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(54) **FABRIC FOR AIR-BAG, USING POLYETHYLENE TEREPHTHALATE WITH EXCELLENT HEAT RESISTANCE**

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(57) **ABSTRACT**

Provided is a fabric for an airbag using a polyethylene terephthalate fiber, and particularly, to a fabric for an airbag having enhanced thermal resistance and instantaneous thermal strain rate, which is manufactured using a polyethylene terephthalate fiber for an airbag manufactured by controlling the strength and elongation of the polyethylene terephthalate fiber to replace a conventional fabric for an airbag using a yarn formed of nylon 66. The fabric for an airbag including a polyethylene terephthalate fiber manufactured by spinning a polyethylene terephthalate chip having an intrinsic viscosity of 0.8 to 1.3 dl/g has thermal resistances of 0.45 to 0.65 seconds at 450° C., and 0.75 to 1.0 seconds at 350° C.

FABRIC FOR AIR-BAG, USING POLYETHYLENE TEREPHTHALATE WITH EXCELLENT HEAT RESISTANCE

TECHNICAL FIELD

[0001] The present invention relates to a fabric for an airbag using a polyethylene terephthalate fiber, and particularly, to a fabric for an airbag having enhanced thermal resistance and instantaneous thermal strain rate, which is manufactured using a polyethylene terephthalate fiber for an airbag manufactured by controlling the strength and elongation of the polyethylene terephthalate fiber to replace a conventional fabric for an airbag using a yarn formed of nylon 66.

BACKGROUND ART

[0002] An airbag requires characteristics of low air permeability to easily rupture in a car crash, and energy absorbability to prevent damage to and bursting of the airbag itself. In addition, to be more easily stored, characteristics relating to foldability of a fabric itself are required. As a suitable fiber having the above-described characteristics, nylon 66 has generally been used. However, recently, in order to save on cost, attention on fibers other than nylon 66 has been increasing.

[0003] As a fiber capable of being used for an airbag, polyethylene terephthalate may be used. However, when polyethylene terephthalate is used as a yarn for an airbag, seams rupture during airbag cushion module tests. To solve this problem, it is important to use a polyethylene terephthalate yarn that does not degrade the energy absorbability of an airbag. In addition, it is necessary to improve flexibility of the fabric for an airbag using a polyethylene terephthalate fiber to be easily stored.

DISCLOSURE

Technical Problem

[0004] The present invention is directed to providing a fabric for an airbag using polyethylene terephthalate, which has excellent energy absorbability resulting in fewer ruptures of outer seams during an airbag cushion development tests, and is more easily stored.

Technical Solution

[0005] According to an exemplary embodiment of the present invention, a fabric for an airbag including a polyethylene terephthalate fiber manufactured by spinning a polyethylene terephthalate chip having an intrinsic viscosity of 0.8 to 1.3 dl/g is provided. The fabric for an airbag has a thermal resistance of 0.45 to 0.65 seconds at 350° C., which is calculated by the following Equation.

$$\text{Thermal Resistance (sec) of Fabric} = T_1 - T_2 \qquad \text{[Equation 1]}$$

[0006] In Equation 1, T_1 is the time in which a steel rod heated to 350° C. falls from 10 cm above the fabric through the fabric, and T_2 is the time in which the same steel rod falls from the same height.

[0007] According to another exemplary embodiment of the present invention, a fabric for an airbag including a polyethylene terephthalate fiber manufactured by spinning a polyethylene terephthalate chip having an intrinsic viscosity of 0.8 to 1.3 dl/g is provided. The fabric for an airbag has a thermal resistance of 0.75 to 1.0 seconds at 450° C., which is calculated by the following Equation, and an instantaneous thermal strain rate of 1.0 to 5.0%.

$$\text{Thermal Resistance (sec) of Fabric} = T_3 - T_4 \qquad \text{[Equation 2]}$$

[0008] In Equation 2, T_3 is the time that a steel rod heated to 450° C. falls from 10 cm above the fabric through the fabric, and T_4 is the time that the same steel rod falls from the same height.

[0009] According to still another exemplary embodiment of the present invention, the fabric for an airbag has a stiffness of 5.0 to 15.0 N.

[0010] According to yet another exemplary embodiment of the present invention, the polyethylene terephthalate fiber has a strength of 8.0 to 11.0 g/d, and an elongation of 15 to 30% at room temperature.

[0011] According to yet another exemplary embodiment of the present invention, the polyethylene terephthalate fiber has an instantaneous thermal strain rate of 1.0 to 5.0%, and a filament size of 4.5 deniers or less.

Advantageous Effects

[0012] The present invention provides a polyethylene terephthalate fabric for an airbag, which overcomes the lack of flexibility, which is a disadvantage of a conventional fabric for an airbag, and has better thermal resistance. As a result, an airbag module manufactured using the fabric for an airbag can be more easily stored and rarely bursts due to pressure and heat instantaneously applied by a high temperature expanding gas during airbag development tests.

BEST MODE

[0013] The present invention provides a polyethylene terephthalate fabric for an airbag manufactured by manufacturing a polyethylene terephthalate fiber for an airbag by controlling the strength and elongation of the polyethylene terephthalate fiber, thereby obtaining excellent thermal resistance and instantaneous thermal strain rate. Accordingly, outer seams rupture less frequently during airbag cushion development tests, and the foldability and storability of the fabric for an airbag are improved.

[0014] In the present invention, the fabric for an airbag uses a polyethylene terephthalate multifilament obtained by spinning a polyethylene terephthalate chip having an intrinsic viscosity (IV) of 0.8 to 1.3 dl/g to safely absorb instantaneous impact energy of an exhausted gas generated due to explosion of gunpowder in the airbag. A polyester yarn having an intrinsic viscosity (IV) of less than 0.8 dl/g is not suitable because the polyester yarn does not have sufficient toughness to be used as an airbag.

[0015] A resin for producing a synthetic fiber multifilament for an airbag may be selected from the group consisting of polymers such as polyethylene terephthalate, polybutylene terephthalate, polyethylene naphthalate, polybutylene naphthalate, polyethylene-1,2-bis(phenoxy)ethane-4,4'-dicarboxylate, and poly(1,4-cyclohexylene-dimethylene terephthalate); copolymers including at least one of the polymers as a repeated unit, such as polyethylene terephthalate/isophthalate copolyester, polybutylene terephthalate/naphthalate copolyester, and polybutylene terephthalate/decane dicarboxylate copolyester; and a mixture of at least two of the polymers and copolymers. Among these, in the present invention, a polyethylene terephthalate resin is most preferably used in terms of mechanical properties and the formation of a fiber.

[0016] The polyethylene terephthalate fiber for an airbag of the present invention may have a strength of 8.0 to 11.0 g/d and an elongation of 15 to 30% at room temperature. When a strength of the polyethylene terephthalate fiber for an airbag of the present invention is less than 8.0 g/d, the polyethylene terephthalate fiber is not suitable for the present invention because of low tensile and tearing strengths of the manufactured fabric for an airbag.

[0017] In addition, when the elongation of the fiber is less than 15%, energy absorbability is decreased when an airbag cushion is suddenly expanded, and thus the airbag cushion bursts, which is not suitable. When a yarn is manufactured to have the elongation of the fiber of more than 30%, sufficient expression of the strength is difficult due to the characteristics of a process of manufacturing a yarn.

[0018] The polyethylene terephthalate fiber for an airbag of the present invention may have a filament size of 4.5 deniers or less, and preferably 3 deniers or less. Generally, as a fiber having a smaller filament size is used, the obtained fabric becomes flexible, thereby achieving excellent foldability and better storability. In addition, when the filament size is smaller, covering properties are enhanced at the same time. As a result, air permeability of the fabric may be inhibited. When the filament size is more than 4.5 deniers, the fabric has degraded foldability and storability, and low air permeability, and thus the fabric cannot properly serve as a fabric for an airbag.

[0019] The polyethylene terephthalate fiber for an airbag of the present invention may have an instantaneous thermal strain rate of 0.1 to 5.0%, and preferably 2.0 to 4.0% at 100° C. When the instantaneous thermal strain rate of the fiber is less than 1.0%, the absorbability of energy applied when the airbag cushion is expanded due to a high temperature gas is degraded, and thus the airbag cushion bursts easily. In addition, when the instantaneous thermal strain rate of the fiber is more than 5.0%, a length of the fiber is increased at high temperature, and thus seams of the airbag cushion rupture when it is expanded due to a high temperature gas. Therefore, an uncontrolled expanding gas is leaked.

[0020] In the uncoated polyethylene terephthalate fabric whose density is 50 wefts or warps per inch after a scouring and contracting process, stiffness may be approximately 5.0 to 15.0 N, and preferably 6.0 to 9.0 N when evaluated by circular bend measurement. When the stiffness is more than 15.0 N, the fabric becomes stiff, and thus is difficult to store in the manufacture of the airbag module and degraded in developing performance of the airbag cushion.

[0021] In the uncoated polyethylene terephthalate fabric whose density is 50 wefts or warps per inch after a scouring and contracting process, thermal resistance measured using a rod heated at 350° C. in a hot rod test may be 0.75 to 1.0 seconds. When the thermal resistance measured at 350° C. is less than 0.75 seconds, the thermal resistance of the fabric for an airbag is too low to withstand a high temperature gas in the development of the airbag cushion, and thus outer seams of the airbag easily rupture. When the thermal resistance measured at 350° C. is more than 1.0 second, since a polyethylene terephthalate yarn having a larger filament size is necessarily used, the stiffness of the fabric is increased, and thus the fabric for an airbag is difficult to store in the module.

[0022] In the uncoated polyethylene terephthalate fabric whose density is 50 wefts or warps per inch after a scouring and contracting process, thermal resistance measured using a steel rod heated to 450° C. in a hot rod test may be 0.45 to 0.65 seconds. When the thermal resistance measured at 450° C. is less than 0.45 seconds, the thermal resistance of the fabric for an airbag is too low to withstand a high temperature gas in the development of the airbag cushion, and thus outer seams of the airbag easily rupture. When the thermal resistance measured at 450° C. is more than 0.65 seconds, since a polyethylene terephthalate yarn having a larger filament size is necessarily used, the stiffness of the fabric is increased, and thus the fabric for an airbag is difficult to store in the module.

[0023] In the present invention, the fabric may be woven with the polyethylene terephthalate fiber as a plain fabric having a symmetrical structure. Alternately, to obtain more favorable physical properties, the fabric may be woven as a 2/2 panama fabric having a symmetrical structure using a yarn having a smaller linear density.

[0024] The woven fabric may be coated with a coating agent selected of silicon-, polyurethane-, acryl-, neoprene-, and chloroprene-based coating agents at a weight of 15 to 60 g/m^2 to secure low air permeability, which is suitable for the fabric for an airbag.

[0025] Evaluation of physical properties in Examples and Comparative Examples were performed as follows:

[0026] 1) Intrinsic Viscosity (I.V.)

[0027] 0.1 g of a sample was dissolved in a reagent prepared by mixing phenol and 1,1,2,2-tetrachloroethanol in a weight ratio of 6:4 (90° C.) for 90 minutes. The resulting solution was transferred to an Ubbelohde viscometer and maintained in a constant temperature oven at 30° C. for 10 minutes, and a drop time of the solution was measured using a viscometer and an aspirator. A drop time of a solvent was also measured as described above, and then R.V. and I.V. values were calculated by the following equations.

[0028] R.V.=Drop Time of Sample/Drop Time of Solvent

$$I.V.=1/4\times[(R.V.-1)/C]+3/4\times(\text{In } R.V./C)$$

[0029] In the above equation, C is the concentration (g/100 ml) of the sample in the solution.

[0030] 2) Measurement of Instantaneous Thermal Strain Rate

[0031] A bundle of filaments having a thickness of approximately 59 deniers was made by randomly selecting filaments from a multi filament yarn. The bundle of filaments was mounted on a TA instrument (model name: TMS Q-400) to have a length of 10 mm, and then a stress of 1.0 gf/den was applied thereto. 2 minutes after the application of a stress, a test started and a temperature was rapidly increased from 30 to 100° C. for 30 minutes. An instantaneous thermal strain rate was obtained by dividing a length increment of the sample when the temperature approached 100° C. by an initial length of the sample, and is shown as a percentage.

[0032] 3) Measurement of Stiffness of Fabric

[0033] The stiffness of a fabric was measured by circular bend measurement according to the specification of ASTM D4032. Here, the stiffness was measured with respect to weft and warp directions, and an average of the values obtained in the weft and warp directions is shown in units of Newtons (N).

[0034] 4) Method of Measuring Thermal Resistance of Fabric (350° C. Hot Rod Test)

[0035] A cylindrical steel rod having a weight of 50 g and a diameter of 10 mm was heated to 350° C. and then dropped vertically from 10 cm above a fabric for an airbag. Here, the time in which the heated rod fell through the fabric was T_1, and the time in which the rod fell without the fabric was T_2.

The thermal resistance was measured by the following equation. Here, one layer of the unfolded fabric for an airbag was used.

$$\text{Thermal Resistance (Sec.) of Fabric} = T_1 - T_2 \quad \text{[Equation 1]}$$

[0036] 5) Method of Measuring Thermal Resistance of Fabric (450° C. Hot Rod Test)

[0037] A cylindrical steel rod having a weight of 50 g and a diameter of 10 mm was heated to 450° C. and then dropped vertically from 10 cm above a fabric for an airbag. Here, the time in which the heated rod fell through the fabric was T_3, and the time in which the rod fell without the fabric was T_4. The thermal resistance was measured by the following equation. Here, one layer of the unfolded fabric for an airbag was used.

$$\text{Thermal Resistance (Sec.) of Fabric} = T_3 - T_4 \quad \text{[Equation 2]}$$

[0038] 6) Method of Measuring Strength and Elongation of Yarn

[0039] A yarn sample was left in a constant temperature and constant humidity chamber under standard conditions, that is, a temperature of 25° C. and a relative humidity of 65% for 24 hours, and tested by a method of ASTM 2256 using a tension tester.

[0040] 7) Weaving and Coating of Fabric

[0041] A plain fabric was woven with a filament yarn to have a yarn density of 50 wefts or warps per inch in both of weft and warp directions. A raw fabric was scoured and contracted in aqueous baths which were gradually set from 50 to 95° C. using a continuous scouring machine, and then treated at 200° C. for 2 minutes by thermomechanical treatment. Afterward, the fabric was coated with a silicon-based coating agent at a weight of 25 g/m^2.

[0042] 8) Airbag Cushion Development Test

[0043] A driver airbag (DAB) module was manufactured with a coated fabric for an airbag, and subjected to a static test within several minutes after being left at 85° C. for 4 hours. Here, a pressure of a powder inflator was 180 kPa, and when the tearing of the fabric, forming of a pin hole and burning of the fabric were not shown after the development test, it was evaluated as "Pass." However, when any one of the tearing of the fabric, forming of a pin hole in a seam and burning of the fabric was shown, it was evaluated as "Fail."

MODE FOR INVENTION

[0044] Hereinafter, the present invention will be described in detail with respect to Examples, but the scope of the present invention is not limited to the following Examples and Comparative Examples.

Example 1

[0045] A raw fabric for an airbag was manufactured with a polyethylene terephthalate yarn having the characteristics listed in Table 1 by plain-weaving using a rapier loom to have a fabric density of 50 wefts or warps per inch in both of weft and warp directions.

Example 2

[0046] A raw fabric for an airbag was manufactured with a polyethylene terephthalate yarn having the characteristics listed in Table 1 by the method as described in Example 1.

Example 3

[0047] A raw fabric for an airbag was manufactured with a polyethylene terephthalate yarn having the characteristics listed in Table 1 by the method as described in Example 1.

Comparative Example 1

[0048] A raw fabric for an airbag was manufactured with a nylon 66 yarn having the characteristics listed in Table 1 by plain-weaving using a rapier loom to have a fabric density of 50 wefts or warps per inch in both of weft and warp directions.

Comparative Example 2

[0049] A raw fabric for an airbag was manufactured with a polyethylene terephthalate yarn having the characteristics listed in Table 1 by the method as described in Comparative Example 1.

Comparative Example 3

[0050] A raw fabric for an airbag was manufactured with a polyethylene terephthalate yarn having the characteristics listed in Table 1 by the method as described in Comparative Example 1.

Example 4

[0051] The raw fabric manufactured in Example 1 was scoured and contracted in aqueous baths gradually set from 50 to 95° C. using a continuous scouring machine, and then treated at 200° C. for 2 minutes by thermomechanical treatment. In an uncoated state, the fabric was measured in stiffness, thermal resistance at 350° C. and thermal resistance at 450° C., the results of which are shown in Table 2.

[0052] In addition, the manufactured fabric was coated with a silicon-based coating agent at a weight of 25 g/m^2, and thermally treated at 180° C. for 2 minutes. An airbag cushion was made with the thermally-treated fabric, and subjected to a development test for the airbag cushion. The test results and storability in a module are shown in Table 2.

Example 5

[0053] The raw fabric manufactured in Example 2 was treated by the method described in Example 4. Physical properties, results of an airbag cushion development test and storability in a module of the manufactured fabric are shown in Table 2.

Example 6

[0054] The raw fabric manufactured in Example 3 was treated by the method described in Example 4. Physical properties, results of an airbag cushion development test and storability in a module of the manufactured fabric are shown in Table 2.

Comparative Example 4

[0055] The raw fabric manufactured in Comparative Example 1 was scoured and contracted in aqueous baths gradually set from 50 to 95° C. using a continuous scouring machine, and then treated at 200° C. for 2 minutes by thermomechanical treatment. In an uncoated state, the fabric was measured in stiffness, thermal resistance at 350° C. and thermal resistance at 450° C., the results of which are shown in Table 2.

[0056] In addition, the manufactured fabric was coated with a silicon-based coating agent at a weight of 25 g/m^2, and thermally treated at 180° C. for 2 minutes. An airbag cushion was made with the thermally-treated fabric, and subjected to a development test for the airbag cushion. The test results and storability in a module are shown in Table 2.

Comparative Example 5

[0057] The raw fabric manufactured in Comparative Example 2 was treated by the method described in Comparative Example 3. Physical properties, results of an airbag cushion development test and storability in a module of the manufactured fabric are shown in Table 2.

Comparative Example 6

[0058] The raw fabric manufactured in Comparative Example 3 was treated by the method described in Comparative Example 3. Physical properties, results of an airbag cushion development test and storability in a module of the manufactured fabric are shown in Table 2.

TABLE 1

	Material	Kind of Yarn	Intrinsic Viscosity (dl/g)	Filament size (den)	Strength (g/den)	Elongation (%)	Instantaneous Thermal Strain Rate (%)
Example 1	Polyethylene terephthalate	500 d/182 f	1.06	2.7	8.4	25.0	2.8
Example 2	Polyethylene terephthalate	500 d/182 f	1.06	2.7	11.0	18.0	3.5
Example 3	Polyethylene terephthalate	500 d/120 f	1.06	4.2	9.0	22.6	2.3
Comparative Example 1	Nylon 66	420 d/68 f	—	6.2	9.7	22.0	1.8
Comparative Example 2	Polyethylene terephthalate	420 d/68 f	1.06	6.2	7.8	14.0	0.4
Comparative Example 3	Polyethylene terephthalate	500 d/96 f	1.06	5.2	7.5	12.0	0.6

TABLE 2

	Stiffness of Fabric (N)	Thermal Resistance at 350° C. (sec.)	Thermal Resistance at 450° C. (sec.)	Airbag Cushion Development Test	Ability to be stored in Fabric for Airbag
Example 4	7.4	0.94	0.56	Pass	Good
Example 5	7.6	0.97	0.62	Pass	Good
Example 6	13.7	0.87	0.50	Pass	Moderate
Comparative Example 4	6.9	0.79	0.46	Pass	Good
Comparative Example 5	15.4	0.69	0.39	Fail	Bad
Comparative Example 6	17.5	0.73	0.42	Fail	Bad

[0059] While the invention has been shown and described with reference to certain exemplary embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the scope of the invention as defined by the appended claims.

1. A fabric for an airbag, comprising:

a polyethylene terephthalate fiber manufactured by spinning a polyethylene terephthalate chip having an intrinsic viscosity of 0.8 to 1.3 dl/g,

wherein the fabric for an airbag has a thermal resistance at 350° C. of 0.75 to 1.0 seconds, which is calculated by the following Equation:

$$\text{Thermal Resistance of Fabric (sec.)} = T1 - T2 \quad \text{[Equation 1]}$$

where T1 is the time in which a steel rod heated to 350° C. falls from 10 cm above the fabric through the fabric, and T2 is the time in which the same steel rod falls from the same height.

2. A fabric for an airbag, comprising:

a polyethylene terephthalate fiber manufactured by spinning a polyethylene terephthalate chip having an intrinsic viscosity of 0.8 to 1.3 dl/g,

wherein the fabric for an airbag has a thermal resistance at 450° C. of 0.45 to 0.65 seconds, which is calculated by the following Equation:

$$\text{Thermal Resistance of Fabric (sec.)} = T3 - T4 \quad \text{[Equation 1]}$$

where T3 is the time in which a steel rod heated at 450° C. falls from 10 cm above the fabric through the fabric, and T4 is the time in which the same steel rod falls from the same height.

3. The fabric for an airbag according to claim 1, wherein the polyethylene terephthalate fiber has an instantaneous thermal strain rate of 1.0 to 5.0%.

4. The fabric for an airbag according to claim 1, wherein the fabric for an airbag has a stiffness of 5.0 to 15.0 N.

5. The fabric for an airbag according to claim 1, wherein the polyethylene terephthalate fiber has a strength of 8.0 to 11.0 g/d, and an elongation of 15 to 30% at room temperature.

6. The fabric for an airbag according to claim 1, wherein the polyethylene terephthalate fiber has a filament size of 4.5 deniers or less.

7. The fabric for an airbag according to claim 2, wherein the polyethylene terephthalate fiber has an instantaneous thermal strain rate of 1.0 to 5.0%.

8. The fabric for an airbag according to claim 2, wherein the fabric for an airbag has a stiffness of 5.0 to 15.0 N.

9. The fabric for an airbag according to claim 2, wherein the polyethylene terephthalate fiber has a strength of 8.0 to 11.0 g/d, and an elongation of 15 to 30% at room temperature.

10. The fabric for an airbag according to claim 2, wherein the polyethylene terephthalate fiber has a filament size of 4.5 deniers or less.

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