivalent to or higher than that of the prior art that used the bio-nylon primarily twisted yarn while using chemical-based nylon primarily twisted yarn with a relatively low modulus, it is required to have the following cord structure.

[0024] Specifically, the cord includes a hybrid raw cord; and a coating layer formed on the hybrid raw cord. Further, the hybrid raw cord includes a first primarily twisted yarn formed by imparting twist to a bio-nylon fiber having a fineness of 600 to 2000 denier; and a second primarily twisted yarn formed by imparting twist to a dissimilar resin fiber different from the bio-nylon having a fineness of 800 to 2200 denier, wherein a twist number of the first primarily twisted yarn is in the range of 250 to 600 TPM, and wherein the hybrid raw cord contains the first primarily twisted yarn in an amount of 20 to 50% by weight relative to 100% by weight of the total weight. The hybrid raw cord provided according to the present application satisfies the strength retention rate of 90% or more after an 8-hour disk fatigue test performed according to JIS-L 1017 method of Japanese Standard Association (JSA).

[0025] The cord that reinforces the performance of the tire shows different characteristics (physical properties) depending on the thickness. A thicker cord improves the performance of the tire in terms of strength and modulus, but the thickness of the rubber that covers the top/bottom of the cord fabric becomes thicker and the size of the tire increases, which thus increases the weight. Therefore, this is unsuitable for a tire where fuel efficiency and weight reduction are important. Further, when the thickness of the cord is thin, it is advantageous for reducing the weight of the tire, but the strength and modulus are lowered, which makes it impossible to sufficiently exhibit the performance as a reinforcing material. In the present application, the fineness of the fibers forming the cord (the fineness of each fiber forming the primarily twisted yarn) is appropriately adjusted in consideration of these points.

[0026] For example, the bio-based nylon primarily twisted yarn may include a bio-based nylon fiber (filament) having a fineness of 600 to 2000 denier (de). For example, the lower limit of the fineness of the bio-based nylon fiber may be 650 denier or more, 700 denier or more, 750 denier or more, 800 denier or more, 850 denier or more, 900 denier or more, 950 denier or more, 1000 denier or more, 1050 denier or more, 1100 denier or more, 1150 denier or more, 1200 denier or more, 1250 denier or more, 1300 denier or more, 1350 denier or more, or 1400 denier or more. And, the upper limit thereof may be, for example, 1950 denier or less, 1900 denier or less, 1850 denier or less, 1800 denier or less, 1750 denier or less, 1700 denier or less, 1650 denier or less, 1600 denier or less, 1550 denier or less, 1500 denier or less, 1450 denier or less, 1400 denier or less, 1350 denier or less, 1300 denier or less, 1250 denier or less, 1200 denier or less, 1150 denier or less, 1100 denier or less, 1050 denier or less, 1000 denier or less, 950 denier or less, 900 denier or less, 850 denier or less, 800 denier or less, 750 denier or less, or 700 denier or less.

[0027] In one illustrative embodiment, the second primarily twisted yarn may include fibers (filaments) having a fineness of 800 to 2200 denier. For example, the lower limit of the fineness of the fibers used for forming the second primarily twisted yarn may be 850 denier or more, 900 denier or more, 950 denier or more, 1000 denier or more, 1050 denier or more, 1100 denier or more, 1150 denier or more, 1200 denier or more, 1250 denier or more, 1300 denier or more, 1350 denier or more, 1400 denier or more, 1450 denier or more, 1500 denier or more, 1550 denier or more, 1600 denier or more, 1650 denier or more, 1700 denier or more, 1750 denier or more, 1800 denier or more, 1850 denier or more, 1900 denier or more, 1950 denier or more, 2000 denier or more, 2050 denier or more, or 2100 denier or more. And, the upper limit thereof may be, for example, 2150 denier or less, 2100 denier or less, 2050 denier or less, 2000 denier or less, 1950 denier or less, 1900 denier or less, 1850 denier or less, 1800 denier or less, 1750 denier or less, 1700 denier or less, 1650 denier or less, 1600 denier or less, 1550 denier or less, 1500 denier or less, 1450 denier or less, 1400 denier or less, 1350 denier or less, 1300 denier or less, 1250 denier or less, 1200 denier or less, 1150 denier or less, 1100 denier or less, 1050 denier or less, 1000 denier or less, 950 denier or less, or 900 denier or less.

[0028] In a specific embodiment of the present application, the hybrid raw cord may include a first primarily twisted yarn formed by imparting twist to a bio-nylon fiber having a fineness of 700 to 1500 denier, and a second primarily twisted yarn formed by imparting twist to a dissimilar resin fiber different from the bio-nylon having a fineness of 900 to 1800 denier.

[0029] When the number of twists of each fiber forming the primarily twisted yarn is controlled within the above range, it is advantageous in securing performance (strength and modulus) as a commercially required reinforcing material in addition to reducing the weight of the tire.

[0030] The twist between the primarily twisted yarns and/or the degree of twist between the primarily twisted yarns affects the physical properties of the cord. Specifically, when the twist number of the primarily twisted yarn is too low, the strength may be increased, but the strength retention rate of the cord decreases due to the characteristics of the tire in which tension and compression are repeated. That is, the lower the number of twists, the lower the strength retention rate after fatigue. On the other hand, when the twist number of the primarily twisted yarn is high, the modulus of the cord is lowered and the elongation is higher, so that the strength retention rate after fatigue against tension/compression can be increased. However, when the number of twists is too high, the external force applied to the nylon cord by twisting increases, and the strength decreases compared to the low number of twists. In the present application, in consideration of the above points, the number of twists of each primarily twisted yarn and the number of twists between the primarily twisted yarns can be adjusted.

[0031] Specifically, the twist number (first twist number) of the first primarily twisted yarn including the bio-nylon may be 250 to 600 TPM. More specifically, the twist number of the bio-based nylon primarily twisted yarn may be 260 TPM or more, 270 TPM or more, 280 TPM or more, 290 TPM or more, 300 TPM or more, 310 TPM or more, 320 TPM or more, 330 TPM or more, 340 TPM or more, 350 TPM or more, 360 TPM or more, 370 TPM or more, 380 TPM or more, 390 TPM or more, 400 TPM or more, 410 TPM or more, 420 TPM or more, 430 TPM or more, 440 TPM or more, 450 TPM or more, 460 TPM or more, 470 TPM or more, 480 TPM or more, 490 TPM or more, 500 TPM or more, 510 TPM or more, 520 TPM or more, 530 TPM or more, 540 TPM or more, 550 TPM or more, 560 TPM or more, 570 TPM or more, 580 TPM or more or 590 TPM or more. And, the upper limit of the twist number may be, for example, 590 TPM or less, 580 TPM or less, 570 TPM or less, 560 TPM or less, 550 TPM or less, 540 TPM or less, 530 TPM or less, 520 TPM or less, 510 TPM or less, 500 TPM or less, 490 TPM or less, 480 TPM or less, 470 TPM or less, 460 TPM or less, 450 TPM or less, 440 TPM or less, 430 TPM or less, 420 TPM or less, 410 TPM or less, 400 TPM or less, 390 TPM or less, 380 TPM or less, 370 TPM or less, 360 TPM or less, 350 TPM or less, 340 TPM or less, 330 TPM or less, 320 TPM or less, 310 TPM or less, 300 TPM or less, 290 TPM or less, 280 TPM or less, 270 TPM or less, or 260 TPM or less.

[0032] The number of twists of the second primarily twisted yarn may be appropriately adjusted considering the physical properties of the cord generated through ply-twisting of the first primarily twisted yarn (formed from bio-based nylon fibers and having the same twist number as above).

[0033] In one illustrative example, the number of twists of the second primarily twisted yarn may be in the range of 250 to 600 TPM. Specifically, the twist number (second twist number) imparted to the resin fiber different from the bio-nylon for forming the second primarily twisted yarn may be 260 TPM or more, 270 TPM or more, 280 TPM or more, 290 TPM or more, 300 TPM or more, 310 TPM or more, 320 TPM or more, 330 TPM or more, 340 TPM or more, 350 TPM or more, 360 TPM or more, 370 TPM or more, 380 TPM or more, 390 TPM or more, 400 TPM or more, 410 TPM or more, 420 TPM or more, 430 TPM or more, 440 TPM or more, 450 TPM or more, 460 TPM or more, 470 TPM or more, 480 TPM or more, 490 TPM or more, 500 TPM or more, 510 TPM or more, 520 TPM or more, 530 TPM or more, 540 TPM or more, 550 TPM or more, 560 TPM or more, 570 TPM or more, 580 TPM or more, or 590 TPM or more. And, the upper limit of the twist number may be, for example, 590 TPM or less, 580 TPM or less, 570 TPM or less, 560 TPM or less, 550 TPM or less, 540 TPM or less, 530 TPM or less, 520 TPM or less, 510 TPM or less, 500 TPM or less, 490 TPM or less, 480 TPM or less, 470 TPM or less, 460 TPM or less, 450 TPM or less, 440 TPM or less, 430 TPM or less, 420 TPM or less, 410 TPM or less, 400 TPM or less, 390 TPM or less, 380 TPM or less, 370 TPM or less, 360 TPM or less, 350 TPM or less, 340 TPM or less, 330 TPM or less, 320 TPM or less, 310 TPM or less, 300 TPM or less, 290 TPM or less, 280 TPM or less, 270 TPM or less, or 260 TPM or less.

[0034] In one illustrative example, the twist number of the bio-nylon primarily twisted yarn (the first twist number) and the twist number of the second primarily twisted yarn (the second twist number) may be the same or different. In order to impart the number of twists as described above, for example, a CC twist machine (Cable Corder Twist machine) or a ring twister can be used, wherein the number of twists for each primarily twisted yarn being the same means that the number of twists for each primarily twisted yarn is set to be the same when using the device. However, depending on the equipment or process conditions (e.g., annealing in the drying stage after dipping in an adhesive solution), a difference in the number of twists may occur within about 15%, within 10%, or within 5% of the set value.

[0035] In one illustrative example, the hybrid raw cord can be formed by secondary twisting the first primarily twisted yarn and the second primarily twisted yarn within a range of 250 to 600 TPM. For example, when the above-mentioned first and second primarily twisted yarns are secondarily twisted together, the twist number (third twist count) may be 260 TPM or more, 270 TPM or more, 280 TPM or more, 290 TPM or more, 300 TPM or more, 310 TPM or more, 320 TPM or more, 330 TPM or more, 340 TPM or more, 350 TPM or more, 360 TPM or more, 370 TPM or more, 380 TPM or more, 390 TPM or more, 400 TPM or more, 410 TPM or more, 420 TPM or more, 430 TPM or more, 440 TPM or more, 450 TPM or more, 460 TPM or more, 470 TPM or more, 480 TPM or more, 490 TPM or more, 500 TPM or more, 510 TPM or more, 520 TPM or more, 530 TPM or more, 540 TPM or more, 550 TPM or more, 560 TPM or more, 570 TPM or more, 580 TPM or more, or 590 TPM or more. And, the upper limit thereof may be, for example, 590 TPM or less, 580 TPM or less, 570 TPM or less, 560 TPM or less, 550 TPM or less, 540 TPM or less, 530 TPM or less, 520 TPM or less, 510 TPM or less, 500 TPM or less, 490 TPM or less, 480 TPM or less, 470 TPM or less, 460 TPM or less, 450

TPM or less, 440 TPM or less, 430 TPM or less, 420 TPM or less, 410 TPM or less, 400 TPM or less, 390 TPM or less, 380 TPM or less, 370 TPM or less, 360 TPM or less, 350 TPM or less, 340 TPM or less, 330 TPM or less, 320 TPM or less, 310 TPM or less, 300 TPM or less, 290 TPM or less, 280 TPM or less, 270 TPM or less, or 260 TPM or less.

[0036] In one illustrative embodiment, the number of twists of the first and second primarily twisted yarns (i.e., the number of twists at the primary twisting) and the number of twists at the secondary twisting may be the same or different. In a specific embodiment of the present application, the number of twists at the time of primary twisting and the number of twists at the time of secondary twisting may be set to be the same. However, in some cases, the number of twists at the time of primary twisting and the number of twists at the time of secondary twisting may be slightly different in the final product. Specifically, in the case of a CC twist machine (Cable Corder Twist machine) used in the preparation of the cord, it is driven by one motor. The yarn in the creel passes through the disk connected to the motor and is connected to a regulator (a section where the primarily twisted yarn and primarily twisted yarn meet to perform secondary twisting). The yarn at the port passes through a tension adjusting guide roll and is connected to a regulator. At this time, due to the rotation of the motor, the regulator to which the yarn coming out of the disk is connected is also rotated. As a result of such mechanical motion, the primary twisting is applied to the creel part yarn and the port part yarn connected by the rotation of the motor. In the regulator, the primarily twisted yarns are secondarily twisted together. In this manner, the raw cord is prepared while a twisting occurs due to the rotational motion of the motor. Even when the twist numbers of the primary twisting and the secondary twisting are imparted (set) to be the same, the twist numbers of the primary twisting and the secondary twisting may be different due to friction generated by the winding tension or guide rollers.

[0037] When the number of twists of the primarily twisted yarn and/or the number of twists between the primarily twisted yarns are controlled within the above range, it may be advantageous to secure physical properties having commercially required levels (i.e., physical properties of levels the cord including a conventional chemical-based nylon primarily twisted yarn has) in relation to properties such as strength, constant load elongation, elongation at break, dry heat shrinkage, adhesive strength, and/or fatigue resistance.

[0038] As described above, the cord includes a first primarily twisted yarn and a second primarily twisted yarn having a predetermined number of twists, and is formed by twisting the first primarily twisted yarn and the second primarily twisted yarn together. At this time, the filament for forming the first primarily twisted yarn and the filament for forming the second primarily twisted yarn are simultaneously primarily twisted by a CC twist machine (e.g., cable corder twist machine) or a ring twister, thereby forming a first primarily twisted yarn and a second primarily twisted yarn. Therefore, a twisting direction (first twisting direction) of the first primarily twisted yarn may be the same as a twisting direction (second twisting direction) of the second primarily twisted yarn. And, when using a CC twist machine (e.g., cable corder twist machine) or a ring twister, subsequent to the primary twisting, the secondary twisting can be performed continuously at the same time as the primary twisting, wherein the twisting direction of the secondary twisting (i.e., third twisting direction) may be opposite to the first twisting direction (or second twisting direction).

[0039] The content of the primarily twisted yarn in the cord affects the characteristics of the cord. For example, when the content of aramid is high, the high-speed driving performance of the tire can be improved due to the high modulus, but fatigue performance is lowered because it receives a lot of load for the same deformation. Further, when the content of nylon is large, the modulus of the initial part of the stress-strain curve pattern indicating the physical properties of the cord is low, and thus the fatigue resistance performance is increased by receiving less load for the same deformation, but the overall power to support the tires is insufficient, and the effect on driving performance is low. In the present application, the content of the primarily twisted yarn can be adjusted in consideration of the above points.

[0040] In a specific embodiment of the present application, the hybrid raw cord may include 20 to 50 % by weight of the first primarily twisted yarn relative to 100% by weight of the total weight of the raw cord. Specifically, the lower limit of the content of the first primarily twisted yarn may be, for example, 20% by weight or more, specifically 25% by weight or more, or 30% by weight or more, more specifically 31 % by weight or more, 32 % by weight or more, 33 % by weight or more, 34 % by weight or more, 35 % by weight or more, 36 % by weight or more, 37 % by weight or more, 38 % by weight or more, 39 % by weight or more, 40 % by weight or more, 41 % by weight or more, 42 % by weight or more, 43 % by weight or more, 44 % by weight or more or 45 % by weight or more. And, the upper limit thereof may be, for example, 50 % by weight or less, specifically 49 % by weight or less, 48 % by weight or less, 47 % by weight or less, 46 % by weight or less, 45 % by weight or less, 44 % by weight or less, 43 % by weight or less, 42 % by weight or less, 41 % by weight or less or 40 % by weight or less.

[0041] In the raw cord, the content of the remaining primarily twisted yarn (second primarily twisted yarn, etc.) that is secondarily twisted together with the first primarily twisted yarn can be appropriately adjusted at a level that does not impair the above-mentioned described purposes of the present application. For example, when the raw cord is prepared by twisting a first primarily twisted yarn and a second primarily twisted yarn, the content of the second primarily twisted yarn in the raw cord may be the content excluding the content of the first primarily twisted yarn described above, that is, 50 to 80% by weight. A more specific content of the second primarily twisted yarn can be determined depending on the above-described content of the first primarily twisted yarn.

[0042] When the content of the primarily twisted yarn in the cord is controlled within the above-mentioned range, it is

advantageous in securing physical properties having commercially required levels (that is, physical properties of levels the cord including the conventional chemical-based nylon primarily twisted yarn has) and ensuring a balance between driving performance and fatigue resistance.

[0043] The type of the dissimilar resin fiber used for forming the second primarily twisted yarn may be selected from a level that does not impair the purpose of the present application. For example, the second primarily twisted yarn may include at least one of polyester fibers, aromatic polyamide fibers, and polyketone fibers.

[0044] In one illustrative embodiment, the second primarily twisted yarn may include aramid fibers. That is, the second primarily twisted yarn may be formed by imparting twist to the aramid fiber, and the hybrid cord of the present application may include a nylon primarily twisted yarn (first primarily twisted yarn) and an aramid primarily twisted yarn (second primarily twisted yarn). Aramid showing a high modulus has little change in modulus at room temperature and high temperature, and thus, it is excellent in suppressing a flat spot phenomenon where the tire deforms when parked for a long period of time, and is an advantageous material for providing high-quality tires.

[0045] In one illustrative embodiment, the cord may be a two-ply or three-ply cord. For example, the cord may have a two-ply structure in which one strand of the first primarily twisted yarn having the above-mentioned fineness and one strand of the second primarily twisted yarn having the above-mentioned fineness are secondarily twisted together. Alternatively, the cord may have a three-ply structure in which one strand of the first primarily twisted yarn having the above-mentioned fineness and two strands of the second primarily twisted yarns having the above-described fineness are secondarily twisted together.

[0046] In a specific embodiment of the present application, the cord may be one in which the fineness and/or the number of twists of each of the primarily twisted yarns are specified.

[0047] In one illustrative embodiment, the first primarily twisted yarn is formed by imparting twist to a bio-nylon fiber having a fineness of 750 to 1100 denier, and the second primarily twisted yarn may be formed by imparting twist to a dissimilar resin fiber different from the bio-nylon having a fineness of 900 to 1200 denier. At this time, the number of twists of the first primarily twisted yarn may be, for example, 300 TPM or more, and the upper limit thereof can be adjusted within the above-mentioned range. The specific fineness can also be adjusted within the above-mentioned range.

[0048] In another illustrative embodiment, the first primarily twisted yarn is formed by imparting twist to a bio-nylon fiber having a fineness of 1100 to 1500 denier, and the second primarily twisted yarn may be formed by imparting twist to a dissimilar resin fiber different from the bio-nylon having a fineness of 1200 to 1800 denier. At this time, the number of twists of the first primarily twisted yarn may be, for example, 400 TPM or less, and the upper limit can be adjusted within the above-mentioned range. The specific fineness can also be adjusted within the above-mentioned range.

[0049] When the second primarily twisted yarn used together with the bio-nylon primarily twisted yarn which is the first primarily twisted yarn according to an embodiment of the present application includes an aramid fiber, the length ratio of the second primarily twisted yarn to the first primarily twisted yarn (length of the second primarily twisted yarn (L_2)/the length of the first primarily twisted yarn (L_1)) may be in the range of 1.0 to 1.10 times. At this time, the length ratio of the second primarily twisted yarn to the first primarily twisted yarn is measured after untwisting the secondary twisting for the plied twisted yarns (raw cord or dipped cord). This is for making the second primarily twisted yarn (aramid primarily twisted yarn) having a higher modulus longer to lower the initial modulus of the cord, and thus improving the fatigue performance of the cord.

[0050] When the ratio of the length of the second primarily twisted yarn to the first primarily twisted yarn (the length of the second primarily twisted yarn (L_2)/the length of the first primarily twisted yarn (L_1)) is less than 1.0, the aramid with high modulus becomes shorter, and the modulus of the initial part becomes higher in the stress-strain curve pattern indicating the tensile properties of the cord, so that the cord receives more load in the same deformation, and ultimately the fatigue resistance performance is lowered. And, when the ratio of the length of the second primarily twisted yarn to the first primarily twisted yarn (the length of the second primarily twisted yarn (L_2)/the length of the first primarily twisted yarn (L_1)) exceeds 1.10, aramid and nylon are subjected to separate forces under cord tension, which may reduce the strength of the final cord.

[0051] Specifically, the lower limit of the ratio may be, for example, 1.01 or more, 1.02 or more, 1.03 or more, 1.04 or more, or 1.05 or more, and the upper limit thereof may be, for example, 1.09 or less, 1.08 or less, 1.07 or less, 1.06 or less, or 1.05 or less.

[0052] In a specific embodiment of the present application, the length ratio control as described above can be achieved by adjusting the amount of tension applied to each of the filaments forming the first primarily twisted yarn and the filaments forming the second primarily twisted yarn, during the primary twisting and/or secondary twisting process for preparing the cord. More specifically, when the primary twisting and secondary twisting are performed, the magnitude of the tension applied to the aramid fiber (forming the second primarily twisted yarn) is made smaller than the tension applied to the bio-nylon fiber forming the first primarily twisted yarn, so that the length of the second primarily twisted yarn can be made longer than the length of the first primarily twisted yarn.

[0053] The coating layer formed on the raw cord means a layer formed from a coating solution capable of exhibiting a predetermined function. Such a coating layer may be formed on at least a portion of the above-mentioned primarily

twisted yarn. The method of forming the coating layer is not particularly limited, and for example, the coating layer can be formed through a known dipping or spraying method.

[0054] The coating layer may be configured to impart predetermined characteristics to the cord or to reinforce the characteristics of the cord. For example, the coating layer may be a layer capable of imparting an adhesive function to the cord, but the characteristics imparted or reinforced by the coating layer are not limited only to the adhesive function.

[0055] In one illustrative embodiment, the coating layer may be formed from an adhesive (composition). For example, the coating layer may include or be formed from a resorcinol formaldehyde latex (RFL) adhesive (composition), an epoxy adhesive (composition), or a urethane adhesive (composition). However, the adhesive component forming the coating layer is not limited to those described above.

[0056] Although not particularly limited, the adhesive composition may include an aqueous or non-aqueous solvent. This adhesive allows the fiber cord to exhibit improved adhesion to other adjacent constructions in tire reinforcement applications.

[0057] The hybrid cord having the configuration as above can provide physical properties having commercially required level (i.e., physical properties of levels the cord including a conventional chemical-based nylon primarily twisted yarn has). Such physical properties include, for example, strength, constant load elongation, elongation at break, dry heat shrinkage, adhesive strength, and fatigue resistance. In particular, since the hybrid cord of the present application is constructed and prepared so as to complement the high modulus properties of the bio-nylon primarily twisted yarn, it is possible to prevent deterioration of the expected cord elongation and fatigue resistance by using a bio-nylon primarily twisted yarn having a high modulus.

[0058] In one illustrative embodiment, the strength of the hybrid cord may be 20 kgf or more. Specifically, the strength may be, for example, 21 kgf or more, 22 kgf or more, 23 kgf or more, 24 kgf or more, or 25 kgf or more. The strength is a level similar to the strength that a cord including a conventional chemical-based nylon primarily twisted yarn has. The strength can be measured according to a method described later.

[0059] In one illustrative embodiment, the constant load elongation (% , @4.5 kg) of the hybrid cord may be 2.8% or more. For example, the constant load elongation may be 2.9 % or more, 3.0 % or more, 3.1 % or more, 3.2 % or more, 3.3 % or more, 3.4% or more, 3.5 % or more, 3.6% or more, 3.7 % or more, 3.8 % or more, 3.9 % or more, 4.0 % or more, 4.1 % or more, 4.2 % or more, 4.3 % or more, 4.4 % or more, 4.5 % or more, 4.6 % or more, 4.7 % or more, 4.8 % or more, 4.9 % or more or 5.0 % or more. The corresponding constant load elongation is a level equivalent to or higher than the constant load elongation possessed by the cord including a conventional chemical-based nylon primarily twisted yarn. The constant load elongation can be measured according to a method described later.

[0060] The constant load elongation may be adjusted or changed according to the number of twists. For example, when the number of twists in the cord is low, the modulus is exhibited highly during the tensile test, which causes a reduction of the constant load elongation. Having high modulus when the number of twists is low is caused by the structural characteristics of the cord. This is because the lower the number of twists in the cord length direction, the more diagonal lines due to the twist are erected in the cord length direction, and the maximum force is received faster, thereby increasing the overall modulus.

[0061] In one illustrative embodiment, the elongation at break (%) of the hybrid cord may be 7.0% or more. For example, the elongation at break may be 7.1 % or more, 7.2 % or more, 7.3 % or more, 7.4 % or more, 7.5 % or more, 7.6 % or more, 7.7 % or more, 7.8 % or more, 7.9 % or more, 8.0% or more, 8.1 % or more, 8.2 % or more, 8.3 % or more, 8.4 % or more, 8.5 % or more, 8.6 % or more, 8.7 % or more, 8.8 % or more, 8.9 % or more, 9.0 % or more, 9.1 % or more, 9.2 % or more, 9.3 % or more, 9.4 % or more, 9.5 % or more, 9.6 % or more, 9.7 % or more, 9.8 % or more, 9.9 % or more or 10% or more. The elongation at break is a level equivalent to or higher than the constant load elongation of a cord including a conventional chemical-based nylon primarily twisted yarn. The elongation at break can be measured according to a method described later.

[0062] The elongation at break can be adjusted or changed according to the number of twists. For example, the higher the twist, the lower the modulus, whereby the S-S curve pattern (stress-strain curve pattern) is more inclined, and consequently may show that the elongation at break is higher.

[0063] In one illustrative embodiment, the dry heat shrinkage rate of the hybrid cord may be 1.2% or more. For example, the dry heat shrinkage rate may be 1.3% or more, 1.4% or more, 1.5% or more, 1.6% or more, 1.7% or more, 1.8% or more, 1.9% or more, or 2.0% or more. The dry heat shrinkage rate is a level similar to the dry heat shrinkage rate of a cord including a conventional chemical-based nylon primarily twisted yarn. The dry heat shrinkage rate can be measured according to a method described later.

[0064] In one illustrative embodiment, the adhesive strength of the hybrid cord may be 12.5 kgf or more. For example, the adhesive strength may be 12.6 kgf or more, 12.7 kgf or more, 12.8 kgf or more, 12.9 kgf or more, 13.0 kgf or more, 13.1 kgf or more, 13.2 kgf or more, 13.3 kgf or more, 13.4 kgf or more, 13.5 kgf or more, 13.6 kgf or more, 13.7 kgf or more, 13.8 kgf or more, 13.9 kgf or more, or 14.0 kgf or more. The adhesive strength is a level similar to the adhesive strength possessed by the cord including a conventional chemical-based nylon primarily twisted yarn. The adhesive strength can be measured according to a method described later.

[0065] In one illustrative embodiment, the strength retention rate after 8-hour fatigue of the hybrid cord may be 90% or more. For example, the strength retention rate after 8-hour fatigue may be 90.5% or more, 91.0% or more, 91.5% or more, 92.0% or more, 92.5% or more, or 93.0% or more. The strength retention rate after 8-hour fatigue as described above is a level equivalent to or higher than the strength retention ratio after 8-hour fatigue of a cord including a conventional chemical-based nylon primarily twisted yarn. The strength retention rate after 8-hour fatigue can be measured according to a method described later.

[0066] In one illustrative embodiment, the strength retention rate after 16-hour fatigue of the hybrid cord may be 70% or more. For example, the strength retention rate after 16-hour fatigue may be 70.5 % or more, 71.0 % or more, 71.5 % or more, 72.0 % or more, 72.5 % or more, 73.0 % or more, 73.5 % or more, 74.0 % or more, 74.5 % or more, 75.0 % or more, 75.5 % or more, 76.0 % or more, 76.5 % or more, 77.0 % or more, 77.5 % or more, 78.0 % or more, 78.5 % or more, 79.0 % or more, 79.5 % or more or 80.0 % or more. The strength retention rate after 16-hour fatigue as described above is a level equivalent to or higher than the strength retention rate after 16 hour-fatigue of a cord including a conventional chemical-based nylon primarily twisted yarn. The strength retention rate after 16-hour fatigue can be measured according to a method described later.

[0067] In the specific embodiment of the present application, the characteristics of the hybrid cord may differ depending on the configuration of the cord.

[0068] For example, in one specific embodiment of the hybrid cord of the present application, the first primarily twisted yarn is formed by imparting twist to a bio-nylon fiber having a fineness of 750 to 1100 denier, the second primarily twisted yarn is formed by imparting twist to a dissimilar resin fiber different from the bio-nylon having a fineness of 900 to 1200 denier, and the plied twisted yarn in which the number of twists of the first primarily twisted yarn is, for example, 350 TPM or more and 400 TPM or less can be used. In this case, the constant load elongation of the cord may be, for example, 3.8 % or more, 3.9 % or more, 4.0 % or more, 4.1 % or more, 4.2 % or more, 4.3 % or more, 4.4 % or more, 4.5 % or more, 4.6 % or more, 4.7 % or more, 4.8 % or more, 4.9 % or more or 5.0 % or more. Further, the elongation at break of the cord may be, for example, 8.5 % or more, 8.6 % or more, 8.7 % or more, 8.8 % or more, 8.9 % or more, 9.0 % or more, 9.1 % or more, 9.2 % or more, 9.3 % or more, 9.4 % or more, 9.5 % or more, 9.6 % or more, 9.7 % or more, 9.8 % or more, 9.9 % or more or 10 % or more. And, in the case of the above cord, the strength retention rate after 8-hour fatigue may be 91.0 % or more, 91.5 % or more, 92.0 % or more, 92.5 % or more or 93.0 % or more, and the strength retention rate after 16-hour fatigue may be 75.0 % or more, 75.5 % or more, 76.0 % or more, 76.5 % or more, 77.0 % or more, 77.5 % or more, 78.0 % or more, 78.5 % or more, 79.0 % or more, 79.5 % or more or 80.0 % or more.

[0069] In another specific embodiment of the hybrid cord of the present application, the first primarily twisted yarn is formed by imparting twist to a bio-nylon fiber having a fineness of 750 to 1100 denier, and the second primarily twisted yarn is formed by imparting twist to a resin fiber different from a bio nylon having a fineness of 900 to 1200 denier, and the plied twisted yarn in which the number of twists of the first primarily twisted yarn may be, for example, 300 TPM or more and less than 350 TPM can be used. In this case, the constant load elongation of the cord may be, for example, 2.8 % or more, 2.9 % or more, 3.0 % or more, 3.1 % or more, 3.2 % or more, 3.3 % or more, 3.4 % or more, 3.5 % or more, 3.6 % or more, 3.7 % or more, 3.8 % or more, 3.9 % or more or 4.0 % or more. Further, the elongation at break of the cord may be, for example, 7.0% or more, 7.1% or more, 7.2% or more, 7.3% or more, 7.4% or more, 7.5% or more, 7.6% or more, 7.7% or more, 7.8% or more, 7.9% or more, 8.0% or more, 8.1% or more, 8.2% or more, 8.3% or more, 8.4% or more, 8.5% or more, 8.6% or more, 8.7% or more, 8.8% or more, 8.9% or more, or 9.0% or more. And, in the case of the plied twisted yarn as described above, the strength retention rate after 8 hour-fatigue may be 90% or more, 90.5% or more, or 91.0% or more, and the strength retention rate after 16 hour-fatigue may be 70% or more, 70.5% or more, 71.0% or more, 71.5% or more, 72.0% or more, 72.5% or more, 73.0% or more, 73.5% or more, 74.0% or more, 74.5% or more, or 75.0% or more.

[0070] In yet another embodiment according to the present application, there is provided a method for preparing an eco-friendly cord including a bio-based fiber. Specifically, the method may be a method for preparing the above-mentioned cord.

[0071] In the case of fibers, for example, synthetic fibers produced through a heat melting process, in order to exhibit the strength and modulus properties suitable for the application, heat setting can be performed so that the molecular chains are well oriented in the fiber length direction. On the other hand, when the heat-set fiber receives a temperature above the glass transition temperature, it returns to its original curly shape, but in this case, the modulus is lowered. In this regard, when a low tension is applied during heat treatment for preparing a dip cord, the molecular chain returns to its original shape and the modulus is lowered. When a high tension is applied, the molecular chains are maintained in an oriented state or are further oriented, thereby increasing the modulus. The inventors of the present application controlled the tension applied to the plied twisted yarn having the above structure to a predetermined range at the time of forming the coating layer in consideration of the heat characteristics of the fiber and the dip cord preparation process described above.

[0072] Specifically, the method includes a step of preparing a plied twisted yarn (or plied yarn) in which a first primarily twisted yarn formed by imparting twist to a bio-nylon fiber having a fineness of 600 to 2000 denier and a second primarily

twisted yarn formed by imparting twist to a dissimilar resin fiber different from the bio-nylon having a fineness of 800 to 2200 denier are secondarily twisted together, and a step of forming a coating layer on the plied twisted yarn while applying a tension to the plied twisted yarn. At this time, a tension applied to the plied twisted yarn is 1.0 kg/cord or less. And, a twist number imparted to the first primarily twisted yarn is in the range of 250 to 600 TPM, and the hybrid raw cord includes the first primarily twisted yarn in an amount of 20 to 50% by weight relative to 100% by weight of the total weight. The hybrid cord prepared according to the above method satisfies a strength retention rate of 90% or more after an 8-hour disk fatigue test performed according to JIS-L 1017 method of Japanese Standard Association (JSA).

[0073] In one illustrative embodiment, the tension applied to the plied twisted yarn may be 0.1 kg/cord or more, 0.2 kg/cord or more, 0.3 kg/cord or more, 0.4 kg/cord or more, 0.5 kg/cord or more, 0.6 kg/cord or more, 0.7 kg/cord or more, 0.8 kg/cord or more or 0.9 kg/cord or more. And, the upper limit thereof may be, for example, 0.9 kg/cord or less, 0.8 kg/cord or less, 0.7 kg/cord or less, 0.6 kg/cord or less, 0.5 kg/cord or less, 0.4 kg/cord or less, 0.3 kg/cord or less or 0.2 kg/cord or less.

[0074] As described above, the method includes a step of forming a coating layer on the plied twisted yarn while applying tension to the plied twisted yarn (raw cord) including the bio-based nylon primarily twisted yarn. At this time, the 'forming a coating layer' may mean that the coating composition (coating solution) is applied onto the raw cord. The applied coating composition may be subjected to heat treatment such as drying or curing described later. In this case, the coating layer may mean a layer obtained through heat treatment.

[0075] The method of applying the coating composition (coating solution) onto the raw cord is not particularly limited, and for example, dipping or spraying can be used. For example, the method may include spraying a coating layer forming composition (coating solution) on the plied-twisted yarn (raw cord). That is, in the method, the coating layer can be formed by spraying the coating layer forming composition (coating solution) onto the plied twisted yarn. In another embodiment, the method may include a step of dipping the plied twisted yarn (raw cord) in the coating layer forming composition (coating solution). That is, in the method, the coating layer can be formed by dipping the plied twisted yarn in the coating layer forming composition (coating solution). When the plied twisted yarn is dipped in the coating composition (coating solution), a specific method of dipping the plied twisted yarn into the coating composition is not particularly limited. For example, a method can be used in which the plied twisted yarn is dipped in a coating bath filled with the coating composition while transferring the plied twisted yarn or a fiber base including the same using a roll can be used. The cord coated with the coating composition after dipping may be referred to as a dip cord.

[0076] In one illustrative example, the forming the coating layer may be performed through transferring the cord, applying (spraying or dipping) a coating composition to the cord and/or subjecting to a subsequent heat treatment. For examples, the step (process) of forming the coating layer while applying tension may include one or more steps of transferring the cord, dipping (or spraying) and heat treatment. Specifically, the step (process) of forming a coating layer performed while applying tension may include heat-treating the plied twisted yarn to which the coating composition has already been applied while applying a tension of the above-mentioned size thereto; (while applying a tension of the above size) applying the coating composition to the plied twisted yarn and heat treating; or (while applying a tension of the above size) transferring the plied twisted yarn, applying the coating composition, and performing heat treatment.

[0077] In a specific embodiment of the present application, the heat treatment may be performed at a temperature within a predetermined range. For example, the heat treatment may be performed at a temperature of 50°C or more, specifically, at a temperature in the range of 60 to 350°C. Although not particularly limited, the heat treatment can be performed for 10 to 300 seconds.

[0078] In one illustrate embodiment, the method may include two times or more of heat treatment steps. Specifically, the method includes a first heat treatment step performed at a temperature of 60 to 220°C; and a second heat treatment step performed at a temperature of 200 to 350°C. The time period during which the heat treatment is performed is not particularly limited, but, for example, each of these heat treatments may be performed for about 10 to 300 seconds.

[0079] In one illustrative embodiment, the temperature at which the first heat treatment is performed may be lower than the temperature at which the second heat treatment is performed. Specifically, the first heat treatment temperature may be in the range of 70 to 180°C, and the second heat treatment temperature may be in the range of 200 to 300 °C. In this case, the first heat treatment performed at a relatively low temperature may be referred to as a drying process, and the second heat treatment performed at a relatively high temperature may be referred to as a curing process.

[0080] In one illustrative example, the step (process) of forming a coating layer performed while applying the tension may be used in a sense including heat-treating the plied twisted yarn to which the coating composition has been applied while applying a tension of the above-described size. More specifically, the step (process) of forming a coating layer performed while applying the tension can be used as the meaning of performing a second heat treatment while applying a tension of the above-mentioned magnitude to the ply-twisted yarn performed up to the first heat treatment after the coating composition is applied. Because high-temperature heat treatment, especially the second heat treatment, greatly affects the final physical properties of the cord, it is important to satisfy the above-mentioned tension range. Therefore, the tension in the above-mentioned range can be maintained during at least the heat treatment, more specifically the second heat treatment, and, in this case, the tension applied to the transfer, dipping (or spray) for forming the coating

layer and the first heat treatment may be the same to or different (slightly changed) from the above-mentioned tension range.

[0081] In one illustrative example, the dipping or spraying may be performed one or more times. When dipping or spraying is performed once or more, the components of the coating composition used for each dipping or spraying may be the same or different.

[0082] For example, the first dipping, the second dipping, and the heat treatment may be sequentially performed. In this case, the heat treatment may sequentially include a first heat treatment (e.g., drying) and/or a second heat treatment (e.g., curing).

[0083] In another embodiment, the first dipping, heat treatment, second dipping and heat treatment may be sequentially performed. In this case, the heat treatment performed between the first dipping and the second dipping may be a drying process performed at a relatively low temperature, and the heat treatment performed after the second dipping may be a curing process performed at a relatively high temperature.

[0084] In one illustrative embodiment, the method may be a method in which a bio-based nylon fiber (filament) is primarily twisted in a first twisting direction to produce a first primarily twisted yarn, and at the same time, a dissimilar fiber (filament) is primarily twisted in a second twisting direction to produce a second primarily twisted yarn.

[0085] In one illustrative embodiment, the method may be a method of preparing a plied twisted yarn by twisting the first and second primarily twisted yarns in a third twisting direction after or simultaneously with the preparation of the primarily twisted yarn as described above. In this case, the first twisting direction and the second twisting direction may be the same, and the first twisting direction and the third twisting direction may be different from each other.

[0086] According to a specific embodiment of the present application, a twisting machine that simultaneously performs primary twisting and secondary twisting, such as a cable corder, may be used in the preparation of a plied twisted yarn. For example, in the case of preparing a hybrid cord, since the first primarily twisted yarn forming filament (bio-based nylon filament yarn) and the second primarily twisted yarn forming filament (e.g., aramid, etc.) are simultaneously primarily twisted by one twisting machine (e.g., cable corder), respectively, while the first primarily twisted yarn and the second primarily twisted yarn is formed, a twisting direction of the first primarily twisted yarn (first twisting direction) may be the same as a twisting direction of the second primarily twisted yarn (second twisting direction). In addition, according to a specific embodiment of the present application performed using a twisting machine such as a cable corder that can perform primary twisting and secondary twisting at the same time, the secondary twisting can be continuously performed at the same time as the primary twisting. The twisting direction of the secondarily twisting (i.e., the third twisting direction) may be opposite to the first twisting direction (or second twisting direction).

[0087] In one illustrative embodiment, the method may be a method of forming the second primarily twisted yarn by imparting a twist number within the range of 250 to 600 TPM to the fibers (filaments) forming the second primarily twisted yarn. That is, the number of twists imparted to the second primarily twisted yarn is in the range of 250 to 600 TPM.

[0088] In one illustrative embodiment, the method may include secondarily twisting the first primarily twisted yarn and the second primarily twisted yarn with a twist number within a range of 250 to 600 TPM to form a plied twisted yarn.

[0089] In one illustrative embodiment, the method may include imparting twist to a bio-nylon fiber having a fineness of 750 to 1100 denier to form a first primarily twisted yarn, and imparting twist to a dissimilar resin fiber different from the bio-nylon having a fineness of 900 to 1200 denier to form a second primarily twisted yarn. At this time, the number of twists imparted to the first primarily twisted yarn may be 300 TPM or more, and the upper limit can be adjusted within the above-mentioned range. The specific fineness can also be adjusted within the above-mentioned range.

[0090] In one illustrative embodiment, the method may include imparting twist to a bio-nylon fiber having a fineness of 1100 to 1500 denier to form the first primarily twisted yarn, and imparting twist to a dissimilar resin fiber different from the bio-nylon having a fineness of 1200 to 1800 denier to form a second primarily twisted yarn. At this time, the number of twists of the first primarily twisted yarn may be, for example, 400 TPM or less, and the upper limit can be adjusted within the above-mentioned range. The specific fineness can also be adjusted within the above-mentioned range.

[0091] In a specific embodiment of the present application, the second primarily twisted yarn used together with the bio-nylon primarily twisted yarn which is the first primarily twisted yarn may include aramid fibers. In this case, the method may be a method of controlling the magnitude of the tension applied to the aramid fiber (forming a second primarily twisted yarn) to be smaller than the tension applied to the bio-nylon fiber (forming a first primarily twisted yarn) when the primary twisting and/or secondary twisting are performed. Through this, the length ratio of the second primarily twisted yarn to the first primarily twisted yarn (length of the second primarily twisted yarn (L_2)/the length of the first primarily twisted yarn (L_1)) measured after the secondary twisting is untwisted with respect to the plied twisted yarn (raw cord or dipped cord) can be adjusted in the range of 1.0 to 1.10 times.

[0092] In relation to the preparation method of the present application, in addition to the above description, the description of the configuration, characteristics, and preparation of the cord and the primarily twisted yarn forming the same are the same as those described in the hybrid cord, and thus will be omitted.

[0093] As described above, the plied twisted yarn (raw cord) formed including the bio-based nylon primarily twisted yarn has poor physical property balance due to the characteristics of the bio-based nylon yarn with a low constant load

elongation (i.e., high modulus) (e.g., strength properties after fatigue are not good). However, as described above, the method of the present application for controlling the properties of the fibers (e.g., the type of fibers, the number of twists, fineness, content, etc.) and the tension when forming the coating layer within a predetermined range can provide elongation characteristics and a strong retention rate after fatigue having the level equivalent to or higher than a conventional cord including a chemical-based nylon primarily twisted yarn, while using a bio-based nylon primarily twisted yarn having a high modulus.

[0094] In another embodiment according to the present application, there is provided a rubber composite or rubber reinforcing material including the cord. The rubber composite or the rubber reinforcing material may further include a rubber substrate such as a rubber sheet in addition to the above-mentioned cord.

[0095] In another embodiment according to the present application, there is provided a tire including the cord. The tire may have a generally known configuration such as a tread, shoulder, sidewall, cap ply, belt, carcass (or body ply), inner liner, bead, and the like.

[Advantageous Effects]

[0096] According to the present application, a hybrid cord that includes a bio-based nylon primarily twisted yarn, and meets the commercially required level of physical properties in terms of strength, constant load elongation, elongation at break, dry heat shrinkage, adhesive strength, and/or fatigue resistance. In particular, the present application has the inventive effect of providing a hybrid cord having elongation and fatigue resistance properties equivalent to or higher than commercially required levels (i.e., the level that the cord containing a conventional chemical-based nylon primarily twisted yarn has), while including a primarily twisted yarn including bio-based nylon having a higher modulus compared to chemical-based nylon.

[DETAILED DESCRIPTION OF THE EMBODIMENTS]

[0097] Hereinafter, the actions and effects of the invention will be described more specifically with reference to specific examples of the present disclosure. However, the examples are for illustrative purposes only, and are not intended to limit the scope of rights of the invention in any sense.

<Experiment 1: Evaluation of physical properties of yarn>

[0098] The physical properties of Chemical Nylon and Bio-based Nylon yarn measured according to ASTM D885 were compared and evaluated as follows. An Instron testing machine (Instron Engineering Corp., Canton, Mass) was used to measure the tensile physical properties, and Testrite was used to measure hot air shrinkage, and an oven and Instron testing machine were used to measure heat resistance strength retention rate.

[Table 1]

	Chemical Nylon PA 66	Bio-based Nylon PA 56
Fineness (detex)	About 940±18	938
Breaking strength (N)	≥ 78.0	≥ 79.7
Tenacity (cN/dtex)	≥ 8.3	≥ 8.5
Elongation at break (%)	19.0±3.0	18.4
Constant load elongation (4.7 Constant load elongation of cN/ dtex) (%)	12.0±1.5	10.1
Hot air shrinkage (177°C*2min) (%)	6.2±1.5	7.2
Heat resistance strength retention rate (180°C*4h) (%)	90	93.7

[0099] It is confirmed that Bio-based Nylon has lower constant load elongation (i.e., higher modulus) and lower elongation at break than Chemical Nylon, on the premise of having a similar fineness. Due to the characteristics of other yarns, it is also confirmed that the dry heat shrinkage rate of Bio-based Nylon is generally higher than that of Chemical Nylon.

<Evaluation 1 of physical properties of hybrid core >**Example 1**

[0100] An aramid filament yarn with about 1000 deniers and a Bio-based Nylon (PA 56) filament yarn with about 840 deniers were put into a cable corder (Allma), and primary twisting in Z-direction and secondary twisting in S-direction were respectively performed at the same time to prepare a 2-ply cabled yarn (raw cord). At this time, for the primary twisting and secondary twisting, the cable corder was set to a twist number of 360 TPM (twist per meter), and the tension applied to each of the nylon filament yarn and the aramid filament yarn was adjusted, so that the ratio of the length of the Bio-Based Nylon single yarn (primarily twisted yarn) and the length of the aramid single yarn (primarily twisted yarn) in the plied twisted yarn (raw cord) ($= \text{aramid single yarn length } (L_A) / \text{Bio-Based Nylon single yarn length } (L_N)$) was set to 1.01. To determine the length ratio of aramid single yarn and Bio-Based Nylon single yarn, a 0.05 g/d load was applied to a 1 m long plied-twisted yarn (raw cord) sample to loosen the twist (secondary twisting), the aramid single yarn and Bio-Based Nylon single yarn were separated from each other, and then the length of the aramid single yarn and the length of the Bio-Based Nylon single yarn were respectively measured under a load of 0.05 g/d. The raw cord prepared as above contains about 45.7 wt% of the first primarily twisted yarn (including bio-nylon fiber) and about 54.3 wt% of the second primarily twisted yarn (including aramid fiber).

[0101] Then, the plied twisted yarn (raw cord) was dipped into a resorcinol-formaldehyde-latex (RFL) adhesive solution containing 2.0 wt% resorcinol, 3.2 wt% formalin (37%), 1.1 wt% sodium hydroxide (10%), 43.9 wt% styrene/butadiene/vinylpyridine (15/70/15) rubber (41%) and water. The plied twisted yarn (raw cord) containing the RFL solution by dipping was dried at 150°C for 100 seconds, and heat treated (cured) at 240°C for 100 seconds, thereby completing the hybrid tire cord. The tension applied to the plied twisted yarn during the dipping, drying, and heat treatment processes was 0.6 kg/cord.

Example 2

[0102] A hybrid cord was prepared in the same manner as in Example 1, except that the tension applied to the plied twisted yarn during coating was set to 0.3 kg/cord.

Reference Example 1

[0103] A hybrid cord was prepared in the same manner as in Example 1, except that Chemical Nylon (PA 66) with 840 deniers was used instead of Bio-Based Nylon with 840 deniers, and the tension applied to the plied twisted yarn during coating was set to 0.8 kg.

Comparative Example 1

[0104] A hybrid cord was prepared in the same manner as in Example 1, except that the tension applied to the plied twisted yarn during coating was set to 1.5 kg/cord.

Comparative Example 2

[0105] A hybrid cord was prepared in the same manner as in Example 1, except that the tension applied to the plied twisted yarn during coating was set to 1.1 kg/cord.

[0106] The method for evaluating the physical properties of the cords prepared in Examples 1 and 2, Reference Examples 1 and Comparative Examples 1 and 2, and the results (Table 2) are as follows.

* **Strength (kgf):** In accordance with ASTM D-885 test method, the strength (arithmetic average value) of the hybrid cord was measured by applying a tensile speed of 300 m/min to 10 samples of 250 mm using an Instron testing machine (Instron Engineering Corp., Canton, Mass.).

* **Constant Load Elongation (%) (@4.5kgf):** In accordance with ASTM D-885 test method, The elongation (arithmetic mean value) at 4.5 kgf of the hybrid cord was measured by applying a tensile speed of 300 m/min to 10 samples of 250 mm using an Instron testing machine (Instron Engineering Corp., Canton, Mass.).

* **Elongation at break (%):** In accordance with ASTM D-885 test method, the elongation at break (arithmetic mean value) of the hybrid cord was measured by applying a tensile speed of 300 m/min to 10 samples of 250 mm using an Instron testing machine (Instron Engineering Corp., Canton, Mass.).

* **Dry heat shrinkage (%):** In accordance with the method for measuring dry heat shrinkage specified in ASTM D885, a sample was left at a temperature of 177°C for 2 minutes using a Testright instrument, and then the shrinkage

was measured.

* **Adhesive strength (kgf):** The adhesive strength of the hybrid cord to rubber was measured using the H-Test method specified in ASTM D885. This is a measure of the strength applied when a single cord was pulled out of the rubber.

* **Fatigue resistance (Fatigue 8H, $\pm 5\%$ (%)):** A hybrid tire cord with measured strength (strength before fatigue) was vulcanized to a rubber to prepare a sample, and then in accordance with JIS-L 1017 method of Japanese Standard Association (JSA), the tension and contraction within $\pm 5\%$ range were repeated for 8 hours while rotating at a speed of 2500 rpm at 80°C using a disk fatigue tester, and thus fatigue was applied to the sample. Then, after removing the rubber from the sample, the strength after fatigue of the hybrid tire cord was measured. The strength retention rate defined by the following Equation 1 was calculated based on the strength before fatigue and the strength after fatigue.

$$\text{[Equation 1]: Strength retention rate (\%)} = \left[\frac{\text{Strength after fatigue (kgf)}}{\text{Strength before fatigue (kgf)}} \right] \times 100$$

[0107] At this time, according to the ASTM D-885 method, the strength (kgf) before fatigue and the strength (kgf) after fatigue were determined by measuring the strength at break of the hybrid tire cord while applying a tensile speed of 300 m/min to a sample of 250 mm using an Instron testing machine (Instron Engineering Corp., Canton, Mass).

* **Fatigue resistance characteristics (Fatigue 16H, $\pm 5\%$ (%)):** Measurements were performed in the same manner as in the aforementioned fatigue resistance characteristics (Fatigue 8H, $\pm 5\%$ (%)), except that tension and contraction were performed for 16 hours.

[Table 2]

	Example 1	Example 2	Reference Example 1	Comparative Example 1	Comparative Example 2
Type of Nylon primarily twisted yarn	PA 56	PA 56	PA 66	PA 56	PA 56
Twist number (TPM)*	360	360	360	360	360
Tension under coating (kgf/cord)**	0.6	0.3	0.8	1.5	1.1
Strength (kgf)	25.1	25.2	25.3	25.3	25.4
Constant load elongation @4.5kgf(%)	4.0	4.5	4.1	3.0	3.5
Elongation at break (%)	9.3	9.9	9.6	7.5	8.2
Dry heat shrinkage (%)	1.6	1.4	1.6	2.1	1.8
Adhesive strength (kgf)	13.3	13.8	13.7	13.7	13.0
Fatigue 8H, $\pm 5\%$ (%)	91.5	92.8	92.7	82.3	84.7
Fatigue 16H, $\pm 5\%$ (%)	76.8	80.1	77.2	68.4	70.3

(continued)

	Example 1	Example 2	Reference Example 1	Comparativ e Example 1	Comparativ e Example 2
5	*Number of twists: when preparing the cords of Examples and Comparative Examples, the number of twists set for each primarily twisted yarn and the number of twists set for secondarily twisting the primarily twisted yarn are the same. **Tension during coating: it refers to the tension applied in the process including heat treatment in relation to the formation of the RFL adhesive coating layer.				

10 **[0108]** Comparing the characteristics of Examples and Comparative Examples using PA56, it is confirmed that the cord of the Comparative Example is low in the constant load elongation (high initial modulus on the s-s curve pattern) and deteriorated in fatigue resistance. On the other hand, the cords of Examples show characteristics equal to or higher than those of Reference Example 1 using PA66.

15 **<Evaluation 2 of properties of hybrid cord>**

Example 3

20 **[0109]** A hybrid cord was prepared in the same manner as in Example 1, except that the number of twists was set to 33 5 TPM when preparing the plied twisted yarn, and the tension applied to the plied twisted yarn during coating was set to 1.0 kg/cord.

Example 4

25 **[0110]** A hybrid cord was prepared in the same manner as in Example 3, except that the tension applied to the plied twisted yarn during coating was set to 0.8 kg/cord.

Reference Example 2

30 **[0111]** A hybrid cord was prepared in the same manner as in Example 3, except that Chemical Nylon (PA 66) with 840 denier was used instead of Bio-Based Nylon with 840 denier and the tension applied to the plied twisted yarn during coating was set to 1.2 kg.

35 **Comparative Example 3**

[0112] A hybrid cord was prepared in the same manner as in Example 3, except that the tension applied to the plied twisted yarn during coating was set to 2.0 kg/cord.

40 **Comparative Example 4**

[0113] A hybrid cord was prepared in the same manner as in Example 3, except that the tension applied to the plied twisted yarn during coating was set to 1.5 kg/cord.

45 **[0114]** The physical property evaluation results of the cords prepared in Examples 3-4, Reference Example 2 and Comparative Example 3-4 are shown in Table 3 below. The physical property evaluation method described in Table 3 is the same as described above.

[Table 3]

	Example 3	Example 4	Reference Example 1	Comparativ e Example 1	Comparativ e Example 2
50	Type of Nylon primarily twisted yarn	PA 56	PA 56	PA 66	PA 56
55	Twist number (TPM)*	335	335	335	335

(continued)

	Example 3	Example 4	Reference Example 1	Comparativ e Example 1	Comparativ e Example 2
Tension under coating (kgf/cord) **	1.0	0.8	1.2	2.0	1.5
Strength (kgf)	25.4	24.8	25.6	25.1	25.5
Constant load elongation @4.5kgf(%)	3.1	3.3	3.1	2.3	2.6
Elongation at break (%)	7.5	7.7	7.7	6.3	6.9
Dry heat shrinkage (%)	1.8	1.6	1.8	2.4	2.0
Adhesive strength (kgf)	13.0	13.6	13.1	12.8	13.5
Fatigue 8H, ±5% (%)	90.1	90.6	90.3	78.4	83.6
Fatigue 16H, ±5% (%)	74.3	77.6	76.4	66.7	67.1
*Number of twists: when preparing the cords of Examples and Comparative Examples, the number of twists set for each primarily twisted yarn and the number of twists set for secondarily twisting the primarily twisted yarn are the same. * **Tension during coating: it refers to the tension applied in the process including heat treatment in relation to the formation of the RFL adhesive coating layer.					

[0115] Comparing the characteristics of the Example and Comparative Example using PA56, it is confirmed that the cords of the Comparative Examples are low in constant load elongation (high initial modulus on the s-s curve pattern) and are deteriorated in fatigue resistance. On the other hand, the cords of Examples show characteristics equal to or higher than that of Reference Example 1 using PA66.

Claims

1. A hybrid cord comprising a hybrid raw cord and a coating layer formed on the hybrid raw cord,

wherein the hybrid raw cord comprises a first primarily twisted yarn formed by imparting twist to a bio-nylon fiber having a fineness of 600 to 2000 denier, and a second primarily twisted yarn formed by imparting twist to a dissimilar resin fiber different from the bio-nylon having a fineness of 800 to 2200 denier, wherein a twist number of the first primarily twisted yarn is in the range of 250 to 600 TPM, wherein the hybrid raw cord contains the first primarily twisted yarn in an amount of 20 to 50% by weight relative to 100% by weight of the total weight, and wherein the hybrid cord satisfies a strength retention rate of 90% or more after an 8-hour disk fatigue test performed according to JIS-L 1017 method of Japanese Standard Association (JSA).

2. The hybrid cord according to claim 1, wherein:
a twist number of the second primarily twisted yarn is in the range of 250 to 600 TPM.

3. The hybrid cord according to claim 1, wherein:
the hybrid raw cord is formed by secondary twisting the first primarily twisted yarn and the second primarily twisted yarn within the range of 250 to 600 TPM.

4. The hybrid cord according to claim 1, wherein:

the second primarily twisted yarn is formed by imparting twist to an aramid fiber.

5. The hybrid cord according to claim 1, wherein:

the first primarily twisted yarn is formed by imparting twist to a bio-nylon fiber having a fineness of 750 to 1100 denier, and
the second primarily twisted yarn is formed by imparting twist to a dissimilar resin fiber different from the bio-nylon having a fineness of 900 to 1200 denier.

6. The hybrid cord according to claim 5, wherein:

a twist number of the first primarily twisted yarn is 300 TPM or more.

7. The hybrid cord according to claim 1, wherein:

the first primarily twisted yarn is formed by imparting twist to a bio-nylon fiber having a fineness of 1100 to 1500 denier, and
the second primarily twisted yarn is formed by imparting twist to a dissimilar resin fiber different from the bio-nylon having a fineness of 1200 to 1800 denier.

8. The hybrid cord according to claim 7, wherein:

a twist number of the first primarily twisted yarn is 400 TPM or less.

9. The hybrid cord according to claim 1, wherein:

the hybrid cord satisfies a strength retention rate of 70% or more after a 16-hour disk fatigue test performed according to JIS-L 1017 method of Japanese Standard Association (JSA).

10. The hybrid cord according to claim 1, wherein:

the hybrid cord has a constant load elongation of at least 2.8% at 4.5 kgf.

11. A method for preparing a hybrid cord, the method comprising the steps of

preparing a plied twisted yarn in which a first primarily twisted yarn formed by imparting twist to a bio-nylon fiber having a fineness of 600 to 2000 denier, and a second primarily twisted yarn formed by imparting twist to a dissimilar resin fiber different from the bio-nylon having a fineness of 800 to 2200 denier are secondarily twisted together, and

forming a coating layer on the plied twisted yarn while applying a tension to the plied twisted yarn, wherein a twist number imparted to the first primarily twisted yarn is in the range of 250 to 600 TPM, wherein the hybrid raw cord contains the first primarily twisted yarn in an amount of 20 to 50% by weight relative to 100% by weight of the total weight,

wherein a tension applied to the plied twisted yarn is 1.0 kg/cord or less, and wherein the hybrid cord satisfies a strength retention rate of 90% or more after an 8-hour disk fatigue test performed according to JIS-L 1017 method of Japanese Standard Association (JSA).

12. The method for preparing a hybrid cord according to claim 11, wherein:

a twist number imparted to the second primarily twisted yarn is in the range of 250 to 600 TPM.

13. The method for preparing a hybrid cord according to claim 11, wherein:

the first primarily twisted yarn and the second primarily twisted yarn are secondary twisted within the range of 250 to 600 TPM to form a plied twisted yarn.

14. The method for preparing a hybrid cord according to claim 11, wherein:

the second primarily twisted yarn is formed by imparting twist to an aramid fiber.

15. The method for preparing a hybrid cord according to claim 11, wherein:

the first primarily twisted yarn is formed by imparting twist to a bio-nylon fiber having a fineness of 750 to 1100 denier, and the second primarily twisted yarn is formed by imparting twist to a dissimilar resin fiber different from the bio-nylon having a fineness of 900 to 1200 denier.

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16. The method for preparing a hybrid cord according to claim 15, wherein:
a twist number imparted to the first primarily twisted yarn is 300 TPM or more.
- 5 17. The method for preparing a hybrid cord according to claim 11, wherein
the first primarily twisted yarn is formed by imparting twist to a bio-nylon fiber having a fineness of 1100 to 1500
denier, and the second primarily twisted yarn is formed by imparting twist to a dissimilar resin fiber different from
the bio-nylon having a fineness of 1200 to 1800 denier.
- 10 18. The method for preparing a hybrid cord according to claim 17, wherein:
a twist number imparted to the first primarily twisted yarn is 400 TPM or less.
- 15 19. The method for preparing a hybrid cord according to claim 11, wherein:
the hybrid cord satisfies a strength retention rate of 70% or more after a 16-hour disk fatigue test performed according
to JIS-L 1017 method of Japanese Standard Association (JSA).
- 20 20. The method for preparing a hybrid cord according to claim 11, wherein:
the hybrid cord has a constant load elongation of at least 2.8% at 4.5 kgf.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2022/005981

A. CLASSIFICATION OF SUBJECT MATTER D02G 3/04(2006.01)i; D02G 3/48(2006.01)i; D02G 3/36(2006.01)i; D02G 3/28(2006.01)i; D02J 13/00(2006.01)i According to International Patent Classification (IPC) or to both national classification and IPC																		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) D02G 3/04(2006.01); B60C 9/00(2006.01); B60C 9/20(2006.01); C08G 69/40(2006.01); C08L 77/00(2006.01); D01D 5/08(2006.01); D01F 6/60(2006.01); D02G 1/12(2006.01); D02G 3/48(2006.01) Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Korean utility models and applications for utility models: IPC as above Japanese utility models and applications for utility models: IPC as above Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) eKOMPASS (KIPO internal) & keywords: 바이오 유래 성분 (bio based component), 나일론 (nylon), 아라미드 (aramid), 코드 (cord)																		
C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>KR 10-1602605 B1 (KOLON INDUSTRIES, INC.) 21 March 2016 (2016-03-21) See claims 1-2, 6-7 and 9; and paragraphs [0050]-[0056] and [0074].</td> <td>1-20</td> </tr> <tr> <td>A</td> <td>CN 112342655 A (TUMUSHUKE CITY EAST LAKE XING TEXTILE CO., LTD.) 09 February 2021 (2021-02-09) See claim 1.</td> <td>1-20</td> </tr> <tr> <td>A</td> <td>KR 10-2020-0080602 A (KOLON INDUSTRIES, INC.) 07 July 2020 (2020-07-07) See claims 1-3 and 7.</td> <td>1-20</td> </tr> <tr> <td>A</td> <td>KR 10-2020-0128791 A (KONKUK UNIVERSITY INDUSTRIAL COOPERATION CORP) 17 November 2020 (2020-11-17) See entire document.</td> <td>1-20</td> </tr> <tr> <td>A</td> <td>JP 2011-195964 A (TORAY IND. INC.) 06 October 2011 (2011-10-06) See entire document.</td> <td>1-20</td> </tr> </tbody> </table>	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	A	KR 10-1602605 B1 (KOLON INDUSTRIES, INC.) 21 March 2016 (2016-03-21) See claims 1-2, 6-7 and 9; and paragraphs [0050]-[0056] and [0074].	1-20	A	CN 112342655 A (TUMUSHUKE CITY EAST LAKE XING TEXTILE CO., LTD.) 09 February 2021 (2021-02-09) See claim 1.	1-20	A	KR 10-2020-0080602 A (KOLON INDUSTRIES, INC.) 07 July 2020 (2020-07-07) See claims 1-3 and 7.	1-20	A	KR 10-2020-0128791 A (KONKUK UNIVERSITY INDUSTRIAL COOPERATION CORP) 17 November 2020 (2020-11-17) See entire document.	1-20	A	JP 2011-195964 A (TORAY IND. INC.) 06 October 2011 (2011-10-06) See entire document.	1-20
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

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