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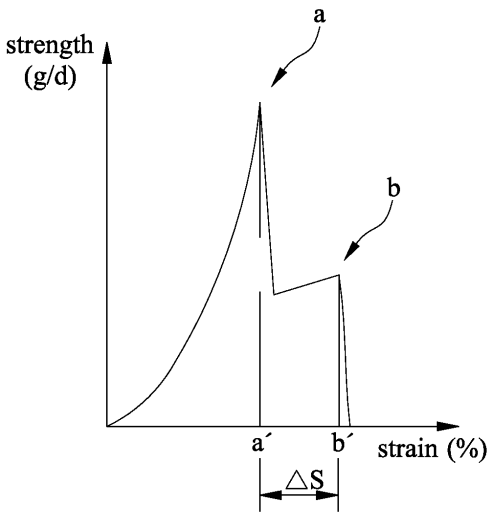
(54) HYBRID FIBER AND METHOD FOR PRODUCING SAME

(57) The present disclosure relates to a hybrid fiber fabricated with a low production cost while having excellent mechanical properties, as well as a method for fabricating the same. The disclosed hybrid fiber includes; a first filament, and a second filament different from the first filament, wherein a strength-strain curve of the hybrid fiber measured according to ASTM D 885 has at least one peak, provided that, if the strength-strain curve has at least two or more peaks, a difference in strain between a first peak having the lowest strain and a second peak having the highest strain, among the above two or more peaks, is 3% or less.

FIG.2



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Description

[Technical Field]

[0001] The present invention relates to a hybrid fiber and a method for fabricating the same and, more particularly, a hybrid fiber having excellent mechanical properties and being able to be prepared at considerably low cost and a method for fabricating the same.

[Background Art]

[0002] In manufacturing a product made of fiber, using a hybrid fiber fabricated by mixing high cost filaments and relatively low cost filaments rather than using only high performance and expensive fibers may be advantageous in manufacturing products in view of cost reduction.

[0003] However, if hetero filaments having different characteristics are mixed by any known method for fabricating a hybrid fiber, characteristics of individual filaments are separately expressed, which in turn cannot attain synergistic effects. For instance, in the case where external force is applied to a hybrid fiber composed of hetero filaments having different strains, all the filaments together do not resist such external force, however, a filament having relatively low strain initially endures such external force then fails (that is, cuts off). Following this, another filament having relatively high strain endures the external force then fails.

[0004] Consequently, although the hybrid fiber as described above may be advantageous in terms of production cost, a problem is encountered in achieving desired physical properties satisfying expected levels thereof.

[Disclosure]

[Technical Problem]

[0005] Accordingly, the present invention relates to a hybrid fiber enabling prevention of problems based on limitations and/or disadvantages of the related art described above, as well as a method for fabricating the same.

[0006] An aspect of the present invention is to provide a hybrid fiber having excellent mechanical properties while being fabricated at a relatively low cost.

[0007] Another aspect of the present invention is to provide a method for fabricating a hybrid fiber having excellent mechanical properties while being fabricated at a relatively low cost.

[0008] Other aspects of the present invention will be described in detail, and may be partially apparent from such a detailed description. Further, through embodiments of the present invention, alternative aspects of the present invention may also be studied and identified. Objects of the present invention may be realized and achieved according to specific configurations defined by the detailed description and appended claims as well as the accompanying drawings.

[Technical Solution]

[0009] According to one aspect of the present invention, there is provided a hybrid fiber, including: a first filament; and a second filament different from the first filament, wherein a strength-strain curve of the hybrid fiber measured according to ASTM D 885 has at least one peak, provided that, if the strength-strain curve has at least two or more peaks, a difference in strain between a first peak having the lowest strain and a second peak having the highest strain, among the above two or more peaks, is 3% or less.

[0010] According to another aspect of the present invention, there is provided a method for fabricating a hybrid fiber, including: preparing a first filament; preparing a second filament having higher strain than that of the first filament; applying tension to the second filament, to maintain a difference in strain between the first and second filaments to 3% or less; and combining the first and second filaments.

[0011] According to another aspect of the present invention, there is provided a method for fabricating a hybrid fiber, including: preparing a first filament; preparing a second filament having higher strain than that of the first filament; and combining the first and second filaments, wherein a length of the first filament is longer than that of the second filament.

[0012] According to a further aspect of the present invention, there is provided a method for fabricating a hybrid fiber, including: preparing a first filament; preparing a second filament having higher strain than that of the first filament; primarily twisting the first filament at a first twist number to form a first primary twisted yarn; primarily twisting the second filament at a second twist number less than the first twist number, to form a second primary twisted yarn; and secondarily twisting the first and second primary twisted yarns.

[0013] The above description as well as the following detailed description are proposed only for illustrative purposes and/or to explain the present invention, and it should be construed that such description is provided to more clearly

understand the invention defined by the claims.

[Advantageous effects]

[0014] According to the present invention described above, a hybrid fiber formed by combining filaments having different characteristics may have new and enhanced characteristics absolutely different from characteristics of individual filaments.

[0015] More particularly, since different types of filaments are treated to have a reduced difference in strain of 3% or less and, then, are mixed together, hetero filaments forming the hybrid fiber may resist external force applied to the hybrid fiber and, as a result, the inventive hybrid fiber may have enhanced tensile strength and elasticity.

[0016] Further, according to the present invention, since low price filaments may be used together with high price filaments to produce a hybrid fiber having excellent mechanical properties, not only the price competitiveness of the hybrid fiber itself but also the price competitiveness of various products manufactured using the same, for example, pseudo-tire cords, hoses, belts, cables, bullet-proof jackets, ropes, composites, or the like can be improved.

[Description of Drawings]

[0017] The accompanying drawings are given to aid in understanding of the present invention and constructing a part of the detailed description, are illustrative of embodiments of the present invention, and explain principles of the present invention, in which:

FIG. 1 is a graph showing a strength-strain curve of a hybrid fiber fabricated by mixing nylon 66 filaments and aramid filaments according to a conventional method; and

FIGS. 2 and 3 are graphs showing respective strength-strain curves of hybrid fibers fabricated by mixing nylon 66 filaments and aramid filaments according to embodiments of the present invention.

[Best Mode]

[0018] Hereinafter, a hybrid fiber and a method for fabrication thereof according to embodiments of the present invention will be described in detail.

[0019] It would be obvious to those skilled in the art that various modifications and variations are possible within the technical spirit and scope of the present invention. Therefore, the present invention includes such modifications and variations in the range of inventions stipulated in the claims and equivalents thereof.

[0020] The term 'hybrid fiber' in the description means a fiber formed by combining different kinds of filaments, for example, a fiber fabricated by twisting nylon filaments and aramid filaments.

[0021] The term 'primary twisting' in the description means twisting of filaments and the term 'primary twisted yarn' means a twisted yarn formed through primary twisting.

[0022] The term 'secondary twisting' in the description means combining and twisting at least two strands of the primary twisted yarns and the term 'secondary twisted yarn' means a twisted yarn formed through secondary twisting.

[0023] The term 'twist number' in the description means the number of twists in a length of 1 meter and its unit is TPM (Twists Per Meter).

[0024] The hybrid fiber of the present invention may include different kinds of filaments. According to the present invention, such different kinds of filaments are combined while having similar strains. Consequently, the inventive hybrid fiber may have excellent tensile strength and elasticity.

[0025] The hybrid fiber of the present invention may include aramid filaments and nylon 66 filaments.

[0026] The aramid filament exhibits low shrinking stress and excellent creep properties, thus being preferable in manufacturing tire cords. Also, since the elasticity of the aramid filament is little changed even at a high temperature, the aramid filament has an advantage of considerably reducing occurrence of a flat spot phenomenon if a tire cord is manufactured using the aramid filament.

[0027] However, the aramid filament is quite expensive and may be disadvantageous in view of economical aspects in the case where it is used for manufacturing general-purpose tires.

[0028] Accordingly, a plan of mixing a nylon 66 filament having relatively favorable physical properties and moderate price with the aramid filament to fabricate a hybrid fiber and using the hybrid fiber to produce tire cords may be considered. However, since there is a large difference in strain between the aramid filament and the nylon 66 filament, a hybrid fiber fabricated using both of the filaments may entail a problem of having tensile strength and elasticity not satisfying expected advantages.

[0029] More particularly, if the aramid filament and the nylon 66 filament are simply mixed even though there is a large difference in strain therebetween, hetero filaments together cannot resist external force applied to a hybrid fiber but,

instead, a filament having relatively low strain initially endures the external force then breaks. Following this, another filament having relatively high strain endures the external force then beaks. As a result, mechanical properties of the hybrid fiber, such as tensile strength and elasticity, may be deteriorated. That is, an important cause of mechanical properties not up to the expected level is that hetero filaments forming the hybrid fiber separately resist the external force.

[0030] Based on the above problems and causes thereof, the present inventors developed an improved hybrid fiber with mechanical properties satisfying expected level and a method for fabricating the same.

[0031] According to the present invention, since different types of filaments are mixed after controlling strains thereof to similar levels, these filaments together may resist the external force applied to a hybrid fiber (made of the filaments). Therefore, a hybrid fiber having excellent mechanical properties may be fabricated.

[0032] Consequently, while retaining price competitiveness as a principal advantage of a hybrid fiber, deterioration of mechanical properties, which is known as a drawback of the hybrid fiber, may be minimized. Therefore, the inventive hybrid fiber may be advantageously used in a wide range of applications.

[0033] With regard to fabrication of the hybrid fiber according to the present invention, various types of filaments may be employed. For instance, the hybrid fiber may include; polyester filaments, polyolefin filaments, polyvinylalcohol filaments, acryl filaments, cellulose filaments, urethane filaments, wholly aromatic polyamide filaments, wholly aromatic polyimide filaments, whole aromatic polyester filaments, xylon filaments, carbon fiber, metallic filaments, mineral filaments, silicon filaments, glass fiber, etc., without being particularly limited thereto.

[0034] Hereinafter, with reference to the accompanying drawings, embodiments of the present invention will be described in detail.

[0035] FIG. 1 illustrates a strength-strain curve of a hybrid fiber fabricated by mixing a nylon 66 filament and an aramid filament according to the present invention.

[0036] As illustrated in FIG. 1, the strength-strain curve of a hybrid fiber known in the art (fabricated by simply mixing and twisting a low strain aramid filament as well as a high strain nylon 66 filament) has two peaks. A first peak 'a' positioned in a lower strain region exhibits cut-off of the low strain aramid filament, while a second peak 'b' positioned in a higher strain region indicates cut-off of the high strain nylon 66 filament.

[0037] As determined from FIG. 1, since the known hybrid fiber is formed by combining filaments while maintaining strains of individual filaments, a distance between the peaks 'a' and 'b', that is, a difference in strain (ΔS) is greatly increased. For instance, if a hybrid fiber known in the art is composed of a nylon 66 filament having 20% strain and an aramid filament having 4% strain, it may show a difference in strain of about 10% or more.

[0038] If the difference in strain is 3% or more, it may be regarded that individual filaments endure external force applied to a hybrid fiber, respectively, without synergistic effects and, in this case, the hybrid fiber never satisfies expected levels of mechanical properties.

[0039] FIG. 2 illustrates a strength-strain curve of a hybrid fiber fabricated by mixing an aramid filament and a nylon 66 filament while controlling strains thereof to similar levels according to one embodiment of the present invention.

[0040] As illustrated in FIG. 2, it can be seen that the hybrid fiber fabricated by mixing different types of filaments under controlled strains thereof to similar levels shows a strength-strain curve having two peaks, wherein a difference in strain is not so great. That is, a distance from a first peak 'a', which is a cut-off point of an aramid filament, to a second peak 'b', which is a cut-off point of a nylon 66 filament, that is, a difference in strain is 3% or less.

[0041] According to the present invention, since different types of filaments are mixed while maintaining a difference in strain thereof to 3% or less, filaments may more or less resist the external force applied to the hybrid fiber. As a result, the inventive hybrid fiber has excellent mechanical properties.

[0042] FIG. 3 illustrates a strength-strain curve of a hybrid fiber fabricated by mixing an aramid filament and a nylon 66 filament after controlling strains thereof to a substantially equal level.

[0043] As illustrated in FIG. 3, in the case where a hybrid fiber is fabricated by mixing different types of filaments under optimal conditions without a difference in strains between the foregoing filaments, the filaments forming the hybrid fiber endure external force applied thereto and, then, are simultaneously broken. Therefore, a strength-strain curve of such a hybrid fiber has only one peak. The fact that only one peak is present in a strength-strain curve when measuring strength and strain of a hybrid fiber, means that the hybrid fiber more efficiently resists external force and has maximal mechanical properties.

[0044] Briefly, a strength-strain curve of the hybrid fiber of the present invention according to ASTM D 885 has at least one peak, provided that, if the strength-strain curve has at least two or more peaks, a difference in strain between a first peak having the lowest strain and a second peak having the highest strain, among the above two or more peaks, is 3% or less.

[0045] Optionally, the strength-strain curve of the inventive hybrid fiber may have only one peak. This hybrid fiber can more efficiently endure external force, compared to a hybrid fiber showing a strength-strain curve having two or more peaks, thereby exhibiting superior mechanical properties.

[0046] Optionally, the strength-strain curve of the inventive hybrid fiber may have at least two or more peaks, wherein a difference in strain between a first peak having the lowest strain and a second peak having the highest strain, among

these two or more peaks, is 3% or less; and the first peak may have a higher strength than the second peak. That is, among filaments forming the hybrid fiber, a filament having relatively higher strength shows lower strain than that of a filament having relatively lower strength. Since the filament having higher strength may efficiently endure external force, compared to the filament having lower strength, it may be advantageous that the former has lower strain than that of the latter.

[0047] The inventive hybrid fiber may include different first and second filaments. As described above, the hybrid fiber according to one embodiment of the present invention includes an aramid filament as a first filament and a nylon 66 filament as a second filament. Since the aramid filament has low shrinkage stress and elasticity substantially not changed even at a high temperature, occurrence of a flat spot phenomenon is minimized. Therefore, it may be advantageous that tire cords are manufactured using aramid filaments. However, such aramid filaments are relatively expensive, thus being unfavorable from an economical viewpoint.

[0048] Therefore, according to one embodiment of the present invention, a hybrid fiber is fabricated by mixing a nylon 66 filament having economic advantages with the aramid filament and using the hybrid fiber may produce various products such as tire cords, hoses, belts, cables, bullet-proof jackets, ropes, gloves, and so forth.

[0049] According to one embodiment of the present invention, a content of aramid filament in the hybrid fiber ranges from 10% to 90%. If the content of aramid filament is less than 10%, a hybrid fiber does not have mechanical properties satisfying expected levels, thus not being applicable to a variety of fields. On the other hand, if the content of aramid filament exceeds 90%, it cannot accomplish a principal benefit of the hybrid fiber, that is, reduction in manufacturing costs.

[0050] The hybrid fiber of the present invention may be a twisted yarn. The hybrid fiber in the form of a twisted yarn may have enhanced tensile strength because of concentration of filaments to form the hybrid fiber.

[0051] According to one embodiment of the present invention, first and second filaments to form a hybrid fiber are first and second primary twisted yarns, respectively; and the hybrid fiber is a ply yarn obtained by secondarily twisting the first and second primarily-twisted yarns. For instance, for a hybrid fiber including an aramid filament and a nylon 66 filament, each of the aramid filament and the nylon 66 filament may be a primary twisted yarn in a Z-direction and the hybrid fiber may be a ply yarn fabricated by secondarily twisting the foregoing primary twisted yarns in an S-direction.

[0052] The hybrid fiber in a ply yarn form described above comprises hetero filaments (to form the hybrid fiber) strongly concentrated therebetween, thus exhibiting excellent mechanical properties. In addition, owing to a wide specific surface area, the hybrid fiber may show superior adhesion to other materials such as resins. Accordingly, the inventive hybrid fiber having advantages described above may be employed in various uses such as production of tire cords, etc.

[0053] Optionally, the first and second primary twisted yarns may have different twist numbers. For example, a first primary twisted yarn prepared by primarily twisting an aramid filament may have a twist number of 600 TPM while a second primary twisted yarn prepared by primarily twisting a nylon 66 filament may have a twist number of 200 TPM. In other words, primarily twisting different types of filaments, respectively, while altering twist numbers thereof based on the strain of the filament, may enable the strains of the first and second primary twisted yarns to be similar to each other artificially, and a hybrid fiber fabricated by secondarily twisting the first and second primary twisted yarns having such reduced difference in strain may have excellent mechanical properties.

[0054] Optionally, the inventive hybrid fiber may further include a resorcinol-formaldehyde-latex (RFL) adhesive. Such a hybrid fiber containing the adhesive exhibits excellent adhesion to rubber, thus being applicable as a reinforcing agent for various rubber products.

[0055] The inventive hybrid fiber may be employed in manufacturing various products including, for example, tire cords, hoses, belts, cables, bullet-proof jackets, ropes, composites, bullet-proof gloves, etc., and may optionally further include phenol resin, urethane resin, polyvinylbutyral resin or ethylenevinyl acetate resin according to use thereof.

[0056] Next, the following description will be given of a method for fabricating a hybrid fiber according to a first embodiment of the present invention.

[0057] The method for fabricating a hybrid fiber according to the first embodiment of the present invention, comprises: preparing a first filament; preparing a second filament having higher strain than that of the first filament; applying tension to the second filament to maintain a difference in strain between the first filament and the second filament to 3% or less; and combining the first and second filaments.

[0058] More particularly, after mounting paper cones wound with the first and second filaments on a creel, the first and second filaments are un-wound, respectively.

[0059] Then, in order to maintain a different in strain of the first and second filaments to 3% or less, tension is applied to the second filament. In this case, quite small tension, compared to the tension applied to the second filament, that is, a minimum tension enabling operation may be applied to the first filament.

[0060] For instance, the first filament may be an aramid filament having a strain of 4% while the second filament may be a nylon 66 filament having a strain of 20%. In order to make both the aramid filament and the nylon 66 filament have the same or similar strain, tension is applied to the nylon 66 filament to elongate the nylon 66 filament by 16% while the aramid filament may only receive a minimum tension enabling operation.

[0061] After combining the second filament having tension applied thereto with the first filament, the combined first

and second filaments are primarily twisted in a Z-direction, to form a primary twisted yarn. Following this, two strands of primary twisted yarns prepared as described above undergo secondary twisting in an S-direction, thus completing a hybrid fiber of the present invention. Combination of the first and second filaments may be executed using a guide roller, an air interlacing nozzle and/or an adhesive, without being particularly limited thereto. Required fineness of the hybrid fiber is different according to use thereof and, in consideration of fineness, the number of primary twisted yarns may be controlled.

[0062] Optionally, combination may be executed by primarily twisting the first and second filaments, respectively, in a Z-direction to form primary twisted yarns; and secondarily twisting both of these filaments in an S-direction, before combining the second filament having tension applied thereto with the fist filament.

[0063] Next, the following description will be given of a method for fabricating a hybrid fiber according to a second embodiment of the present invention.

[0064] The method for fabricating a hybrid fiber according to the present invention, comprises: preparing a first filament; preparing a second filament having higher strain than that of the first filament; and combining the first and second filaments.

[0065] According to the second embodiment of the present invention, when combining the first and second filaments, a feeding amount of the first filament is larger than that of the second filament, to make a length of the combined first filament longer than that of the combined second filament.

[0066] For instance, the first filament may be an aramid filament having a strain of 4%, the second filament may be a nylon 66 filament having a strain of 20%, and the aramid filament may be supplied in excess to make a length of the combined aramid filament longer 15% than a length of the nylon 66 filament to be combined.

[0067] Optionally, a process of applying tension to the second filament may be further included before combining the first and second filaments. That is, according to the above embodiment, tension for elongating the nylon 66 filament by 5% is applied to the nylon 66 filament, and the aramid filament may be excessively fed such that a length of the combined aramid filament is 10% longer than a length of the nylon 66 filament having tension applied thereto.

[0068] After combining the first filament having a longer length with the second filament, the combined first and second filaments are primarily twisted in a Z direction, to form a primary twisted yarn. Following this, plural primary twisted yarns prepared according to the foregoing, are secondarily twisted together, thus completing the inventive combined fiber. Required fineness of the hybrid fiber is different according to uses thereof and, therefore, in consideration of fineness, the number of primary twisted yarns may be controlled.

[0069] Optionally, before a first filament having a longer length is combined with a second filament, the first and second filaments are primarily twisted in the Z direction to produce primary twisted yarns and, then, the primary twisted yarns are secondarily twisted in the S direction, thus completing the combination process.

[0070] Next, the following description will be given of a method for fabricating a hybrid fiber according to a third embodiment of the present invention.

[0071] The method for fabricating a hybrid fiber according to the third embodiment of the present invention, comprises: preparing a first filament; preparing a second filament having higher strain than that of the first filament; primarily twisting the first filament at a first twist number to form a first primary twisted yarn; primarily twisting the second filament at a second twist number less than the first twist number, to form a second primary twisted yarn; and secondarily twisting the first and second primary twisted yarns.

[0072] For instance, the first filament may be an aramid filament having 4% strain, the second filament may be a nylon 66 filament having a strain of 20%, and the first primary twisted yarn formed by primarily twisting the aramid filament may have a twist number of 600 TPM while the second primary twisted yarn formed by primarily twisting the nylon 66 filament may have a twist number of 200 TPM.

[0073] According to the third embodiment of the present invention, different types of filaments are respectively primarily twisted, enabling artificial control of strains of the first and second primary twisted yarns to similar levels. By secondarily twisting the first and second primary twisted yarns together, both of which show reduced difference in strain, a hybrid fiber having excellent mechanical properties is manufactured.

[0074] Optionally, when forming the second primary twisted yarn, the second filament may be primarily twisted while applying tension to the second filament. That is, according to the above embodiment, the aramid filament is primarily twisted without elongation while the nylon 66 filament may be primarily twisted in a 15% elongated state.

[0075] A method for fabricating a hybrid fiber of the present invention may further include the following operation.

[0076] As described above, according to any one of the methods described in the first to third embodiments of the present invention, the first and second filaments are combined and the combined first and second filaments may contain resorcinol-formaldehyde-latex (RFL) adhesive added thereto, respectively.

[0077] A process of applying the RFL adhesive may be executed according to various methods. For instance, a dipping process that immerses the combined first and second filaments in an RFL adhesive solution, may enable the adhesive to be applied to the combined first and second filaments. Here, first-bath (bath 1) dipping or second-bath (bath 2) dipping may be employed. The RFL adhesive solution may contain 2.0 wt.% of resorcinol, 3.2 wt.% of formalin (37%), 1.1 wt. % of sodium hydroxide (10%), 43.9 wt.% of styrene/butadiene/vinyl pyridine (15/70/15) rubber (41%), and water.

[0078] After applying the adhesive to the combined first and second filaments, respectively, thermal degradation may be implemented. For thermal degradation, primary thermal degradation proceeding at 105 to 200 °C for 10 to 400 seconds and secondary thermal degradation proceeding at 105 to 300 °C for 10 to 400 seconds may be executed sequentially.

[0079] The inventive hybrid fiber fabricated as described above may be appropriately used in various applications, for example, tire cords, hoses, belts, cables, bullet-proof jackets, ropes, composites, bullet-proof gloves, etc.

[0080] Hereinafter, the present invention will be described in more detail with reference to the following examples and comparative examples. However, such examples are provided only to aid in understanding of the present invention and should not be construed as limiting the scope and spirit of the present invention.

[EXAMPLE 1]

[0081] A nylon 66 filament having a tensile strength of 9 g/d, a strain of 20% and a fineness of 1,000 denier, and a para aromatic polyamide filament having a tensile strength of 23 g/d, a strain of 4% and a fineness of 1,000 denier were combined to form a ply yarn. In this regard, the nylon 66 filament was elongated by 16% and combined with the para aromatic polyamide filament. On the other hand, the para aromatic polyamide filament was combined with the nylon 66 filament without elongation.

[0082] Then, a ring type twister manufactured by Allma Co. was used to twist the combined filaments in a Z-direction at a twist number of 285 TPM, to form a primary twisted yarn.

[0083] Following this, two strands of the primary twisted yarns formed above were twisted in an S-direction at a twist number of 300 TPM, to fabricate a hybrid fiber. A content of the para aromatic polyamide filament in the hybrid fiber was 50%.

[EXAMPLES 2 AND 3]

[0084] A hybrid fiber was fabricated by the same procedure as described in Example 1, except that the nylon 66 filament in Example 1 was elongated by 15% and 17%, respectively, and then combined with the para aromatic polyamide filament.

[EXAMPLE 4]

[0085] A nylon 66 filament having a tensile strength of 9 g/d, a strain of 20% and a fineness of 1,000 denier, and a para aromatic polyamide filament having a tensile strength of 23 g/d, a strain of 4% and a fineness of 1,000 denier were combined to form a ply yarn. In this regard, the para aromatic polyamide filament was excessively fed such that a length of the combined para aromatic polyamide filament was 15% longer than a length of the combined nylon 66 filament.

[0086] Then, a ring type twister manufactured by Allma Co. was used to twist the combined filaments in a Z-direction at a twist number of 285 TPM, to form a primary twisted yarn.

[0087] Following this, two strands of the primary twisted yarns formed above were twisted in an S-direction at a twist number of 300 TPM, to fabricate a hybrid fiber.

[EXAMPLE 5]

[0088] After elongating a nylon 66 filament having a tensile strength of 9 g/d, a strain of 20% and a fineness of 2,000 denier by 15%, a ring type twister manufactured by Allma Co. was used to twist the elongated nylon 66 filament in a Z-direction at a twist number of 200 TPM, to form a nylon 66 primary twisted yarn.

[0089] Alternatively, a para aromatic polyamide filament having a tensile strength of 23 g/d, a strain of 4% and a fineness of 2,000 denier were twisted using a ring type twister manufactured by Allma Co. in a Z-direction at a twist number of 400 TPM, to form a para aromatic polyamide primary twisted yarn.

[0090] Following this, the nylon 66 primary twisted yarn and the para aromatic polyamide primary twisted yarn were twisted in the S-direction at a twist number of 300 TPM, to fabricate a hybrid fiber.

[EXAMPLES 6 AND 7]

[0091] A hybrid fiber was fabricated by the same procedure as described in Example 1, except that fineness of each of the nylon 66 filament and the para aromatic polyamide filament was adjusted such that a content of the para aromatic polyamide filament in the hybrid fiber was 10 and 90 wt. %, respectively.

[COMPARATIVE EXAMPLE 1]

[0092] A hybrid fiber was fabricated by the same procedure as described in Example 1, except that the nylon 66 filament in Example 1 was combined with the para aromatic polyamide filament without elongation.

[COMPARATIVE EXAMPLE 2]

[0093] A hybrid fiber was fabricated by the same procedure as described in Example 1, except that the nylon 66 filament in Example 1 was elongated by 2% and combined with the para aromatic polyamide filament.

[0094] The hybrid fibers fabricated according to the foregoing examples and comparative examples, were subjected to measurements of tensile strength, strain and difference in strain, respectively, by the following procedures, and results thereof are shown Table 1.

Tensile strength (g/d) and strain (%) of hybrid fiber

[0095] According to the ASTM D 885 test method, a tensile speed of 300 m/min was applied to a sample having a length of 250 mm, using an Instron tester (Instron Engineering Corp., Canton, Mass.) under conditions of a temperature of 25°C and a relative humidity of 65%, thereby measuring the tensile strength and strain of the hybrid fiber.

Difference in strain (ΔS)

[0096] When the tensile strength and strain of the hybrid fiber were measured according to the forgoing method, a strength-strain curve of the hybrid fiber was produced and, using a strain a' at a first peak and a strain b' at a second peak, a difference in strain of the hybrid fiber was determined.

[TABLE]

	Tensile strength (g/d)	Strain (%)	Difference in strain (Δ S)
Example 1	16.4	3.8	1.8
Example 2	16.0	4.1	1.9
Example 3	16.5	3.5	1.8
Example 4	15.1	3.6	2.2
Example 5	15.4	4.2	2.3
Example 6	20.2	3.4	0.5
Example 7	15.5	5.3	2.4
Comparative Example 1	11.5	15.4	12.8
Comparative Example 2	9.3	13.4	10.2

[0097] Although preferred embodiments of the present invention have been described, the scope and spirit of the present invention are not limited to such embodiments described above, and subject matters disclosed in the appended claims and modifications, variations and equivalents thereof will be construed as being included in the present invention.

Claims

1. A hybrid fiber, comprising:

a first filament; and
a second filament different from the first filament, wherein a strength-strain curve of the hybrid fiber measured according to ASTM D 885 regulation has at least one peak, provided that, if the strength-strain curve has at least two or more peaks, a difference in strain between a first peak having the lowest strain and a second peak having the highest strain, among the above two or more peaks, is 3% or less.

2. The hybrid fiber, according to claim 1, wherein the strength-strain curve has one peak.

3. The hybrid fiber according to claim 1, wherein the strength-strain curve has at least two peaks and a first peak has higher strength than that of a second peak.

4. The hybrid fiber according to claim 1, wherein the first filament is an aramid filament, the second filament is a nylon 66 filament, and a content of the aramid filament in the hybrid fiber ranges from 10 and 90 wt.%.

5. The hybrid fiber according to claim 1, wherein the hybrid fiber is a twisted yarn.

6. The hybrid fiber according to claim 1, wherein the first filament is a first primary twisted yarn, the second filament is a second primary twisted yarn, and the hybrid fiber is a ply yarn formed by secondarily twisting the first primary twisted yarn and the second primary twisted yarn.

7. The hybrid fiber according to claim 6, wherein the first and second primary twisted yarns have different twist numbers from each other.

8. The hybrid fiber according to claim 1, further comprising a resorcinol-formaldehyde-latex adhesive.

9. A method for fabricating a hybrid fiber, comprising:

preparing a first filament;
preparing a second filament having higher strain than that of the first filament;
applying tension to the second filament, to maintain a difference in strain between the first and second filaments to 3% or less; and
combining the first and second filaments having a difference in strain of 3% or less.

10. The method according to claim 9, further comprising: applying tension to the first filament, wherein the tension applied to the first filament is smaller than tension applied to the second filament.

11. The method according to claim 9, wherein the first filament is an aramid filament and the second filament is a nylon 66 filament.

12. The method according to claim 9, further comprising: primarily twisting the first and second filaments, respectively, to form primary twisted yarns, before combining the first and second filaments, and wherein the combination is executed by secondarily twisting the primary twisted yarns.

13. The method according to claim 9, further comprising: primarily twisting the combined first and second filaments to form primary twisted yarns; and secondarily twisting the primary twisted yarns.

14. A method for fabricating a hybrid fiber, comprising:

preparing a first filament;
preparing a second filament having higher strain than that of the first filament; and
combining the first and second filaments, wherein a length of the first filament is longer than that of the second filament.

15. The method according to claim 14, wherein the length of the first filament to be combined is longer than that of the second filament to be combined.

16. The method according to claim 14, further comprising: applying tension to the second filament, before combining the first and second filaments.

17. The method according to claim 14, further comprising: primarily twisting the first and second filaments, respectively, to form primary twisted yarns, before combining the first and second filaments, and wherein the combination is executed by secondarily twisting the primary twisted yarns.

18. The method according to claim 14, further comprising: primarily twisting the combined first and second filaments to form primary twisted yarns; and secondarily twisting the primary twisted yarns.

19. A method for fabricating a hybrid fiber, comprising:

preparing a first filament;
preparing a second filament having higher strain than that of the first filament;
primarily twisting the first filament at a first twist number to form a first primary twisted yarn;
primarily twisting the second filament at a second twist number less than the first twist number, to form a second primary twisted yarn; and
secondarily twisting the first and second primary twisted yarns.

20. The method according to claim 19, wherein the second filament is primarily twisted while applying tension to the second filament, to form the second primary twisted yarn.

FIG.1

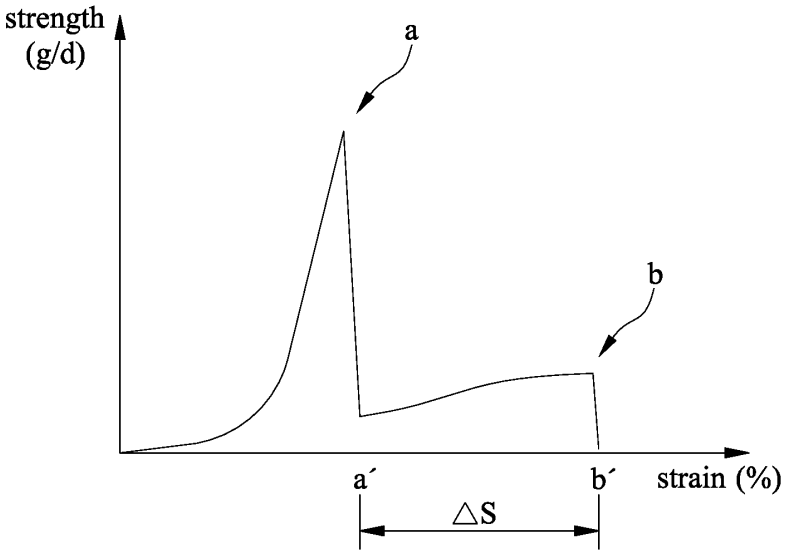

FIG.2

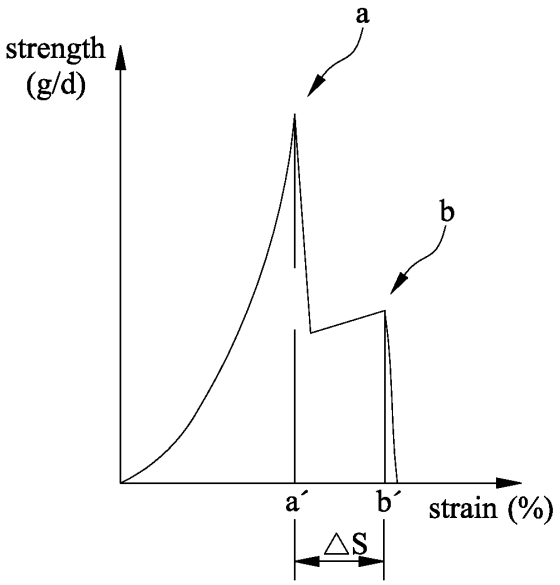

FIG.3