(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 956 120 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 158(3) EPC

(43) Date of publication:
13.08.2008 Bulletin 2008/33

(21) Application number: **06797439.4**

(22) Date of filing: **05.09.2006**

(51) Int Cl.:
D02G 3/02 *(2006.01)* ***A47G 27/02*** *(2006.01)*

(86) International application number:
PCT/JP2006/317533

(87) International publication number:
WO 2007/029688 (15.03.2007 Gazette 2007/11)

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR

(30) Priority: **07.09.2005 JP 2005258632**
30.09.2005 JP 2005286444
30.09.2005 JP 2005286452

(71) Applicant: **Suminoe Textile Co., Ltd.**
Osaka-shi,
Osaka 542-0081 (JP)

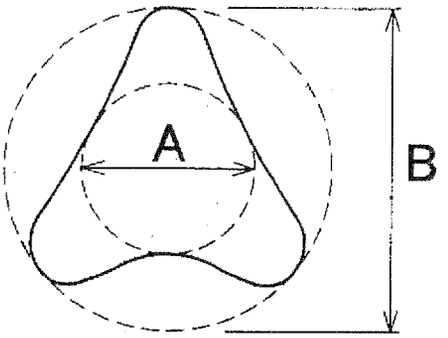
(72) Inventors:
- **FUNATSU, Kenichi**
  Yamatotakada-shi, Nara 6350076 (JP)
- **OKAMOTO, Yoshihiko**
  Moriyama-shi, Shiga 5240031 (JP)
- **HAYASHI, Yoshiki**
  Kouka-shi, Shiga 5280041 (JP)
- **YOSHIDA, Hiroji**
  Okazaki-shi, Aichi 4440244 (JP)

(74) Representative: **Viering, Jentschura & Partner**
Grillparzerstrasse 14
81675 München (DE)

(54) SPUN-DYED, CRIMPED POLYLACTIC ACID FIBER, METHOD FOR MANUFACTURE THEREOF, AND CARPET

(57) A spun-dyed textured polylacted filament yarn according to the present invention comprises a textured polylacted filament yarn, wherein the textured polylacted filament yarn includes a filament having an approximately circular or circular cross-section and has a relative viscosity of 2.5 to 3.8, wherein the textured polylacted filament yarn contains a coloring agent in an amount of 0.01 to 3 mass%, and wherein the textured polylacted filament yarn is 1.75 to 3.5 cN/dtex in tenacity, 35 to 60% in elongation, 500 to 3,500 dtex in total fineness, 2.5 to 25 dtex in a filament fineness, 2 to 8 % in hot water shrinkage ratio, and 5 to 25 % in dry heat crimp ratio. By employing the above structure, a spun-dyed textured polylacted filament yarn excellent in loftiness, toughness and abrasion resistance can be obtained. It is preferable that the cross-section of the filament has a degree of deformation less than 1.5, the degree of deformation being expressed by a ratio (B/A) of a diameter B of an circumscribed circle of the filament cross-section to a diameter A of a inscribed circle of the filament cross-section.

Fig. 2



EP 1 956 120 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a spun-dyed textured polylacted filament yarn excellent in bulkiness, toughness and abrasion resistance, and the production method thereof. It also relates to a carpet constituted by the textured filament yarns, which has sufficient voluminous look and is excellent in texture and abrasion resistance.

[0002] In this specification, the wording of "spun-dyed textured synthetic filament yarn" is used as an interpretation of the word which does not include a spun-dyed textured polylacted filament yarn.

BACKGROUND TECHNIQUE

[0003] Polylactide polymer is a biodegradable resin made from lactide obtained from amylum of, e.g., corn and can be decomposed into water and carbon dioxide by microorganisms, etc. Therefore, it has attracted attention as an earth-conscious material matching the natural global material circulation. Using polylacted filament yarns made from biodegradable resin, it has been considered to produce an option carpet for vehicles, a house roll carpet or rug, etc. If the same properties as those of a currently available nylon textured filament yarn, polypropylene textured filament yarn or polyester textured filament yarn can be obtained using filament yarns made from polylactide resin, it can be expected to provide wide variety of materials including, e.g., interior materials as well as carpet materials.

[0004] A conventional carpet using textured polylacted filament yarns, however, has such drawbacks that it lacks bulkiness, it is easily worn away and it is easily buckled. Because of these drawbacks, such a carpet has very limited practical usages. This is because the filament yarn properties and crimp characteristics, such as, e.g., tenacity or elongation, of the textured polylacted filament yarn are inferior to those of the currently available nylon textured filament yarn, polypropylene textured filament yarn and polyester textured filament yarn.

[0005] On the other hand, as to a textured polylacted filament yarn and the production method thereof, Patent Documents 1 to 3 have been publicly known. Patent Document 1 discloses that it is possible to suppress deterioration of tenacity and/or crimp characteristic due to dyeing by using a yarn-dyeing textured polylacted filament yarn having tenacity, a crimping extension ratio, a crimping latescent ratio and a tenacity retention ratio after a pressure hot-water treatment falling within specified ranges.

[0006] Furthermore, Patent Document 2 discloses that a carpet having softness, bulkiness and refreshing unique texture can be provided by employing a textured polylacted filament yarn having rectangle cross-section made of polylacted filament yarns in which an ellipticity of a cross-section of a filament calculated from the ratio of the major axis of the filament to the minor axis thereof is 3 to 8 and the filament has a filament fineness of 5 to 25 dtex.

[0007] Furthermore, Patent Document 3 discloses that it is possible to improve the bulkiness, abrasion resistance and buckling resistance of a carpet by employing a spun-dyed textured polylacted filament yarn made of filaments in which a deformed cross-sectional filament has a degree of deformation of 1.5 to 5.5 and the filament yarn has relative viscosity, tenacity, a textured extension ratio, a textured latescent ratio, an entangled number, and a entangled point tenacity each falling within a specified range.

[0008] A conventional carpet using textured polylacted filament yarns and the production method thereof are disclosed in Patent Document 4, Patent Document 5 and Patent Document 6.

[0009] In Patent Document 4, it discloses that the purpose is to "provide a tufted carpet base fabric which causes no problem in natural environment when discarded and a tufted carpet using the base fabric." As the means for solving problems, it discloses that "the tufted carpet base fabric is constituted by long-filament yarn nonwoven fabric made of polylactic acid series copolymer, this carpet has a structure in which pile yarns made of polylactic acid series copolymer are tufted in the base fabric, and the backing material is made from biodegradable material." This Patent Document describes a tufted carpet in which properties, such as, e.g., the lateral cross-sectional configuration of long-filament yarn nonwoven fabric, the crystallinity, are specified and that the pile yarn for use in the carpet and the backing material are specified by polylactic acid series copolymer and a material having biodegradability, respectively.

[0010] In Patent Document 5, it discloses that the purpose is to "provide a carpet which is in harmony with the environment and has biodegradability." As the means for solving problems, it discloses a "carpet using biodegradable filament yarns having bulkiness preferably used as a carpet and biodegradability as piles, and biodegradable materials as a base fabric and backing materials." This Patent Document describes a biodegradable carpet in which the pile filament yarns, the base fabric and the backing film are specified using fatty acid polyester, especially polylactic acid.

[0011] In Patent Document 6, it discloses that the purpose is to "provide a carpet which can be easily disposed since, e.g. , it will naturally decompose and disappear in the ground when landfilled, generate no harmful gas when incinerated and is low in combustion heat. As the means for solving problems, it discloses a "polylactic acid resin filament yarns are used as filament yarns for, e.g., piles and ground yarn and fabric such as, e.g., a base fabric and a back fabric, and polylactic acid resin compositions is used as an adhesive resin layer for joining the base fabric and the back fabric." This

Patent Document describes a carpet in which the filament yarns and fabrics are made of polylacted resin filament yarns and the adhesive agent is made of polylactic acid resin compositions.

Patent Document 1: Japanese Unexamined Laid-open Patent Publication No. 2005-8997
Patent Document 2: Japanese Unexamined Laid-open Patent Publication No. 2005-48303
Patent Document 3: Japanese Unexamined Laid-open Patent Publication No. 2005-60850
Patent Document 4: Republished PCT Patent Publication WO 00/65140
Patent Document 5: Japanese Unexamined Laid-open Patent Publication No. 2002-248047
Patent Document 6: Japanese Unexamined Laid-open Patent Publication No. 2003-10030

DISCLOSURE OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0012] However, the textured polylacted filament yarn disclosed in Patent Document 1 relates to a yarn-dyeing textured polylacted filament yarn. The yarn-dyeing textured polylacted filament yarn assuredly deteriorates in tenacity, elongation and crimping characteristics by a pressure hot-water treatment for dyeing. Especially, in the case of dark color dyeing represented by black color dyeing, it is inevitable to execute the dying treatment with high-temperature hot-water (e.g., 120 to 130 ˚C), which causes remarkable deterioration of the properties. Accordingly, in cases where a dark color carpet is formed using textured polylacted filament yarns as disclosed in Patent Document 1, the improvements of bulkiness, abrasion resistance and buckling resistance were insufficient.

[0013] In the textured polylacted filament yarn obtained by the technique disclosed in Patent Document 2, the filament yarn properties, especially the filament yarn tenacity, was insufficient (In Patent Document 2, the filament yarn tenacity was 1.6 cN/dtex in Example 1, 1.7 cN/dtex in Example 2, 1.5 cN/dtex in Example 3, 1.8 cN/dtex in Example 4, and 1.5 cN/dtex in Example 5). Accordingly, in the carpet constituted by the textured polyactic acid filament yarns, it was poor in abrasion resistance and buckling resistance, resulting in limited applications.

[0014] Furthermore, in the carpet constituted by the spun-dyed textured polyactic acid filament yarns disclosed in Patent Document 3, the improvements of bulkiness, abrasion resistance and buckling resistance were insufficient. For example, in the case of constituting an automobile option carpet, an automobile line matt, a tile carpet, or a household roll carpet by the spun-dyed textured polyactic acid filament yarns, the durability, such as, e.g., bulkiness, abrasion resistance and buckling resistance, was not sufficiently satisfied at practical level. Patent Document 3 is completely silent about a hot water shrinkage ratio, etc., related to the orientation/crystal of the textured polylacted filament yarn.

[0015] Patent Document 4 is directed to a biodegradable carpet in which a long-filament yarn nonwoven fabric made of polylactic acid series polymer is used as the base fabric, polylactic acid polymer is used as the pile yarn, and biodegradable material is used for the backing material. However, it is silent about durability, such as abrasion resistance or bulkiness, of the carpet manufactured by using polylactic acid series polymer.

[0016] Patent Document 5 refers to a biodegradable carpet using fatty acid polyester, especially polylactic acid. Although Patent Document 5 refers to the covering property and the firm-elastic feeling of the carpet produced using polylacted resin filament yarns, it is silent about the durability, such as, e.g., the abrasion resistance or buckling resistance, of the carpet.

[0017] Patent Document 6 refers to a carpet using filament yarns and adhesive made of polylactic acid resin, especially a biodegradable carpet. However, it is completely silent about the durability, such as, e.g., abrasion resistance or buckling resistance, of the carpet manufactured by using polylactic acid series polymer.

[0018] The aforementioned Patent Documents 4 to 6 do not refer to durability, such as, e.g., abrasion resistance or buckling resistance, of a carpet. Therefore, it can be hardly said that a carpet obtained by the technique has reached a satisfactory level in durability, such as, e.g., abrasion resistance, bulkiness and buckling resistance.

[0019] The present invention was made in view of the aforementioned technical background, and aims to provide a spun-dyed textured polylacted filament yarn excellent in bulkiness, toughness and abrasion resistance and the production method thereof. It also aims to provide a carpet using the textured filament yarns and having sufficient voluminous look and texture which is excellent in bulkiness, abrasion resistance and buckling resistance.

[0020] In order to attain the aforementioned object of the invention, the present inventors eagerly studied to improve deficiency of filament yarn properties, deficiency of crimping characteristics, nonconformance of hydrothermal contraction characteristics, insufficient abrasion resistance or insufficient bulkiness of a carpet due to the above. As a result, the inventors found the fact that the aforementioned problems can be solved by limiting the cross-sectional configuration of the filament constituting the spun-dyed textured filament yarn to a specific configuration, by limiting the relative viscosity to a specified range and by limiting the tenacity, the elongation, the total fineness, the filament fineness, the hot water shrinkage ratio and the dry heat crimp ratio to the respective specified range, and completed the present invention. That is, the present invention provides the following means.

[0021] [1] A spun-dyed textured polylacted filament yarn, comprising a textured polylacted filament yarn,
wherein the textured polylacted filament yarn comprises a filament having an approximately circular or circular cross-section and has a relative viscosity of 2.5 to 3.8,
wherein the textured polylacted filament yarn contains a coloring agent in an amount of 0.01 to 3 mass%, and
wherein the textured polylacted filament yarn is 1.75 to 3.5 cN/dtex in tenacity, 35 to 60% in elongation, 500 to 3,500 dtex in total fineness, 2.5 to 25 dtex in a filament fineness, 2 to 8 % in hot water shrinkage ratio, and 5 to 25 % in dry heat crimp ratio.

[0022] [2] The spun-dyed textured polylacted filament yarn as recited in the aforementioned Item 1, wherein the filament has an approximately circular or circular cross-section having a degree of deformation less than 1.5.

[0023] [3] The spun-dyed textured polylacted filament yarn as recited in the aforementioned Item 1 or 2, wherein the coloring agent is at least one pigment selected from the group consisting of an inorganic pigment and an organic pigment.

[0024] [4] A carpet in which the spun-dyed textured polylacted filament yarn as recited in any one of the aforementioned Items 1 to 3 is used as at least a part of constituent yarn.

[0025] [5] A method for manufacturing a spun-dyed textured polylacted filament yarn, comprising the steps of:

spinning a polylacted resin composition containing a coloring agent and a polylacted resin and having a coloring agent content of 0.01 to 3 mass% and a relative viscosity of 2.5 to 3.8 to obtain spun filaments comprising a filament having an approximately circular or circular cross-section and a degree of deformation less than 1.5;
drawing the spun filaments at a draw ratio of 3 times to 6 times with a draw roller set to 70 to 125 ˚C;
heat-setting the drawn spun filaments with a heat-set roller set to 100 to 150 ˚C;
giving crimps to the heat-set drawn spun filaments by bringing a heated fluid of 90 to 160 ˚C into contact with the heat-set drawn spun filaments using a texturing device; and
cooling the textured spun filaments after the crimping step to a temperature lower than a glass transition temperature of polylacted polymer.

[0026] [6] A method for manufacturing a spun-dyed textured polylacted filament yarn, comprising the steps of:

obtaining spun filaments by extruding a polylacted resin composition containing a coloring agent and a polylacted resin and having a coloring agent content of 0.01 to 3 mass% and a relative viscosity of 2.5 to 3.8 through a spinning nozzle into filaments each having an approximately circular or circular cross-section and a degree of deformation less than 1.5, cooling the filaments with quench air, and then coating the filaments with lubricant;
drawing the spun filaments at a draw ratio of 3 times to 6 times with a draw roller set to 70 to 125 ˚C;
heat-setting the drawn spun filaments with a heat-set roller set to 100 to 150 ˚C;
giving crimps to the heat-set drawn spun filaments by bringing a heated fluid of 90 to 160 ˚C into contact with the heat-set drawn spun filaments using a texturing device; and
cooling the textured spun filaments after the crimping step to a temperature lower than a glass transition temperature of the polylacted polymer.

[0027] [7] The method of manufacturing a spun-dyed textured polylacted filament yarn as recited in the aforementioned Item 5 or 6, wherein the following relational expression is met:

$$30\ ^{\circ}C \geqq S-R \geqq -10\ ^{\circ}C$$

where "S" is a temperature of the heat-set roller, and "R" is a temperature of the heated fluid in the texturing device.

[0028] [8] The method of manufacturing a spun-dyed textured polylacted filament yarn as recited in any one of the aforementioned Items 5 to 7, wherein the drawn spun filaments are heat-set with a heat-set roller set to a temperature range of 100 ˚C to a softening point of the polylacted polymer.

[0029] [9] The method of manufacturing a spun-dyed textured polylacted filament yarn as recited in any one of the aforementioned Items 5 to 8, wherein crimps are given to the heat-set drawn spun filaments by bringing the heated fluid set to a temperature range of 90 ˚C to a softening point of the polylacted polymer into contact with the filaments using the texturing device.

[0030] [10] The method of manufacturing a spun-dyed textured polylacted filament yarn as recited in any one of the aforementioned Items 5 to 9, further comprising a step of subjecting the textured spun filaments went through the cooling step to an entangle process using a entangle processing device.

[0031] [11] A spun-dyed textured polylacted filament yarn manufactured by the manufacturing method as recited in any one of the aforementioned Items 5 to 10.

[0032] [12] A carpet in which at least a part of constituent yarns of the carpet is constituted by the spun-dyed textured polylacted filament yarn as recited in the aforementioned Item 11.

[0033] [13] A carpet using a spun-dyed textured polylacted filament yarn comprising a filament having an approximately circular or circular cross-section as a pile yarn.

[0034] [14] The carpet as recited in the aforementioned Item 13, wherein the spun-dyed textured polylacted filament yarn meets all of the following characteristics (1) to (7):

(1) a filament has an approximately circular or circular cross-section having a degree of deformation less than 1.5, wherein the degree of deformation is expressed by a ratio (B/A) of a diameter B of an circumscribed circle of the filament cross-section to a diameter A of a inscribed circle of the filament cross-section;
(2) relative viscosity (RV) is 2.5 to 3.8;
(3) tenacity is 1.75 to 3.5 cN/dtex;
(4) elongation is 35 to 60 %;
(5) a filament fineness is 2.5 to 25 dtex;
(6) hot water shrinkage ratio is 2 to 8 %; and
(7) dry heat crimp ratio is 5 to 25 %.

[0035] [15] The carpet as recited in the aforementioned Item 13 or 14, wherein the pile yarn comprises a single yarn and/or two or more doubled and twisted yarns made of a non-twisted and/or twisted spun-dyed textured polylacted filament yarn.

[0036] [16] The carpet as recited in any one of the aforementioned Items 13 to 15, wherein an average length of piles forming a carpet is 5 to 15 mm, and a weight per unit area of the piles is 500 to 3, 000 g/m^2.

[0037] [17] The carpet as recited in any one of the aforementioned Items 13 to 16, wherein an abrasion amount of pile yarns forming a carpet measured by a TABER abrasion test (abrasion ring: H-18, abrasion number: 2,500 times) is 5 to 30 mass%.

[0038] [18] A carpet comprising a spun-dyed textured polylacted filament yarn and a spun-dyed textured synthetic filament yarn as a pile yarn, wherein an abrasion amount of the pile yarn forming a carpet measured by a TABER abrasion test (abrasion ring: H-18, abrasion number: 5,000 times) is 5 to 30 mass%.

[0039] [19] The carpet as recited in the aforementioned Item 18, wherein the spun-dyed textured synthetic filament yarn is at least one of spun-dyed textured synthetic filament yarn selected from the group consisting of a spun-dyed textured polyester filament yarn, a spun-dyed textured nylon filament yarn, and a spun-dyed textured polypropylene filament yarn.

[0040] [20] The carpet as recited in the aforementioned Item 18 or 19, wherein the spun-dyed textured polylacted filament yarn meets all of the following characteristics (1) to (7):

(1) a filament has an approximately circular or circular cross-section having a degree of deformation less than 1.5, wherein the degree of deformation is expressed by a ratio (B/A) of a diameter B of an circumscribed circle of the filament cross-section to a diameter A of a inscribed circle of the filament cross-section;
(2) relative viscosity (RV) is 2.5 to 3.8;
(3) tenacity is 1.75 to 3.5 cN/dtex;
(4) elongation is 35 to 60 %;
(5) a filament fineness is 2.5 to 25 dtex;
(6) hot water shrinkage ratio is 2 to 8 %; and
(7) dry heat crimp ratio is 5 to 25 %.

[0041] [21] The carpet as recited in any one of the aforementioned Items 18 to 20, wherein an average length of piles forming a carpet is 5 to 15 mm, and a weight per unit area of the piles is 500 to 3, 500 g/m^2.

[0042] [22] The carpet as recited in any one of the aforementioned Items 18 to 21, wherein the spun-dyed textured polylacted filament yarn is made of plant-derived material, and the spun-dryed textured synthetic filament yarn is made of petroleum-derived material.

EFFECTS OF THE INVENTION

[0043] In the invention [1], the cross-section of the filament constituting the spun-dyed textured filament yarn is limited to a specific configuration, the relative viscosity is limited so as to fall within a specific range, and the tenacity, the elongation, the total fineness, the filament fineness, the hot water shrinkage ratio and the dry heat crimp ratio are each limited so as to fall within respective specified ranges. Therefore, a spun-dyed textured polylacted filament yarn excellent in bulkiness, toughness, and abrasion resistance can be provided.

[0044] In the invention [2], since the filament has an approximately circular or circular cross-section having a degree of deformation less than 1.5, the abrasion resistance can be further improved.

[0045] In the invention [3], since as the coloring agent, at least one pigment selected from the group consisting of an inorganic pigment and an organic pigment is used, there is an advantage that the heat resistance, the light resistance, the weather resistance can be improved as compared with other coloring agents such as colorants (in other words, in the case of colorants, since they can be easily decomposed, sufficient heat resistance cannot be obtained).

[0046] In the invention [4], since the spun-dyed textured polylacted filament yarn as recited in any one of the aforementioned Items [1] to [3] is used as at least a part of constituent yarns, the carpet is rich in voluminous look, and rich in texture and excellent in bulkiness, abrasion resistance and buckling resistance.

[0047] In the invention [5], a spun-dyed textured polylacted filament yarn excellent in bulkiness, toughness and abrasion resistance can be manufactured. Furthermore, since spun-dyed polylacted polymer is used as filament yarn forming material, a dyeing process requiring a heat treatment as a post-process can be eliminated. Therefore, there is an advantage that adverse effects (e.g., deterioration of mechanical tenacity) due to the heat treatment can be avoided.

[0048] In the invention [6], a spun-dyed textured polylacted filament yarn excellent in bulkiness, toughness, and abrasion resistance can be manufactured. Furthermore, since spun-dyed polylacted polymer is used as filament yarn forming material, dyeing process requiring a heat treatment as a post-process can be eliminated. Therefore, there is an advantage that adverse effects (e.g., deterioration of mechanical tenacity) due to the heat treatment can be avoided. Since a spun filament is obtained by extruding a polylacted resin composition through a spinning nozzle, cooling the filament with quench air, and then coating the filament with lubricant, a spun filament can be manufactured efficiently, and smoothness and antistatic property can be given to the spun filament by the coating of the lubricant. Furthermore, since the textured filament yarn is cooled to a temperature lower than the glass transition temperature of the polylacted polymer, a spun-dyed textured polylacted filament yarn to which sufficient crimp is given can be manufactured.

[0049] In the invention [7], a spun-dyed textured polylacted filament yarn is manufactured under the conditions meeting the following relational expression:

$$30\ ^{\circ}C \geqq S-R \geqq -10\ ^{\circ}C$$

where "S" is a temperature of the heat-set roller, and "R" is a temperature of the heated fluid in the texturing device. Therefore, both the tenacity and the elongation of the spun-dyed textured polylacted filament yarn to be obtained can be improved.

[0050] In the invention [8], the drawn spun filament is heat-set with a heat-set roller set to a temperature ranging from 100 ˚C to a temperature of a softening point of the polylacted polymer. Therefore, appropriate polylacted polymer crystallization can be attained, resulting in improved tenacity and elongation of the textured filament yarn.

[0051] In the invention [9], crimps are given to the heat-set drawn filament yarn by bringing the heated fluid having a temperature ranging from 90 ˚C to a temperature of a softening point of the polylacted polymer into contact with the filament yarn using a texturing device. Therefore, damages to the orientated crystallized filament yarn can be reduced at the time of giving crimp, resulting in improved tenacity and elongation of the spun-dyed textured polylacted filament yarn.

[0052] In the invention [10], the textured filament yarn went through the cooling step is subjected to an entangle process using a entangle processing device. Therefore, the tufting property of the textured filament yarn at the time of the tufting can be improved.

[0053] In the invention [11], a spun-dyed textured polylacted filament yarn excellent in loftiness, toughness and abrasion resistance can be provided.

[0054] In the invention [12], a carpet sufficient in voluminous look, rich in texture, excellent in loftiness, abrasion resistance and buckling resistance can be provided.

[0055] In the invention [13], since the filament constituting the spun-dyed textured polylacted filament yarn is approximately circular or circular in cross-section, a carpet excellent in abrasion resistance can be provided. Furthermore, using a spun-dyed textured polylacted filament yarn can eliminate a dyeing process requiring a heat treatment in the production steps of a carpet, which can avoid adverse effects (e.g., deterioration of mechanical tenacity) due to the heat treatment. Thus, a carpet improved in plant-derived ratio and excellent in toughness and abrasion resistance can be provided.

[0056] In the invention [14], the cross-section and the degree for deformation of the filament constituting the spun-dyed textured polylacted filament yarn are each specifically limited, the relative viscosity is limited so as to fall within a specific range, and the tenacity, the elongation, the filament fineness, the hot water shrinkage ratio, and the dry heat crimp ratio are limited so as to fall within respective specified ranges. Thus, a carpet improved in plant-derived ratio and excellent in loftiness, toughness and abrasion resistance can be provided.

[0057] In the invention [15], the pile yarn comprises a single and/or two or more doubled and twisted yarns made of

a non-twisted and/or twisted spun-dyed textured polylacted filament yarn. Therefore, in accordance with the requirements of texture of the carpet pile portion, various yarns can be employed.

[0058] In the invention [16], since an average length of piles forming a carpet using pile yarns made of a spun-dyed textured polylacted filament yarn is 5 to 15 mm, and a weight per unit area of the piles is 500 to 3, 000 g/m^2, a carpet excellent in loftiness and abrasion resistance and having no bottom-out feeling can be provided.

[0059] In the invention [17], since an abrasion amount of pile yarns forming a carpet measured by a TABER abrasion test (abrasion ring: H-18, abrasion number: 2,500 times) is 5 to 30 mass%, a carpet excellent in abrasion resistance can be provided.

[0060] In the invention [18], since a spun-dyed textured polylacted filament yarn and a spun-dyed textured synthetic filament yarn are used as pile yarns, a carpet having abrasion resistance superior to a carpet made of only spun-dyed textured polylacted filament yarns can be provided. Furthermore, since the abrasion amount of the pile yarn forming a carpet measured by a TABER abrasion test (abrasion ring: H-18, abrasion number: 5,000 times) is 5 to 30 mass%, a carpet excellent in abrasion resistance can be provided. Furthermore, because of using a spun-dyed polylacted filament yarn, a dyeing process requiring a heat treatment as a post-process can be eliminated at the time of manufacturing a carpet. Therefore, adverse effects (e.g., deterioration of mechanical tenacity) due to the heat treatment can be avoided, and a carpet excellent in toughness and abrasion resistance can be provided.

[0061] In the invention [19], at least one of spun-dyed textured synthetic resin filament yarns selected from the group consisting of a spun-dyed textured polyester filament yarn, a spun-dyed textured nylon filament yarn, and a spun-dyed textured polypropylene filament yarn and a spun-dyed textured synthetic filament yarn are used as pile yarns. Therefore, a dyeing process requiring a heat treatment can be eliminated at the time of manufacturing a carpet and combustion heat can be reduced during the burning, resulting in easy incinerating.

[0062] In the invention [20], since the cross-section and the degree of deformation of the filament constituting the spun-dyed textured polylacted filament yarn are each specifically limited, the relative viscosity is limited so as to fall within a specific range, and the tenacity, the elongation, the filament fineness, the hot water shrinkage ratio, and the dry heat crimp ratio are limited so as to fall within respective specified ranges, by using the spun-dyed textured polylacted filament yarn together with the spun-dyed textured synthetic filament yarn, a carpet further improved in loftiness, toughness and abrasion resistance can be provided.

[0063] In the invention [21], since the average length of piles forming a carpet is 5 to 15 mm and the weight per unit area of the piles is 500 to 3,500 g/m^2, a carpet excellent in loftiness and abrasion resistance and having no bottom-out feeling can be provided.

[0064] In the invention [22], a carpet using plant-derived materials excellent in toughness and abrasion resistance can be provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0065]

[Fig. 1] Fig. 1 is a schematic structural view showing an example of a manufacturing method for use in manufacturing a spun-dyed polylacted filament yarn.
[Fig. 2] Fig. 2 is an explanatory view for explaining a degree of deformation of a filament.
[Fig. 3] Fig. 3 is a schematic view showing an example of a carpet according to the third invention.
[Fig. 4] Fig. 4 is a schematic view showing an example of a carpet according to the third invention.

DESCRIPTION OF THE REFERENCE NUMERALS

[0066]

2...preheating roller
3...draw roller
4...heat-set roller
5...texturing device
6...textured filament yarn
20...cooling drum
21...entangle processing device

BEST MODE FOR CARRYING OUT THE INVENTION

[0067] A spun-dyed textured polylacted filament yarn according to the first invention is comprised of a filament having

an approximately circular or circular cross-section. This textured filament yarn is 2.5 to 3.8 in relative viscosity. Furthermore, the spun-dyed textured polylacted filament yarn according to the first invention is made from a polylacted resin compound containing a coloring agent and polylacted resin.

[0068] The polylacted resin constituting the polylacted resin compound to be used as the raw material of the spun-dyed textured polylacted filament yarn is polylacted resin in which lactide monomer containing L-lactide as a main ingredient is polymerized. It is preferable that the polylacted resin contains L-lactide in the amount of 90 mass% or more in the lactide monomer. In other words, D-lactide can be contained in the lactide monomer within a range not exceeding 10 mass%. If the optical purity (optical purity of L-lactide) of the lactide monomer to be used is 90 % or more, the polylacted polymer becomes crystalline, which is preferable. If the optical purity (optical purity of L-lactide) of the lactide monomer to be used is 97 % or more, the melting point becomes about 170 ˚C, which is more preferable. It should be noted that polylacted polymer in which a component other than lactide is copolymerized can be used so long as the amount of the component falls within the range which does not harm the effects of the present invention. In the case of copolymerizing components other than lactide, the lactide unit should be 70 mass% or more but less than 100 mass% of the repeating unit of the polymer molecular chain, preferably 80 mass% or more but less than 100 mass%, more preferably 90 mass% or more but less than 100 mass%.

[0069] The relative viscosity (RV) of the spun-dyed textured polylacted filament yarn of the first invention is required to be 2.5 to 3.8. The relative viscosity is a value measured as a mixed solution of 20 ˚C, phenol/tetrachloroethane=60/40 (mass ratio). If the relative viscosity is less than 2.5, sufficient tenacity and elongation cannot be given to the polylacted textured filament yarn, and abrasion property appropriate to the carpet usage cannot be given thereto. On the other hand, if the relative viscosity exceeds 3.8, the melt viscosity becomes high excessively. As a result, it is required to raise the spinning temperature, resulting in decreased relative viscosity of the textured polylacted filament yarn which is extremely lower than a before-melt level thereof and also resulting in insufficiently improved tenacity. In addition, this also causes difficulty in spinning. It is more preferable that the relative viscosity of the spun-dyed textured polylacted filament yarn is 2.8 to 3.6.

[0070] Furthermore, the polylacted resin compound used as a material of the spun-dyed textured polylacted filament yarn of the first invention contains a coloring agent in the amount of 0.01 to 3 mass%. This concentration can give an appropriate color density to the textured filament yarn, resulting in improved design property. If the concentration is set to 0.01 mass% or more, generation of color shading due to the coloring agent irregularity can be prevented. If it is set to 3 mass% or less, generation of filament yarn breakage can be sufficiently prevented. It is especially preferable that the ratio of content of the coloring agent is 0.05 to 1 mass%. Furthermore, the coloring agent can be used together with a dispersing agent normally used (e.g. , olefin series compound).

[0071] In addition to polymer (including polymer particles) other than polylacted polymer, it should be noted that any additive agent, such as, e.g., a delustering agent, a plasticizing agent, a fire retardant, an antistatic agent, an odor eliminating agent, an antibacterial agent, an antioxidant agent, a heat resisting agent, a light resistant agent, and an ultraviolet [UV] absorber, can be added to the polylacted resin composition so long as the amount falls within the range which does not harm the effects of the present invention.

[0072] The spun-dyed textured polylacted filament yarn of the first invention has a filament having an approximately circular or circular cross-section (i.e., filament is circular in cross-section). This cross-sectional configuration gives abrasion resistance to the filament yarn. That is, a filament yarn can have resistance to abrasion. Among other things, it is preferable that the cross-sectional configuration of the filament is an approximately circular or circular having a degree of deformation less than 1.5 (exceeding 1 but less than 1.5). If the degree of deformation exceeds 1.5, the covering property of the textured polylacted filament yarn can be improved. However, due to the large degree of deformation, the hard and brittle properties inherent in the polylacted polymer tend to be exerted, resulting in deteriorated abrasion resistance of the filament yarn, and therefore it is not preferable. The degree of deformation is expressed by a ratio (B/A) of a diameter B of an circumscribed circle of the filament cross-section to a diameter A of a inscribed circle of the filament cross-section (see Fig. 2).

[0073] Furthermore, the spun-dyed textured polylacted filament yarn of the first invention meets all of the following characteristics (1) to (6):

(1) tenacity is 1.75 to 3.5 cN/dtex;
(2) elongation is 35 to 60 %;
(3) total fineness is 500 to 3,500 dtex;
(4) a filament fineness is 2.5 to 25 dtex;
(5) hot water shrinkage ratio is 2 to 8 %; and
(6) dry heat crimp ratio is 5 to 25 %.

[0074] The tenacity of the spun-dyed textured polylacted filament yarn is 1.75 to 3.5 cN/dtex. If the tenacity of the textured filament yarn is less than 1.75 cN/dtex, when the textured filament yarn is used as a carpet, a part of the textured

filament yarn may sometimes be worn out, which cannot give sufficient abrasion resistance appropriate to a carpet. It is preferable that the tenacity of the spun-dyed textured polylacted filament yarn is 2.0 to 3.25 cN/dtex, more preferably 2.25 to 3.25 cN/dtex.

[0075] The elongation of the spun-dyed textured polylacted filament yarn is 35 to 60 %. If the elongation of the textured filament yarn is less than 35%, when the textured filament yarn is used as a carpet, a part of the textured filament yarn may sometimes be worn out, which cannot give sufficient abrasion resistance appropriate to a carpet. It is preferable that the elongation of the spun-dyed textured polylacted filament yarn is 40 to 55 %.

[0076] If the tenacity of the spun-dyed textured polylacted filament yarn is 2.0 to 3.25 cN/dtex and the elongation of the spun-dyed textured polylacted filament yarn is 40 to 55 %, the filament yarn can have higher toughness, which is preferable.

However, raising of the tenacity generally causes deterioration of elongation. Even if the elongation is set to 35 % or more, the tenacity is merely increased to 3.5 cN/dtex. Furthermore, if the elongation exceeds 60 %, the tenacity cannot be increased to 1.75 cN/dtex or more.

[0077] Furthermore, the total fineness of the spun-dyed textured polylacted filament yarn falls within the range of 500 to 3,500 dtex. Setting the total fineness within this range can provide a spun-dyed textured polylacted filament yarn preferably used for a carpet such as a tufted carpet, but not limited thereto. It is preferable that the total fineness of the spun-dyed textured polylacted filament yarn falls within the rage of 1,000 to 3,000 dtex.

[0078] The filament fineness of the spun-dyed textured polylacted filament yarn falls within the range of 2.5 to 25 dtex. If the filament fineness is less than 2.5 dtex, it becomes difficult to perform the yarn-making stably. If the filament fineness exceeds 25 dtex, it become difficult to obtain the filament yarn property of the spun-dyed textured polylacted filament yarn of the present invention and the hard and brittle properties inherent in the polylacted polymer tend to be exerted, resulting in deteriorated abrasion resistance of the filament yarn, and therefore it is not preferable. This tendency becomes prominent as the degree of deformation of the cross-section of the polylacted filament increases in the same filament fineness. Accordingly, the smaller degree of deformation of the filament is preferable. It is preferable that the filament fineness of the spun-dyed textured polylacted filament yarn falls within the range of 4 to 20 dtex, more preferably 5 to 15 dtex. In cases where the filament fineness falls within the range of 2.5 to 25 dtex, the soft and brittle property of the polylacted polymer can be weakened and the tenacity and the elongation of the spun-dyed textured polylacted filament yarn can be further improved and that the abrasion resistance of a carpet using the spun-dyed textured polylacted filament yarn can also be improved.

[0079] The hot water shrinkage ratio of the spun-dyed textured polylacted filament yarn falls within the range of 2 to 8 %. If the hot water shrinkage ratio is less than 2 %, the crystallinity of the spun-dyed textured polylacted filament yarn becomes higher. As a result, the hard and brittle property of the polylacted polymer will be easily exerted, resulting in poor balanced tenacity and elongation and insufficient abrasion resistance as a carpet. On the other hand, if the hot water shrinkage ratio exceeds 8 %, there are problems that filament yarn shrinkage occurs at the time of the heat-set treatment and it becomes difficult to administrate each carpet manufacturing step. Among other things, it is preferable that the hot water shrinkage ratio of the spun-dyed textured polylacted filament yarn falls within the range of 3 to 6 %.

[0080] The dry heat crimp ratio of the spun-dyed textured polylacted filament yarn falls within the range of 5 to 25 %. This dry heat crimp ratio is a parameter showing the loftiness of the spun-dyed textured polylacted filament yarn, and a value showing the degree of crimps formed by treating the spun-dyed textured polylacted filament yarn with heated air of 100 ˚C. If the dry heat crimp ratio is less than 5 %, crimping becomes insufficient, the loftiness as a carpet becomes insufficient, and the buckling resistance becomes poor. On the other hand, it is difficult to obtain a textured polylacted filament yarn having a dry heat crimp ratio exceeding 25 % by currently available manufacturing technique. Even if it is possible, the carpet using the textured filament yarn becomes a felt-like carpet. Among other things, the dry heat crimp ratio preferably falls within the range of 8 to 20 %.

[0081] As the coloring agent, for example, an inorganic pigment and an organic pigment can be exemplified. But the coloring agent is not specifically limited thereto so long as it gives a color to the textured filament yarn. Examples of the inorganic pigment include oxides such as, e.g., titanium oxide, zinc oxide, titan yellow, zinc-iron series brown, titan-cobalt series green, cobalt green, cobalt blue, and cupper-iron series brown, ferrocyanide such as, e.g., iron blue, silicate such as, e.g., ultramarine blue pigment, carbonate such as, e.g., calcium carbonate, phosphate such as, e.g., manganese violet, carbon black, aluminum powder, bronze powder, titanium powder covering mica. Examples of the organic pigment include phthalocyanine series such as, e.g., cupper phthalocyanine blue, cupper phthalocyanine green, and brominated cupper phthalocyanine green, perylene series such as, e.g., perylene scarlet, perylene rare, and isoindolinon series.

[0082] Among other things, it is preferable to use at least one type of pigment selected from the group consisting of inorganic pigment and organic pigment. It is more preferable to use at least one type of pigment selected from the group consisting of carbon black, oxide series inorganic pigment, ferrocyanide series inorganic pigment, silicate series inorganic pigment, carbonate series inorganic pigment, phosphate series inorganic pigment, phthalocyanine series organic pigment, perylene series organic pigment and isoindolinon series organic pigment.

[0083] Next, the method for manufacturing the spun-dyed textured polylacted filament yarn having the aforementioned

features will be explained.

[0084] Initially, a polylacted polymer is spun to obtain a spun filament (spinning process). For example, as shown in Fig. 1, polylacted resin is poured in through the polylacted resin inlet 10 and a coloring agent (pigment, etc.) is poured in through the coloring agent inlet 11. After melt-blending them in the extruder 12 having vents 13, they are extruded through the spinning nozzle 15 attached to the spinning head 14 to form filaments. At this time, the configuration of the hole of the spinning nozzle 15 should be appropriately designed so that the filament to be obtained has an approximately circular or circular cross-section having the degree of deformation of the cross-section of the filament less than 1.5. The mixing amount of the coloring agent is adjusted so that the coloring agent content rate falls within the range of 0.01 to 3 mass%. It is preferable that the melt-blending temperature in the extruder 12 is set to 210 to 235 ˚C. As the polylacted resin, polylacted resin having relative viscosity of 2.8 to 3.8, more preferably 3.0 to 3.6, is used. The relative viscosity is a value measured as a mixed solution of 20 ˚C, phenol/tetrachloroethane=60/40 (mass ratio). The reasons for using the polylacted resin having relative viscosity of 2.8 to 3.8 are the same reasons as mentioned above. As the coloring agent, a coloring agent in the form of a master batch in which a coloring agent is previously added to polylacted polymer can be used.

[0085] The polylacted resin is generally 0.4 to 0.5 mass% (4,000 to 5, 000 ppm) in official moisture regain in the polymer. In order to use polylacted polymer for mel t-spinning, it is preferable that the official moisture regain in the polylacted resin is 0.01 mass% (100 ppm) or less, more preferably 0.005 mass% (50 ppm) or less. For example, the water content in the polylacted resin is decreased by drying the polylacted resin at a temperature of 100 to 130 ˚C for about 5 hours using a vacuum hot air drying machine. In the case of using a biaxial extruder with vents, it is practically possible to use undried polylacted resin, and melt-spinning can be performed while maintaining the relative viscosity of the polylacted polymer.

[0086] The configuration and the size of the hole of the spinning nozzle 15 are designed so that a desired spun-dyed textured polylacted filament yarn can be obtained considering the melt viscosity, the spinning temperature, the quenching conditions after the spinning.

[0087] Subsequently, the filaments extruded from the spinning 15 are cooled with quench air from the quench air blowing apparatus 16 (see Fig. 1).

[0088] Thereafter, after applying lubricant to the filaments with the lubricant applying apparatus 17, a spun filament yarn is obtained by bundling them. The lubricant is not specifically limited, but can be, for example, the lubricant having lubricating agent as a main gradient and containing, e.g., an emulsifying agent and an antistatic agent. The preferable lubricant composition is exemplified as follows. As the lubricating agent, it is preferable to use neopentyl glycol dioleate. As the emulsifying agent, it is preferable to use polyoxyethylene castor oil or polyoxyalkylene sorbitan ester. As the antistatic agent, it is preferable to use polyoxyethylene alkyl phosphate. Furthermore, depending on the needs, additive agents such as, e.g., an antioxidizing agent and an ultraviolet [UV] absorber can be added to the lubricant. The preferable content rate of each composition of the lubricant is as follows: the lubricating agent is 35 to 75 mass%; the emulsifying agent is 20 to 60 mass%; and the antistatic agent is 0.5 to 8 mass%.

[0089] By applying the lubricant, the tenacity and the elongation of the textured filament yarn can be stably secured at the spinning and expanding steps for manufacturing a spun-dyed textured polylacted filament yarn and generation of crimps at the crimping step can be stably secured. Furthermore, electrostatic generation of the carpet using the spun-dyed textured polylacted filament yarn can be suppressed, and the friction coefficient of the filament yarn surface can be reduced, which can further improve the abrasion resistance of the carpet surface.

[0090] Thereafter, the spun filaments are received by the receiving roller 1 rotating at a predetermined rotational rate. The rotational rate of the receiving roller 1 is preferably set to 400 to 1, 000 m/min. If the rotational rate is less than 400 m/min., the filament yarn tensile force during the spinning becomes too low, which is not preferable. On the other hand, if it exceeds 1, 000 m/min. , the drawing speed and the crimping process become higher. Therefore it is difficult to execute the manufacturing by a currently available practical process.

[0091] The spun filaments received by the receiving roller 1 are heat-drawn at a single stage or multiple stages using rollers 2, 3 and 4. In detail, initially, the received spun filaments are introduced to the preheating roller 2 to preheat the spun filaments. At this time, it is preferable to set the temperature of the preheating roller 2 so that the temperature falls within the range of 55 to 95 ˚C. Setting the temperature within the aforementioned range enables even preheating. Among other things, the temperature of the preheating roller 2 is set so as to fall within the range of 55 to 70 ˚C.

[0092] Thereafter, the spun filaments are introduced from the preheating roller 2 to the draw roller 3. At this time, the temperature of the draw roller 3 is set so as to fall within the range of 70 to 125 ˚C. If the temperature is lower than 70 ˚C, uneven extension may easily occur, and it is difficult to attain sufficient extension, which in turn may sometimes cause filament yarn breakage. On the other hand, if it exceeds 125 ˚C, the filament yarn loosens during the processing. It is preferable to set the temperature of the draw roller 3 so that the temperature falls within the range of 85 to 125 ˚C, more preferably 95 to 120 ˚C. In the aforementioned temperature ranges, the temperature of the draw roller 3 is set to a temperature higher than the temperature of the preheating roller 2.

[0093] The draw ratio is set to 3 to 6 times. If it is less than 3 times, sufficient tenacity cannot be attained. If it exceeds

6 times, feather-like things will be generated remarkably. Among other things, the draw ratio is preferable set to 3.5 to 5.0 times.

[0094] Setting the temperature of the draw roller 3 so as to fall within the range of 70 to 125 ˚C and setting the draw ratio to 3 to 6 times makes it possible to obtain high tenacity, high elongation, and high crimp property of the spun-dyed textured polylacted filament yarn of the first invention, which in turn can realize the improved loftiness and excellent abrasion resistance required for a carpet using the textured filament yarn as the constituent yarn of the carpet.

[0095] Thereafter, the spun filaments are introduced from the draw roller 3 to the heat-set roller 4 to execute heat-setting. At this time, the temperature of the heat-set roller 4 is set so as to fall within the range of 100 to 150 ˚C. By setting the temperature so as to fall within the range, appropriate crystallization as a polylacted filament yarn can be exerted, resulting in improved tenacity and elongation of the textured filament yarn. Among other things, the temperature of the heat-set roller 4 is set so as to fall within the range of 105 to 140 ˚C, more preferably 110 to 130 ˚C. The still more preferable range is 110 to 125 ˚C. The temperature of the heat-set roller 4 is preferably set to a temperature higher than the temperature of the draw roller 3 within the range of 100 to 150 ˚C.

[0096] Especially, in order to attain the high tenacity, high elongation, and high crimping characteristics of the spun-dyed textured polylacted filament yarn of the first invention, it is preferable that the temperature of the heat-set roller 4 is set to a temperature not higher than the temperature (Ts) of the softening point of the polylacted polymer. That is, it is preferable that the temperature of the heat-set roller 4 is set to a temperature not lower than 100 ˚C but not higher than the temperature (Ts) of the softening point of the polylacted polymer. The temperature of the softening point of polylacted polymer is about 130 ˚C, and therefore it is preferable that the temperature of the heat-set roller is set to 100 to 130 ˚C, more preferably 110 to 130 ˚C, still more preferably 110 to 125 ˚C.

[0097] Next, the heat-set spun filaments are introduced to the texturing device 5 to give crimps to the spun filaments to thereby give loftiness (crimping step). The texturing device 5 is a device for giving crimps to the filament yarn by bringing a heated fluid to the filament yarn. The temperature of the texturing device 5 is set so as to fall within the range of 90 to 160 ˚C. If the temperature is lower than 90 ˚C, sufficient crimps cannot be given. On the other hand, a temperature exceeding 160 ˚C may sometimes cause fusion bonding of the filaments.

[0098] In this embodiment, the texturing device 5 is equipped with a heated fluid spraying nozzle device configured to spray a heated high pressure fluid in a thread-like manner to entangle filaments to thereby form a three-dimensional crimp and a compression heat treatment device configured to execute a compression heat treatment of the textured filament yarn with a heated fluid. The compression heat treatment device is a circular device in which metal plates are arranged at constant gaps. The heated pressurized fluid is sucked outwards between the metal plates. Within the texturing device 5, the filament yarn is folded and accumulated for a certain period of time for a heat treatment.

[0099] As the heated fluid used for the texturing device 5, superheated vapor and heated air can be exemplified. Among other things, it is preferable to use heated air. The temperature of the heated air is set so as to fall within the range of 90 to 160 ˚C, preferably 100 to 140˚C, more preferably 105 to 125 ˚C. The temperature of the heated fluid can be set to a temperature falling within the range of 90 to 160 ˚C, and appropriate conditions can be selected depending on the pressure and flow amount of the heated fluid, and the fineness and the crimping processing rate, etc., of the polylacted filament yarn to be subjected to crimping processing.

[0100] Furthermore, in order to attain high tenacity, high elongation and high crimping characteristics of the spun-dyed textured polylacted filament yarn of the first invention, it is preferable that the temperature of the heated fluid is set to a crystallization temperature (Tc) of the polylacted polymer or below. If the temperature of the heated fluid set to 90 ˚C or above but not higher than the crystallization temperature (Tc) of the polylacted polymer, damages to the filament yarn at the time of giving crimps to the orientated crystallized polylacted filament yarn can be decreased, resulting in desired crimping characteristics. Since the crystallization temperature of the polylacted polymer is about 115 to 120 ˚C, the temperature of the heated fluid is preferably set to 90 to 120 ˚C. Among other things, it is more preferable that the temperature of the heated fluid is set to 90 to 115 ˚C.

[0101] It is more preferable that the following relational expression is met:

$$30\ °C \geqq S-R \geqq -10\ °C$$

where "S" is a temperature of the heat-set roller, and "R" is a temperature of the heated fluid in the texturing device. When the above conditions are met, both the tenacity and the elongation of the spun-dyed textured polylacted filament yarn to be obtained can be improved. Among other things, it is still more preferable that the following relational expression is met:

20 °C≧S-R≧-10 °C, still yet more preferably

15 °C≧S-R≧-10 °C.

[0102] The textured filament yarn 6 to which crimps are given with the texturing device 5 is cooled with a cooling drum 20. In this embodiment, the textured filament yarn 6 fed on the cooling drum 20 is transferred while being absorbed and cooled with the apertures formed in the surface of the cooling drum 20. At this cooling step, it is preferable that the textured filament yarn 6 is cooled to a temperature lower than the glass transition temperature (Tg) (57 to 60 ˚C) of the polylacted polymer. This makes it possible to manufacture a spun-dyed textured polylacted filament yarn having sufficient crimps which would not be loosen even if a certain time has passed. Among other things, it is preferable to cool the textured filament yarn 6 to 30 to 55 ˚C.

[0103] Thereafter, the textured filament yarn is passed into the entangle processing device 21 to execute the entangle processing. It is preferable that high pressure air of 0.2 to 0.5 MPa is sprayed onto the traveling textured filament yarn from the confounding nozzle at an approximately rectangular angle.

[0104] Next, the entangled textured filament yarn is rolled up onto a winder 22. The winding tensile force at that time is preferably set to 0.10 cN/dtex. Among other things, it is preferable that the winding tensile force falls within the range of 0. 02 to 0.07 cN/dtex, more preferably 0.03 to 0.05 cN/dtex.

[0105] The spun-dyed textured polylacted filament yarn obtained as mentioned above is excellent in loftiness, toughness and abrasion resistance. Therefore, it can be preferably used as a constituent yarn of a carpet. For example, the obtained spun-dyed textured polylacted filament yarn is tufted in the base fabric to produce a carpet. The base fabric is not specifically limited, but can be exemplified by a nonwoven fabric made of polylacted filament yarns, as well as polyester nonwoven fabric and polypropylene nonwoven fabric. Among other things, as the base fabric, a nonwoven fabric made of polylacted filament yarns is preferably used. In this case, the entire tufted carpet will be decomposed by microorganisms, etc., when discarded after the usage, which sufficiently contributes to global environment protections.

[0106] The spun-dyed textured polylacted filament yarn of the first embodiment is not specifically limited to the filament yarn manufactured by the aforementioned exemplified manufacturing method.

[0107] The spun-dyed textured polylacted filament yarn of the first invention can be used in the form of a twisted yarn or a non-twisted yarn, or can be used in the form of a combined filament yarn in which a non-twisted yarn and other non-twisted yarn are entangled with an air entangling facility. Furthermore, the spun-dyed textured polylacted filament yarn of the first invention can be used as a constituent yarn of a carpet by twisting together with other nylon textured filament yarns, polypropylene textured filament yarns and polyester textured filament yarns. Sufficiently considering an environment-responsive recycle, as other constituent materials (materials other than the spun-dyed textured polylacted filament yarn) of a carpet, it is preferable to use polyester such as, e.g., PET (polyethylene terephthalate).

[0108] Furthermore, after forming a twisted textured filament yarn (twisted number is preferably 150 to 250 times/m) by executing upper twisting and lower twisting using two or three spun-dyed textured polylacted filament yarns of the first invention, the twisted textured filament yarn is subjected to a heated air treatment of 100 to 125 ˚C and a steam treatment of 90 to 115 ˚C in a vacuum equipment to execute the twist fixing. As a result, a textured filament yarn further improved in loftiness, abrasion resistance and buckling resistance can be obtained, which in turn can provide a high-grade carpet by tufting the textured filament yarn.

[0109] The spun-dyed textured polylacted filament yarn of the first invention and the spun-dyed textured polylacted filament yarn obtained by the manufacturing method of the first invention can be preferably used as, for example, a constituent yarn of a carpet. The carpet produced using the spun-dyed textured polylacted filament yarn of the first invention and the carpet produced using the spun-dyed textured polylacted filament yarn obtained by the manufacturing method of the first invention can have sufficient loftiness and sufficient voluminous look and can be excellent in abrasion resistance and buckling resistance.

[0110] Next, a carpet according to the second invention will be explained. The spun-dyed textured polylacted filament yarn made from plant-derived material according to the second invention is a textured filament yarn obtained by yarn-making a specific polylacted polymer and subjecting it to a crimping process and will be formed into a pile yarn specified in filament yarn properties. The carpet manufacturing method is not specifically limited, and can be any method for manufacturing, for example, a woven carpet, an embroider carpet, an adhesive carpet and a knitted carpet. The configuration of the pile is not specifically limited, and can be in the form of a cut pile, a loop file, or a cut-and-loop file.

[0111] The polylacted polymer constituting a polylacted resin composition as a material of the spun-dyed textured polylacted filament yarn is polylacted polymer in which lactide monomer containing L-lactide as a main ingredient is polymerized. It is preferable that 90 mass% or more of the lactide monomer is constituted by L-lactide. In other words, D-lactide can be contained in the lactide monomer in the range not exceeding 10 mass%. When the optical purity (optical

purity of L-lactide) of the lactide monomer to be used is 90 % or more, the polylacted polymer becomes crystalline, which is preferable. When the optical purity of the lactide monomer to be used is 97 % or more, the melting point becomes about 170 ˚C, which is more preferable. Polylacted polymer in which components other than lactide are copolymerized can be used so long as the amount falls within the range which does not harm the effects of the present invention. In the case of copolymerizing components other than lactide, the lactide unit should be 70 mass% or more but less than 100 mass% of the repeating unit of the polymer molecular chain, preferably 80 mass% or more but less than 100 mass%, more preferably 90 mass% or more but less than 100 mass%.

[0112] The relative viscosity (RV) of the spun-dyed textured polylacted filament yarn is required to be 2.5 to 3.8. The relative viscosity is a value measured using a mixed solution of 20 ˚C, phenol/tetrachloroethane=60/40 (mass ratio). If the relative viscosity is less than 2.5, sufficient tenacity and elongation cannot be given to the polylacted textured filament yarn, and abrasion property appropriate to the carpet usage cannot be given thereto. On the other hand, if the relative viscosity exceeds 3.8, the melt viscosity becomes high excessively. As a result, it is required to raise the spinning temperature, resulting in decreased relative viscosity of the textured polylacted filament yarn which is extremely lower than a before-melt level thereof and also resulting in insufficiently improved tenacity. In addition, this also causes difficulty in spinning. It is more preferable that the relative viscosity of the spun-dyed textured polylacted filament yarn is 2.8 to 3.6.

[0113] Furthermore, the polylacted resin compound used as a material of the spun-dyed textured polylacted filament yarn contains a coloring agent in the amount of 0.01 to 3 mass%. This concentration can give an appropriate color density to the textured filament yarn, resulting in improved design property. If the concentration is set to 0.01 mass% or more, generation of color shading due to the coloring agent irregularity can be prevented. If it is set to 3 mass% or less, generation of filament yarn breakage can be sufficiently prevented. It is especially preferable that the ratio of content of the coloring agent is 0.05 to 1.0 mass%. Furthermore, the coloring agent can be used together with a dispersing agent normally used (e.g., olefin series compound).

[0114] In addition to polymer (including polymer particles) other than polylacted polymer, it should be noted that any additive agent, such as, e.g., a delustering agent, a plasticizing agent, a fire retardant, an antistatic agent, an odor eliminating agent, an antibacterial agent, an antioxidant agent, a heat resisting agent, a light resistant agent, and an ultraviolet [UV] absorber, can be added to the polylacted resin composition so long as the amount falls within the range which does not harm the effects of the present invention.

[0115] The carpet of the second invention using the spun-dyed textured polylacted filament yarn as a pile yarn is a carpet in which the spun-dyed textured polylacted filament yarn used as the pile yarn meets all of the following characteristics (1) to (7):

(1) a filament has an approximately circular or circular cross-section (i.e., circular cross-sectional filament yarn). This cross-sectional configuration gives abrasion resistance to the filament yarn. It is preferable that the cross-sectional configuration of the filament is an approximately circular or circular having a degree of deformation less than 1.5, wherein the degree of deformation is expressed by a ratio (B/A) of a diameter B of an circumscribed circle of the filament cross-section to a diameter A of a inscribed circle of the filament cross-section (see Fig. 2). If the degree of deformation exceeds 1.5, the covering property of the textured polylacted filament yarn can be improved. However, due to the large degree of deformation, the hard and brittle properties inherent in the polylacted polymer tend to be exerted, resulting in deteriorated abrasion resistance of the filament yarn, and therefore it is not preferable;
(2) relative viscosity (RV) is 2.5 to 3.8;
(3) tenacity is 1.75 to 3.5 cN/dtex;
(4) elongation is 35 to 60 %;
(5) a filament fineness is 2.5 to 25 dtex;
(6) hot water shrinkage ratio is 2 to 8 %; and
(7) dry heat crimp ratio is 5 to 25 %.

[0116] The tenacity of the spun-dyed textured polylacted filament yarn is 1.75 to 3.5 cN/dtex. If the tenacity of the textured filament yarn is less than 1.75 cN/dtex, when the textured filament yarn is used as a carpet, the abrasion resistance becomes insufficient, and a part of the textured filament yarn may sometimes be worn out. It is preferable that the tenacity of the spun-dyed textured polylacted filament yarn is 2.0 to 3.25 cN/dtex, more preferably 2.25 to 3.25 cN/dtex. The elongation of the spun-dyed textured polylacted filament yarn is 35 to 60 %. If the elongation of the textured filament yarn is less than 35 %, when the textured filament yarn is used as a carpet, the abrasion resistance becomes insufficient, and a part of the textured filament yarn may sometimes be worn out. It is preferable that the elongation of the spun-dyed textured polylacted filament yarn is 40 to 55 %.

[0117] If the tenacity of the spun-dyed textured polylacted filament yarn is 2.0 to 3.25 cN/dtex and the elongation of the spun-dyed textured polylacted filament yarn is 40 to 55 %, the filament yarn can have higher toughness, which is preferable. However, raising of the tenacity generally causes deterioration of elongation. Even if the elongation is set to 35 % or more, the tenacity is merely 3.5 cN/dtex. Furthermore, if the elongation exceeds 60 %, the tenacity cannot

be increased so as to exceed 1.75 cN/dtex.

[0118] Furthermore, the total fineness of the spun-dyed textured polylacted filament yarn preferably falls within the range of 500 to 3,500 dtex. So long as it falls within the range, it becomes an optimal spun-dyed textured filament yarn for a tufted carpet, but not limited to such usage. Among other things, it is preferable that the total fineness of the spun-dyed textured polylacted filament yarn falls within the range of 1,000 to 3,000 dtex. The filament fineness of the spun-dyed textured polylacted filament yarn falls within the range of 2.5 to 25 dtex. If the filament fineness is less than 2.5 dtex, it becomes difficult to perform the yarn-making stably, and the loftiness of the carpet formed using the textured filament yarns becomes insufficient. If the filament fineness exceeds 25 dtex, it become difficult to obtain the filament yarn property of the spun-dyed textured polylacted filament yarn and the hard and brittle properties inherent in the polylacted polymer tend to be exerted, resulting in deteriorated abrasion resistance of the filament yarn. This tendency becomes prominent as the degree of deformation of the cross-section of the polylacted filament yarn increases in the same filament fineness. Accordingly, the smaller degree of deformation of the filament is preferable. It is preferable that the filament fineness of the spun-dyed textured polylacted filament yarn falls within the range of 4 to 20dtex, more preferably 5 to 15 dtex. In cases where the filament fineness falls within the range of 2.5 to 25 dtex, the soft and brittle property of the polylacted polymer can be weakened and the tenacity and the elongation of the spun-dyed textured polylacted filament yarn can be further improved and that the abrasion resistance of a carpet using the spun-dyed textured polylacted filament yarn can also be improved.

[0119] The hot water shrinkage ratio of the spun-dyed textured polylacted filament yarn falls within the range of 2 to 8 %. If the hot water shrinkage ratio is less than 2 %, the crystallinity of the spun-dyed textured polylacted filament yarn becomes higher. As a result, the hard and brittle property of the polylacted polymer will be easily exerted, resulting in poor balanced tenacity and elongation and resulting in insufficient abrasion resistance as a carpet. On the other hand, if the hot water shrinkage ratio exceeds 8 %, there are problems that filament yarn shrinkage occurs at the time of the heat-set treatment and it becomes difficult to administrate each carpet manufacturing step. Among other things, it is preferable that the hot water shrinkage ratio of the spun-dyed textured polylacted filament yarn falls within the range of 3 to 6 %.

[0120] The dry heat crimp ratio of the spun-dyed textured polylacted filament yarn falls within the range of 5 to 25 %. This dry heat crimp ratio is a parameter showing the loftiness of the spun-dyed textured polylacted filament yarn, and a value showing the degree of crimps formed by treating the spun-dyed textured polylacted filament yarn with heated air of 100 ˚C. If the dry heat crimp ratio is less than 5 %, crimping becomes insufficient, the loftiness as a carpet becomes insufficient, and the buckling resistance becomes poor. On the other hand, it is difficult to obtain a textured polylacted filament yarn having a dry heat crimp ratio exceeding 25 % by currently available manufacturing technique. Even if it is possible, the carpet using the textured filament yarn becomes a felt-like carpet. Among other things, the dry heat crimp ratio preferably falls within the range of 8 to 20 %.

[0121] As the coloring agent for the spun-dyed textured polylacted filament yarn, for example, an inorganic pigment and an organic pigment can be exemplified. But the coloring agent is not specifically limited thereto so long as it gives a color to the textured filament yarn. As the coloring agent, for example, at least one of pigments selected from the group comprising a carbon black, an inorganic pigment such as, e.g., an oxidization series organic pigment, a ferrocyanide inorganic pigment, a silicate inorganic pigment, a carbonate inorganic pigment, and a phosphate inorganic pigment, a phthalocyanine series organic pigment, a perylene series organic pigment, and an isoindolinon series organic pigment is used.

[0122] Hereinafter, a concrete manufacturing method of the spun-dyed textured polylacted filament yarn required in the second invention will be explained, but not limited thereto.

[0123] As the polylacted resin for use in manufacturing the spun-dyed textured polylacted filament yarn, polylacted resin having a relative viscosity (RV) of 2.5 to 3.8 measured as a mixed solution of 20 ˚C, phenol/tetrachloroethane = 60/40 (mass ratio) is used. In the carpet usage of the second invention, since the tenacity and the elongation of the textured filament yarn, the crimping characteristics and the abrasion resistance are required, polylacted polymer having a high molecular weight, i.e., polymer having the above-specified relative viscosity, will be required.

[0124] As the inorganic pigment and the organic pigment to be used as a coloring agent for the spun-dyed textured polylacted filament yarn, at least one pigment selected from the above-specified compounds is used. After adding a coloring agent to the polylacted polymer, yarn-making can be performed.

[0125] Polylacted polymer in which the aforementioned polylacted polymer and the coloring agent are mixed at a certain ratio with a mixing device is supplied to a biaxial extruder 12 with vents 13 and molten and extruded from the spinning nozzle 15 via a spinning pack.

[0126] The spun-dyed textured polylacted filament yarn comprises a filament having an approximately circular or circular cross-sectional configuration. The degree of deformation of the filament cross-section expressed by a ratio (B/A) of a diameter B of an circumscribed circle of the filament cross-section to a diameter A of a inscribed circle of the filament cross-section is preferably less than 1.5.

[0127] Next, the spun filaments are cooled and solidified with quench air of the cooling device 16.

[0128] After applying a lubricant to the cooled and solidified spun filaments, the filaments are received with the receiving roller 1 rotating at a predetermined rotational rate.

[0129] The rotational speed of the receiving roller 1 is 400 to 1,000 m/mim.

[0130] The manufacturing method of the textured filament yarn according to the second invention is characterized in a direct spinning extension and crimping process, and therefore the aforementioned receiving speed is preferably employed.

[0131] The received undrawn filaments are continuously heat-drawn at a single stage or multiple stages using rollers 1 to 4. The temperature of the draw roller 3 is set to 70 to 125 ˚C. The draw ratio is set so as to fall within the range of 3.0 to 6.0. Especially in order to attain the high tenacity and elongation of the spun-dyed textured polylacted filament yarn of this invention and the excellent loftiness and the abrasion resistance when it is used as a carpet, it is importance that a sufficiently drawn and oriented polylacted filament yarn is subjected to crimping processing.

[0132] The sufficiently drawn and oriented polylacted filaments are heat-set with the heat-set roller 4. The temperature of the heat-set roller 4 is 100 to 150 ˚C. Appropriately setting the temperature range of the heat-set roller 4 makes it possible to control the crystallization of the polylacted filaments, resulting in desired properties.

[0133] The drawn polylacted filaments are continuously introduced into the texturing device 5 to give crimps to the filaments. The filament yarn 6 textured with the texturing device 5 is cooled on the cooling drum 20.

[0134] The heated fluid is preferably heated air and the temperature is 90 to 160 ˚C. Appropriate conditions are selected depending on the fineness, processing rate, etc., of the polylacted filament yarn.

[0135] Subsequently, the textured filament yarn is subjected to entangle process via the nozzle of the entangle processing device 21. The entangling nozzle has normally 2 to 6 apertures and is configured to execute entangle processing by spraying high pressure air of 0.2 to 0.5 MPa onto the traveling textured filament yarn at an approximately rectangular angle.

[0136] Then, the polylacted textured filament yarn is rolled up onto a winder 22. The winding is performed with a winding tensile force of 0.10 cN/dtex or below.

[0137] As the pile yarn for the carpet according to the second invention, it is preferable to use a non-twisted or twisted spun-dyed textured polylacted filament yarn as a single yarn and/or two or more doubled and twisted yarn.

[0138] Concretely, the following (1) to (8) can be used as a pile yarn.

(1) a pile yarn which is a non-twisted spun-dyed textured polylacted filament yarn (raw filament yarn)
(2) a pile yarn in which non-twisted spun-dyed textured polylacted filament yarns are air-tangled
(3) a pile yarn in which two or more non-twisted spun-dyed textured polylacted filament yarns are twisted
(4) a pile yarn in which the spun-dyed textured polylacted filament yarn is twisted at the twist count of 50 to 250 T/m
(5) a pile yarn in which two or more of the twisted spun-dyed textured polylacted filament yarns are twisted
(6) a pile yarn in which a heat-set pile yarn of the spun-dyed textured polylacted filament yarn is subjected to a wet heat treatment and a dry heat treatment
(7) a pile yarn in which the dry heat treatment temperature of the pile yarn of the spun-dyed textured polylacted filament yarn is set to 90 to 130 ˚C
(8) a pile yarn in which the wet heat treatment temperature of the pile yarn of the spun-dyed textured polylacted filament yarn is set to 80 to 120 ˚C

By employing any one of the pile yarns or any combination thereof, a carpet using the spun-dyed textured polylacted filament yarn as a pile yarn can be manufactured.

[0139] In the pile yarn using the spun-dyed textured polylacted filament yarn, the color, the total fineness (dtex) of the pile yarn, the state (non-twisted yarn or twisted yarn) of the polylacted textured filament yarn, the number of combined spun-dyed textured polylacted filament yarns, and the conditions/status of the twisted yarn, etc., are decided based on the manufacturing standard of a carpet.

[0140] The spun-dyed textured polylacted filament yarn can be used in the form of a non-twisted filament yarn, or in the form of a combined filament yarn in which a non-twisted filament yarn and other non-twisted filament yarn are combined with an air tangling device, or can be used as it is or in the form of a twisted yarn.

[0141] The spun-dyed textured polylacted filament yarn according to the second invention can be used in the form of a twisted yarn (the twist count is preferably 150 to 250 T/m), or can be used after twisting two or more of twisted yarns (the twist count is preferably 50 to 200 T/m).

[0142] For example, using two or three spun-dyed textured polylacted filament yarns, lower twisting and upper twisting are performed to obtain a twisted textured yarn. Thereafter, twist setting is executed with the heated air treatment of 100 to 125 ˚C or steam treatment of 90 to 115 ˚C in a vacuum equipment to thereby obtain a pile yarn for a carpet.

[0143] It is preferable that the average pile length of the carpet surface using the pile yarn of the spun-dyed textured polylacted filament yarn is 5 to 15 mm, and the pile weight per unit area is 500 to 3,000 g/m^2. The carpet manufacturing method is not specifically limited, and can be any method for manufacturing, for example, a woven carpet, an embroider

carpet, an adhesive carpet and a knitted carpet. The configuration of the pile is not specifically limited, and can be any one of configurations selected from a cut pile, a loop file, and a cut-and-loop file depending on the required texture.

[0144] The average pile length of the spun-dyed textured polylacted filament yarn formed into the carpet of the second invention is 5 to 15 mm, preferably 6.5 to 15 mm, more preferably 7.5 to 12 mm, still more preferably 8 to 12 mm. If the average pile length is less than 5 mm, the base fabric can be seen via the gaps of the pile surface. This results in deteriorated loftiness and bottom-out feeling at the time of using the carpet. If the average pile length exceeds 15 mm, although it is excellent in loftiness and it looks good, the cost increases. Furthermore, the pile yarn becomes weak in drape, resulting in easy-to-fall pile in use.

[0145] The weight per unit area of the pile of the carpet according to the second invention is 500 to 3, 000 g/cm^2, more preferably 600 to 2,500 g/m^2, still more preferably 800 to 2, 200 g/m^2. If the weight per unit area of the pile is less than 500 g/m^2, the backing can be seen via the gaps of the pile surface. This results in deteriorated loftiness and bottom-out feeling at the time of using the carpet. If the weight per unit area of the pile exceeds 3,000 g/m^2, although it is excellent in loftiness and it looks good, it becomes heavy, resulting in hard-to-handle carpet.

[0146] For example, in the case of tufting a pile yarn of the spun-dyed textured polylacted filament yarn, the gauge is preferably 1/16 to 1/4 (the number of needles with 1 inch (2.54 cm) space), more preferably 1/12 to 1/8. The stitch number is 25 to 70 stitch/10 cm, preferably 35 to 65 stitch/10 cm, more preferably 46 to 65 stitch/10 cm.

[0147] The carpet using the spun-dyed textured polylacted filament yarn as a pile yarn is subjected to a backing treatment to fix the pile yarn. At this time, the carpet will pass a drying step and a heat-set step to exert crimps inherent in the spun-dyed textured polylacted filament yarn normally by a dry heat treatment and/or a vapor treatment, resulting in a carpet excellent in loftiness and giving no bottom-out feeling.

[0148] The carpet of the second invention uses the spun-dyed textured polylacted filament yarn as a pile yarn. If polylacted resin in the amount of 30 to 70 mass% is added to the base fabric, the backing resin, etc., constituting the carpet, the plant-percentage thereof increases, resulting in a global environment friendly carpet which increases less carbon dioxide from the view point of environmental protection.

[0149] The pile abrasion amount of the carpet surface of the second invention measured by a Taber type abrasion test (a test is performed according to a Taber type abrasion test defined by JIS L1096.8.17.3. An H-18 abrasion ring is used, and the number of the abrasion is 2, 500 times) is 5 to 30 mass%. When the abrasion amount of the pile yarn by the Taber type abrasion test is 5 to 30 mass%, a carpet excellent in abrasion resistance can be provided. It is preferable that the abrasion amount of the pile yarn is less than 5 mass%, which is, however, a number practically difficult to attain. If the abrasion amount of the pile yarn exceeds 30 mass%, the filament yarns gradually drop off from the carpet during the use. As a result, the base fabric can be seen in due course, resulting in largely different appearance, which is not preferable.

[0150] The carpet using the spun-dyed textured polylacted filament yarn made from the above-specified plant-derived material is used as a pile yarn can be provided as a carpet excellent in loftiness and having voluminous look. Furthermore, a carpet remarkably improved in abrasion resistance and buckling resistance as compared with a carpet manufactured using conventional polylacted filament yarns can be provided. The carpet can be used as a carpet for various purposes in the fields of a roll carpet, a piece carpet, a tile carpet, an automobile carpet and an option carpet, and a household rug/mat, which can make use of the characteristics of the carpet of the invention.

[0151] Next, a carpet according to the third invention will be explained. The carpet of the third invention is a carpet using a pile yarn made of the spun-dyed textured polylacted filament yarn and the spun-dyed textured synthetic filament yarn, wherein the carpet meets the pile yarn abrasion amount of the carpet surface measured by a Taber type abrasion test (a test is performed according to a Taber type abrasion test defined by JIS L1096.8.17.3. An H-18 abrasion ring is used, and the number of the abrasion is 5, 000 times) is 5 to 30 mass%.

[0152] When the pile yarn abrasion amount of the surface by the Taber type abrasion test is 5 to 30 mass%, a carpet excellent in abrasion resistance can be provided. It is ideal that the abrasion amount of the pile yarn is less than 5 mass%, which is, however, a number practically difficult to attain. If the abrasion amount of the pile yarn exceeds 30 mass%, the filament yarns gradually drop off from the carpet during the use. As a result, the base fabric can be seen in due course, resulting in largely different appearance, which is not preferable.

[0153] The method of using the spun-dyed textured polylacted filament yarn and the spun-dyed textured synthetic filament yarn as a pile yarn is not specifically limited. The pile yarn made of the spun-dyed textured polylacted filament yarns and the pile yarn made of the spun-dyed textured synthetic filament yarns can be arranged every one or two rows (see Fig. 3). Alternatively, the spun-dyed textured polylacted filament yarn and the spun-dyed textured synthetic filament yarn are combined into a composite yarn and this composite yarn can be used as a pile yarn (see Fig. 4).

[0154] The carpet manufacturing method is not specifically limited, and can be any method for manufacturing, for example, a woven carpet, an embroider carpet, an adhesive carpet and a knitted carpet. The configuration of the pile is not specifically limited, and can be in the form of a cut pile, a loop file, or a cut-and-loop file.

[0155] The polylacted polymer constituting a polylacted resin composition as a material of the spun-dyed textured polylacted filament yarn is polylacted in which lactide monomer containing L-lactide as a main ingredient is polymerized.

It is preferable that 90 mass% or more of the lactide monomer is constituted by L-lactide. In other words, D-lactide can be contained in the lactate monomer in the range not exceeding 10 mass%. When the optical purity (optical purity of L-lactide) of the lactide monomer to be used is 90 % or more, the polymer (polylacted) becomes crystalline, which is preferable. When the optical purity of the lactide monomer to be used is 97 % or more, the melting point becomes about 170 ˚C, which is more preferable. Polylacted polymer in which components other than lactide are copolymerized can be used so long as the amount falls within the range which does not harm the effects of the present invention. In the case of copolymerizing components other than lactide, the lactide unit should be 70 mass% or more but less than 100 mass% of the repeating unit of the polymer molecular chain, preferably 80 mass% or more but less than 100 mass%, more preferably 90 mass% or more but less than 100 mass%.

[0156] The relative viscosity (RV) of the spun-dyed textured polylacted filament yarn is required to be 2.5 to 3.8. The relative viscosity is a value measured using a mixed solution of 20 ˚C, phenol/tetrachloroethane=60/40 (mass ratio). If the relative viscosity is less than 2.5, sufficient tenacity and elongation cannot be given to the polylacted textured filament yarn, and abrasion property appropriate to the carpet usage cannot be given thereto. On the other hand, if the relative viscosity exceeds 3.8, the melt viscosity becomes high excessively. As a result, it is required to raise the spinning temperature, resulting in decreased relative viscosity of the textured polylacted filament yarn which is extremely lower than a before-melt level thereof and also resulting in insufficiently improved tenacity. In addition, this also causes difficulty in spinning. It is more preferable that the relative viscosity of the spun-dyed textured polylacted filament yarn is 2.8 to 3.6.

[0157] Furthermore, the polylacted resin compound used as a material of the spun-dyed textured polylacted filament yarn contains a coloring agent in the amount of 0.01 to 3 mass%. This concentration can give an appropriate color density to the textured filament yarn, resulting in improved design property. If the concentration is set to 0.01 mass% or more, generation of color shading due to the coloring agent irregularity can be prevented. If it is set to 3 mass% or less, generation of filament yarn breakage can be sufficiently prevented. It is especially preferable that the ratio of content of the coloring agent is 0.05 to 1.0 mass%. Furthermore, the coloring agent can be used together with a dispersing agent normally used (e.g., olefin series compound).

[0158] In addition to polymer (including polymer particles) other than polylacted polymer, it should be noted that any additive agent, such as, e.g., delustering agent, plasticizing agent, fire retardant, antistatic agent, odor eliminating agent, antibacterial agent, antioxidant agent, heat resisting agent, light resistant agent, and ultraviolet [UV] absorber, can be added to the polylacted resin composition so long as the amount falls within the range which does not harm the effects of the present invention.

[0159] The carpet of the third invention using the spun-dyed textured polylacted filament yarn as a pile yarn is a carpet in which the spun-dyed textured polylacted filament yarn used as the pile yarn meets all of the following characteristics (1) to (7):

(1) a filament has an approximately circular or circular cross-section (i.e., circular cross-sectional filament yarn). This cross-sectional configuration gives abrasion resistance to the filament yarn. It is preferable that the cross-sectional configuration of the filament is an approximately circular or circular having a degree of deformation less than 1.5, wherein the degree of deformation is expressed by a ratio (B/A) of a diameter B of an circumscribed circle of the filament cross-section to a diameter A of a inscribed circle of the filament cross-section (see Fig. 2). If the degree of deformation exceeds 1.5, the covering property of the textured polylacted filament yarn can be improved. However, due to the large degree of deformation, the hard and brittle properties inherent in polylacted polymer tend to be exerted, resulting in deteriorated abrasion resistance of the filament yarn, and therefore it is not preferable;
(2) relative viscosity (RV) is 2.5 to 3.8;
(3) tenacity is 1.75 to 3.5 cN/dtex;
(4) elongation is 35 to 60 %;
(5) a filament fineness is 2.5 to 25 dtex;
(6) hot water shrinkage ratio is 2 to 8 %; and
(7) dry heat crimp ratio is 5 to 25 %.

[0160] The tenacity of the spun-dyed textured polylacted filament yarn is 1.75 to 3.5 cN/dtex. If the tenacity of the textured filament yarn is less than 1.75 cN/dtex, when the textured filament yarn is used as a carpet, the abrasion resistance becomes insufficient, and a part of the textured filament yarn may sometimes be worn out. It is preferable that the tenacity of the spun-dyed textured polylacted filament yarn is 2.0 to 3.25 cN/dtex, more preferably 2.25 to 3.25 cN/dtex. The elongation of the spun-dyed textured polylacted filament yarn is 35 to 60 %. If the elongation of the textured filament yarn is less than 35%, when the textured filament yarn is used as a carpet, the abrasion resistance becomes insufficient, and a part of the textured filament yarn may sometimes be worn out. It is preferable that the elongation of the spun-dyed textured polylacted filament yarn is 40 to 55 %.

[0161] If the tenacity of the spun-dyed textured polylacted filament yarn is 2.0 to 3.25 cN/dtex and the elongation of the spun-dyed textured polylacted filament yarn is 40 to 55 %, the filament yarn can have higher toughness, which is

preferable. However, raising of the tenacity generally causes deterioration of elongation. Even if the elongation is set to 35 % or more, the tenacity is merely 3.5 cN/dtex. Furthermore, if the elongation exceeds 60 %, the tenacity cannot be increased so as to exceed 1.75 cN/dtex.

[0162] Furthermore, the total fineness of the spun-dyed textured polylacted filament yarn preferably falls within the range of 500 to 3,500 dtex. So long as it falls within the range, it becomes an optimal spun-dyed textured filament yarn for a tufted carpet, but not limited to such usage. Among other things, it is preferable that the total fineness of the spun-dyed textured polylacted filament yarn falls within the rage of 1,000 to 3,000 dtex. The filament fineness of the spun-dyed textured polylacted filament yarn falls within the range of 2.5 to 25 dtex. If the filament fineness is less than 2.5 dtex, it becomes difficult to perform the yarn-making stably, and the loftiness of the carpet formed using the textured filament yarns becomes insufficient. If the filament fineness exceeds 25 dtex, it become difficult to obtain the filament yarn property of the spun-dyed textured polylacted filament yarn and the hard and brittle properties inherent in polylacted polymer tend to be exerted, resulting in deteriorated abrasion resistance of the filament yarn. This tendency becomes prominent as the degree of deformation of the cross-section of the polylacted filament yarn increases in the same filament fineness. Accordingly, the smaller degree of deformation of the filament is preferable. It is preferable that the filament fineness of the 1 spun-dyed textured polylacted filament yarn falls within the range of 4 to 20dtex, more preferably 5 to 15 dtex. In cases where the filament fineness falls within the range of 2.5 to 25 dtex, the soft and brittle property of the polylacted polymer can be weakened and the tenacity and the elongation of the spun-dyed textured polylacted filament yarn can be further improved and that the abrasion resistance of a carpet using the spun-dyed textured polylacted filament yarn can also be improved.

[0163] The hot water shrinkage ratio of the spun-dyed textured polylacted filament yarn falls within the range of 2 to 8 %. If the hot water shrinkage ratio is less than 2 %, the crystallinity of the spun-dyed textured polylacted filament yarn becomes higher. As a result, the hard and brittle property of the polylacted polymer will be easily exerted, resulting in poor balanced tenacity and elongation and insufficient abrasion resistance as a carpet. On the other hand, if the hot water shrinkage ratio exceeds 8 %, there are problems that filament yarn shrinkage occurs at the time of the heat-set treatment and it becomes difficult to administrate each carpet manufacturing step. Above all things, it is preferable that the hot water shrinkage ratio of the spun-dyed textured polylacted filament yarn falls within the range of 3 to 6 %.

[0164] The hot water shrinkage ratio of the spun-dyed textured polylacted filament yarn falls within the range of 5 to 25 %. If the hot water shrinkage ratio is less than 5 %, the crystallinity of the spun-dyed textured polylacted filament yarn becomes higher. As a result, the hard and brittle property of the polylacted polymer will be easily exerted, resulting in poor balanced tenacity and elongation and insufficient abrasion resistance as a carpet. On the other hand, if the hot water shrinkage ratio exceeds 25 %, there are problems that filament yarn shrinkage occurs at the time of the heat-set treatment and it becomes difficult to administrate each carpet manufacturing step. Above all things, it is preferable that the hot water shrinkage ratio of the spun-dyed textured polylacted filament yarn falls within the range of 8 to 20 %.

[0165] As the coloring agent for the spun-dyed textured polylacted filament yarn, for example, an inorganic pigment and an organic pigment can be exemplified. But the coloring agent is not specifically limited thereto so long as it gives a color to the textured filament yarn. As the coloring agent, for example, at least one of pigments selected from the group comprising carbon black, inorganic pigment such as, e.g., oxidization series organic pigment, ferrocyanide inorganic pigment, silicate inorganic pigment, carbonate inorganic pigment, and phosphate inorganic pigment, phthalocyanine series organic pigment, perylene series organic pigment, and isoindolinon series organic pigment is used.

[0166] The spun-dyed textured polylacted filament yarn used in the third invention is preferably a spun-dyed textured polyester filament yarn, a spun-dyed textured nylon filament yarn, or a spun-dyed textured polypropylene filament yarn. Considering environmental protections such as recyclability, the most preferable one is a spun-dyed textured polyester filament yarn. Combining a spun-dyed textured synthetic filament yarn made from a plant-derived material and a spun-dyed textured synthetic filament yarn made from a petroleum-derived material makes it possible to further improve the abrasion resistance and the loftiness as compared with a carpet only using a spun-dyed textured polylacted filament yarn made from a plant-derived material.

[0167] The pile yarn for a carpet of the third invention can be used as a single yarn and/or two or more of twisted yarns of a non-twisted yarn and/or a twisted yarn made of a spun-dyed textured polylacted filament yarns made from a plant-derived material and a spun-dyed textured synthetic filament yarns made from petroleum-derived material. Alternatively, the spun-dyed textured polylacted filament yarn and the spun-dyed textured synthetic filament yarn are combined into a composite yarn and this composite yarn can be used as a pile yarn (see Fig. 4).

[0168] Concretely, using the spun-dyed textured polylacted filament yarns made from a plant-derived material and the spun-dyed textured synthetic filament yarns made from petroleum-derived material, the following (1) to (7) can be used as a pile yarn.

(1) the non-twisted textured filament yarn (raw filament yarn) can be used as a pile yarn
(2) by air-tangling the non-twisted filament yarns, it can be used as a pile yarn
(3) by twisting them, it can be used as a pile yarn

(4) by twisting them at the twist count of 50 to 250 T/m, it can be used as a pile yarn
(5) by twisting two or more of them, it can be used as a pile yarn
(6) a pile yarn in which a heat-set pile yarn of the spun-dyed textured polylacted filament yarn is subjected to a wet heat treatment and a dry heat treatment
(7) by combining the spun-dyed textured polylacted filament yarn and the spun-dyed textured synthetic filament yarn and heat-setting the composite yarn, it can be used as a pile yarn.
By arbitrarily selectively employing the aforementioned spun-dyed textured polylacted filament yarns made from a plant-derived material and a spun-dyed textured synthetic filament yarns made from petroleum-derived material, a carpet improved in abrasion resistance can be manufactured.

[0169] In the carpet of the third invention, it is preferable that the carpet uses a pile yarn made of a spun-dyed textured polylacted filament yarns made from a plant-derived material and a spun-dyed textured synthetic filament yarns made from petroleum-derived material and that the carpet surface is 5 to 15 mm in the average pile length, and 500 to 3, 500 g/m^2 in pile weight per unit area.

[0170] When a spun-dyed textured polylacted filament yarns made from a plant-derived material and a spun-dyed textured synthetic filament yarns made from petroleum-derived material are used as a pile yarn, the average pile length is 5 to 15 mm, preferably 6.5 to 15 mm, more preferably 7.5 to 12 mm, still more preferably 8 to 12 mm. If the average pile length is less than 5 mm, the base fabric can be seen via the gaps of the pile surface. This results in deteriorated loftiness and bottom-out feeling at the time of using the carpet. If the average pile length exceeds 15 mm, although it is excellent in loftiness and it looks good, the cost increases. Furthermore, the pile yarn becomes weak in drape, resulting in easy-to-fall pile in use.

[0171] The weight per unit area of the pile of the carpet is 500 to 3, 500 g/cm^2, more preferably 600 to 3,200 g/m^2, still more preferably 800 to 3,000 g/m^2. If the weight per unit area of the pile is less than 500 g/m^2, the backing can be seen via the gaps of the pile surface. This results in deteriorated loftiness and bottom-out feeling at the time of using the carpet. If the weight per unit area of the pile exceeds 3,500 g/m^2, although it is excellent in loftiness and it looks good, it becomes heavy, resulting in hard-to-handle carpet.

[0172] For example, in the case of tufting a pile yarn made of a spun-dyed textured polylacted filament yarns made from a plant-derived material and a spun-dyed textured synthetic filament yarns made from petroleum-derived material, the gauge is preferably 1/16 to 1/4 (the number of needles with 1 inch (2.54 cm) space), more preferably 1/12 to 1/8. The stitch number is 20 to 70 stitch/10 cm, preferably 25 to 65 stitch/10 cm, more preferably 35 to 60 stitch/10 cm. The optimal stitch number is 40 to 60 stitch/10cm.

[0173] The carpet using a spun-dyed textured polylacted filament yarns made from a plant-derived material and a spun-dyed textured synthetic filament yarns made from petroleum-derived material as a pile yarn is subjected to a backing treatment to fix the pile yarn. At this time, the carpet will pass a drying step and a heat-set step to exert crimps inherent in the a spun-dyed textured polylacted filament yarns made from a plant-derived material and a spun-dyed textured synthetic filament yarns made from petroleum-derived material normally by a dry heat treatment and/or a vapor treatment, resulting in a carpet excellent in loftiness and giving no bottom-out feeling.

[0174] The tufted carpet using a spun-dyed textured polylacted filament yarns made from a plant-derived material and a spun-dyed textured synthetic filament yarns made from petroleum-derived material as a pile yarn can be provided as a carpet excellent in loftiness and having voluminous look. Furthermore, a carpet remarkably improved in abrasion resistance and buckling resistance as compared with a carpet manufactured using conventional polylacted filament yarns can be provided.

[0175] The carpet using a spun-dyed textured polylacted filament yarns made from a plant-derived material and a spun-dyed textured synthetic filament yarns made from petroleum-derived material as a pile yarn according to the third invention can be used as a carpet for various purposes in the fields of a roll carpet, a piece carpet, a tile carpet, an automobile carpet and an option carpet, and a household lag/mat, which can make use of the characteristics of the carpet of the invention.

[0176] The carpet of the third invention uses the spun-dyed textured polylacted filament yarn as a part (especially as a main portion) of a pile yarn. If polylacted resin in the amount of 30 to 70 mass% is added to the base fabric, the backing resin, etc., constituting the carpet, the plant-percentage thereof increases, resulting in a global environment friendly carpet which increases less carbon dioxide from the view point of environmental protection.

[0177] Hereinafter, a concrete manufacturing method of the spun-dyed textured polylacted filament yarn required in the third invention will be explained, but not limited thereto.

[0178] As the polylacted monomer for use in manufacturing the spun-dyed textured polylacted filament yarn, polylacted monomer having a relative viscosity (RV) of 2.5 to 3.8 measured as a mixed solution of 20 ˚C, phenol/tetrachloroethane=60/40 (mass ratio) is used. In the carpet usage of this invention, since the tenacity and the elongation of the textured filament yarn, the crimping characteristics and the abrasion resistance are required, polylacted polymer having a high molecular weight, i.e., polymer having the above-specified relative viscosity, will be required.

[0179] As the inorganic pigment and the organic pigment to be used as a coloring agent for the spun-dyed textured polylacted filament yarn, at least one pigment selected from the above-specified compounds is used. After adding a coloring agent to the polylacted polymer, yarn-making can be performed.

[0180] Polylacted polymer in which the aforementioned polylacted polymer and the coloring agent are mixed at a certain ratio with a mixing device is supplied to a biaxial extruder 12 with vents 13 and molten and extruded from the spinning 15 via a spinning pack.

[0181] The spun-dyed textured polylacted filament yarn has an approximately circular or circular cross-sectional configuration. The degree of deformation of the filament cross-section expressed by a ratio (B/A) of a diameter B of an circumscribed circle of the filament cross-section to a diameter A of a inscribed circle of the filament cross-section is preferably less than 1.5.

[0182] Next, the spun filament is cooled and solidified with quench air of the cooling device 16.

[0183] After applying a lubricant to the cooled and solidified spun filament, the filament yarn is received with the receiving roller 1 rotating at a predetermined rotational rate.

[0184] The rotational speed of the receiving roller 1 is 400 to 1,000 m/mim.

[0185] The manufacturing method of the textured filament yarn according to the third invention is characterized in a direct spinning extension and crimping process, and therefore the aforementioned receiving speed is preferably employed.

[0186] The received undrawn filament yarn filament is continuously heat-drawn at a single stage or multiple stages using rollers 1 to 4. The temperature of the draw roller 3 is set to 70 to 125 ˚C. The draw ratio is set so as to fall within the range of 3.0 to 6.0. Especially in order to attain the high tenacity and elongation of the spun-dyed textured polylacted filament yarn of this invention and the excellent loftiness and the abrasion resistance when it is used as a carpet, it is importance that a sufficiently drawn and oriented polylacted filament yarn is subjected to texturing processing.

[0187] The sufficiently drawn and oriented polylacted filament yarn is heat-set with the heat-set roller 4. The temperature of the heat-set roller 4 is 100 to 150 ˚C. Appropriately setting the temperature range of the heat-set roller 4 makes it possible to control the crystallization of the polylacted filament yarn, resulting in desired properties.

[0188] The drawn polylacted filament yarn is continuously introduced into the texturing device 5 to give crimps to the filament yarn. The filament yarn 6 textured with the texturing device 5 is cooled on the cooling drum 20.

[0189] The heated fluid is preferably heated air and the temperature is 90 to 160 ˚C. Appropriate conditions are selected depending on the fineness, processing rate, etc., of the polylacted filament yarn.

[0190] Subsequently, the textured filament yarn is subjected to entangle process via the nozzle of the entangle processing device 21. The confounding nozzle has normally 2 to 6 apertures and is configured to execute entangle process by spraying high pressure air of 0.2 to 0.5 MPa onto the traveling textured filament yarn at an approximately rectangular angle.

[0191] Then, the polylacted textured filament yarn is rolled up onto a winder 22. The winding is performed with a winding tensile force of 0.10 cN/dtex or below.

[0192] Next, the manufacturing method of the pile yarn for the carpet of the third invention will be explained. The pile yarn for a carpet of the third invention can be used as a single yarn and/or two or more of twisted yarns of a non-twisted yarn and/or a twisted yarn made of a spun-dyed textured polylacted filament yarns made from a plant-derived material and a spun-dyed textured synthetic filament yarns made from petroleum-derived material. Alternatively, the spun-dyed textured polylacted filament yarn and the spun-dyed textured synthetic filament yarn are combined into a composite yarn and this composite yarn can be used as a pile yarn.

[0193] In the pile yarn using both the textured filament yarns, the color, the total fineness (dtex) of the pile yarn, the state (non-twisted yarn or twisted yarn) of the polylacted textured filament yarn, the number of combined textured filament yarns, and the conditions/status of the twisted yarn, etc. , are decided based on the manufacturing standard of a tufted carpet.

[0194] Both the textured filament yarns can be used in the form of a non-twisted filament yarn, or in the form of a combined filament yarn in which a non-twisted filament yarn and other non-twisted filament yarn are combined with an air tangling device, or can be used as it is or in the form of a twisted yarn.

[0195] Both the textured filament yarns can be used in the form of a twisted yarn (the twist count is preferably 150 to 250 T/m), or can be used after twisting two or more of twisted yarns (the twist count is preferably 50 to 200 T/m).

[0196] For example, using two or three spun-dyed textured polylacted filament yarns, lower twisting (180 T/m) and upper twisting (180 T/m) are performed to obtain a twisted textured yarn.
Thereafter, twist setting is executed with the heated air treatment of 100 to 125 ˚C or steam treatment of 90 to 115 ˚C in a vacuum equipment to thereby obtain a pile yarn for a carpet.

EXAMPLES

[0197] Next, concrete examples of this invention will be explained, but it should be understood that the invention is not specifically limited to these examples.

[0198] Initially, a concrete example of the first invention will be explained.

<Example 1>

[0199] Using the manufacturing device shown in Fig. 1, a polylacted textured filament yarn was manufactured. In detail, polylacted chips (polymer of lactide monomer consisting of L-lactide 98 mass% and D-lactide 2 mass%, weight-average molecular weight: 140,000, relative viscosity: 3.2; glass transition temperature Tg: 57 ˚C, melting point: 170 ˚C, temperature of a softening point Ts: 130 ˚C, crystallization temperature Tc: 115 ˚C) in the amount of 100 mass parts were thrown in through the polylacted chips inlet 10 and carbon black master batch (including the aforementioned polylacted polymer: 75 mass%, carbon black: 25 mass%) 4 mass parts were thrown in through the coloring agent inlet 11. While expelling any remaining air, they were melt-blended in the biaxial extruder 12 with vents 13 at 230 ˚C. Thereafter, they were extruded through a total of 64 holes each having a circular cross-section (round circular cross-section) of the spinning nozzle 15 attached to the tip of the biaxial extruder 12 into filament yarns simultaneously from three nozzles.

[0200] Next, the spun filaments were cooled and solidified with quench air (20 ˚C 70% RH) from the quench air blowing apparatus 16 to thereby obtain a total of 192 multi-filaments each having a circular cross-section. Then, a lubricant was applied to the filaments with the lubricant applying apparatus 17, and then the filaments were gathered and received by the non-heated receiving roller 1 rotating at a rotational rate of 462 m/min. Then, the filaments were pre-heated with the pre-heating roller 2 set to a rotational rate of 462 m/min. and a temperature of 70 ˚C.

[0201] Thereafter, the spun filaments were introduced to the draw roller 3 set to a rotational rate of 489 m/min. and a temperature of 105 ˚C and the heat-set roller 3 set to a rotational rate of 2,200 m/min. and a temperature of 120 ˚C to execute drawing. The draw ratio was 4.5. The temperature of the heat-set roller 4 was set to 120 ˚C lower than the temperature of a softening point Ts of the polylacted polymer.

[0202] Next, the heat-set spun filaments were introduced in the texturing device 5 to bring heated and pressurized air of 110˚C and 0.6 MPa into contact with the filaments to give crimps to the filaments. The textured filament yarns were cooled to 30 ˚C with a cooling drum 20. The temperature of the heated and pressurized air was set to 110 ˚C lower than the crystallization temperature Tc of the polylacted polymer. Then, the textured filament yarns were subjected to entangle processing of 30 counts/m with the entangle processing device 21 and wounded on the winder 22 with winding tensile force of 0.05 cN/dtex and at the rotational rate of 1, 910 m/min. Thus, a spun-dyed textured synthetic filament yarn was obtained.

[0203] The obtained spun-dyed textured polylacted filament yarn was a circular cross-sectional filament yarn having a total fineness of 1,448 dtex/192 filament (a filament fineness: 7.5 dtex), relative viscosity of 3.0, tenacity of 3.12 cN/dtex, elongation of 46.6 %, hot water shrinkage ratio of 4.5 %, and dry heat crimp ratio of 11.2 %.

[0204] Using two obtained the spun-dyed textured polylacted filament yarns, lower twisting and upper twisting were executed at the twist count of 180 times/m to obtain a twisted yarn. Thereafter, the twisted yarn was subjected to a heated air treatment at 115 ˚C to fix the twists to thereby obtain a pile yarn for a carpet. Using this pile yarn, a tufted carpet equipped with cut piles having a standard of gauge: 1/10 (2.54cm/10stitches), stitch: 48 pieces/10 cm, pile length: 10 mm, and pile portion weight per unit area: 1,500 g/m^2 was obtained.

<Example 2>

[0205] Using the manufacturing device shown in Fig. 1, a polylacted textured filament yarn was manufactured. In detail, polylacted chips (polymer of lactide monomer consisting of L-lactide 98 mass% and D-lactide 2 mass%, weight-average molecular weight: 140,000, relative viscosity: 3.2; glass transition temperature Tg: 57 ˚C, melting point: 170 ˚C, temperature of a softening point Ts: 130 ˚C, crystallization temperature Tc: 115 ˚C) in the amount of 100 mass parts were thrown in through the polylacted chips inlet 10 and carbon black master batch (including the aforementioned polylacted: 75 mass%, carbon black: 25 mass%) in the amount of 4 mass parts were thrown in through the coloring agent inlet 11. While expelling any remaining air, they were melt-blended in the biaxial extruder 12 with vents 13 at 230 ˚C. Thereafter, they were extruded through a total of 64 holes each having a circular cross-section (round circular cross-section) of the spinning nozzle 15 attached to the tip of the biaxial extruder 12 into filaments simultaneously from three nozzles.

[0206] Next, the spun filaments were cooled and solidified with quench air (20 ˚C 70% RH) from the quench air blowing apparatus 16 to thereby obtain a total of 192 multi-filaments each having a circular cross-section. Then, a lubricant was applied to the filaments with the lubricant applying apparatus 17, and then the filaments were gathered and received by the non-heated receiving roller 1 rotating at a rotational rate of 510 m/min. Then, the filaments were pre-heated with the pre-heating roller 2 set to a rotational rate of 516 m/min. and a temperature of 95 ˚C.

[0207] Thereafter, the spun filaments were introduced to the draw roller 3 set to a rotational rate of 524 m/min. and a temperature of 110 ˚C and the heat-set roller 3 set to a rotational rate of 2,200 m/min. and a temperature of 125 ˚C to execute drawing. The draw ratio was 4.3. The temperature of the heat-set roller 4 was set to 125 ˚C lower than the

temperature of a softening point Ts of the polylacted polymer.

[0208] Next, the heat-set spun filaments were introduced in the texturing device 5 to bring heated and pressurized air of 115 ˚C and 0.6 MPa into contact with the filament yarns to give crimps to the filaments. The textured filament yarn was cooled to 30 ˚C with a cooling drum 20. The temperature of the heated and pressurized air was set to the same 115 ˚C as the crystallization temperature Tc of the polylacted polymer. Then, the textured filament yarn was subjected to entangle processing of 25 pieces/m with the entangle processing device 21 and wounded on the winder 22 with winding tensile tenacity of 0.05 cN/dtex and at the rotational rate of 1,636 m/min. Thus, a spun-dyed textured synthetic filament yarn was obtained.

[0209] The obtained spun-dyed textured polylacted filament yarn was a circular cross-sectional filament yarn having a total fineness of 3,200 dtex/192 filament (a filament fineness: 16.7 dtex), relative viscosity of 3.0, tenacity of 1.84 cN/dtex, elongation of 53.1 %, hot water shrinkage ratio of 3.8 %, and dry heat crimp ratio of 12.3 %.

[0210] Using two obtained the spun-dyed textured synthetic filament yarns, lower twisting and upper twisting were executed at the twist count of 180 times/m to obtain a twisted yarn. Thereafter, the twisted yarn was subjected to a heat treatment by a steam vapor of 95 ˚C to fix the twists to thereby obtain a pile yarn for a carpet. Using this pile yarn, a tufted carpet equipped with cut piles having a standard of gauge: 1/10 (2.54cm/10stitches), stitch: 44 pieces/10 cm, pile length: 10 mm, and pile portion weight per unit area: 1,500 g/m^2 was obtained.

<Example 3>

[0211] A spun-dyed polylacted textured filament yarn was manufactured in the same manner as in Example 1 except that a filament yarn comprising a filament having an approximately circular cross-section having a degree of deformation of 1.4 was used. The characteristics of the obtained spun-dyed polylacted textured filament yarn are shown in Table 1. Furthermore, using the obtained spun-dyed polylacted textured filament yarn, a tufted carpet was obtained in the same manner as in Example 1.

] <Example 4>

[0212] A spun-dyed polylacted textured filament yarn was manufactured in the same manner as in Example 1 except that a filament yarn comprising a filament having an approximately circular cross-section having a degree of deformation of 4.1 was used. The characteristics of the obtained spun-dyed polylacted textured filament yarn are shown in Table 1. Furthermore, using the obtained spun-dyed polylacted textured filament yarn, a tufted carpet was obtained in the same manner as in Example 1.

<Example 5, Comparative Example 2>

[0213] A spun-dyed polylacted textured filament yarn was manufactured in the same manner as in Example 1 except that the manufacturing was executed under the conditions shown in Table 1. The characteristics of the obtained spun-dyed polylacted textured filament yarn are shown in Table 1. Furthermore, using the obtained spun-dyed polylacted textured filament yarn, a tufted carpet was obtained in the same manner as in Example 1.

< Comparative Example 1>

[0214] A spun-dyed polylacted textured filament yarn was manufactured in the same manner as in Example 1 except that a spinning nozzle equipped with a total of 32 holes each having an approximately Y-shape in cross-section was used as a spinning 15.

[0215] The obtained spun-dyed polylacted textured filament yarn was a modified cross-section filament yarn having total fineness of 1,100 dtex/96 filaments (a filament fineness: 11.5 dtex) and a degree of deformation of 2.2. The relative viscosity was 3.0, the tenacity was 1.54 cN/dtex, the elongation was 32.0%, the hot water shrinkage ratio was 4.1 %, and the dry heat crimp ratio was 12.3 %.

[0216] The obtained three textured polylacted filament yarns were twisted into a twisted yarn, and then the twisted yarn was subjected to a heated air treatment at 115 ˚C to fix the twists to thereby obtain a pile yarn for a carpet. Using this pile yarn, a tufted carpet equipped with cut piles having a standard of gauge: 1/10 (2.54cm/10stitches), stitch: 44 pieces/10 cm, pile length: 10 mm, and pile portion weight per unit area: 1,500 g/m^2 was obtained.

<Comparative Example 3>

[0217] Polylacted chips (polymer of lactide monomer consisting of L-lactide 98 mass% and D-lactide 2 mass%, weight-average molecular weight: 220, 000, relative viscosity: 4.0) in the amount of 100 mass parts were thrown in through the

polylacted chips inlet 10 of the manufacturing apparatus shown in Fig. 1 and carbon black master batch (including the aforementioned polylacted polymer: 75 mass%, carbon black: 25 mass%) in the amount of 4 mass parts were thrown in through the coloring agent inlet 11. While expelling any remaining air, they were melt-blended in the biaxial extruder 12 with vents 13 at 230 ˚C. Since the melt viscosity of the polylacted polymer at the outlet of the biaxial extruder 12 was excessively high, the pressure loss in the polymer tube having a polymer tube temperature of 225 ˚C up to the spinning head 14 was large, which caused remarkable irregular discharge rate of the polylacted polymer at the outlet of the spinning head 14. Therefore, the temperature of the biaxial extruder 12 was set to 235 ˚C and the polymer tube temperature was set to 250 ˚C. As a result, the discharge amount of the polylacted polymer was stabilized, but the polylacted polymer became yellow at the outlet of the spinning head 14. Furthermore, smoke which was assumed due to thermal decomposition was generated, resulting in poor spinning.

[0218]

[Table 1]

		Ex.1	Ex.2	Ex.3	Ex.4	Ex.5	Com. Ex1	Com. Ex. 2
Manufacturing conditions	Temp. of quench air (°C)	20	20	20	20	20	20	20
	Temp. of pre-heating roller (°C)	70	100	70	70	70	70	70
	Temp. of draw roller (°C)	105	110	105	105	105	105	105
	Draw ratio (times)	4.5	4.3	4.5	4.5	4.5	4.5	4.5
	Temp. of heat-set roller S(°C)	120	125	120	120	120	120	140
	Temp. of heated fluid R(°C)	110	115	110	110	130	110	105
	S-R (°C)	10	10	10	10	-10	10	35
	Cooling temp. of filament yarn by cooling drum (°C)	30	30	30	30	30	30	30
Characteristics of textured filament yarn	Relative viscosity	3.0	3.0	3.0	3.0	3.0	3.0	3.0
	Degree of deformation	1 (circular cross-section)	1 (circular cross-section)	1.4	1 (circular cross-section)	1 (circular cross-section)	2.2	1 (circular cross-section)
	Tenacity (cN/dtex)	3.12	1.84	2.34	2.72	1.94	1.54	1.01
	Elongation (%)	46.6	53.1	46.0	43.5	42.2	32.0	28.4
	Total fineness (dtex)	1448	3200	1449	1179	1459	1100	1452
	A filament fineness (%)	7.5	16.7	7.5	4.1	7.6	11.5	7.6
	hot water shrinkage ratio (%)	4.5	3.8	5.1	5.8	2.5	4.1	1.6
	dry heat crimp ratio (%)	11.2	12.3	11.8	10.8	12.5	12.3	12.7
Evaluation of Carpet property	Loftiness	◎	◎	◎	○	◎	◎	◎
	Abrasion resistance	◎	○	◎	◎	○	×	×

[0219] Characteristics of each spun-dyed polylacted textured filament yarn were measured based on the following measuring methods. The loftiness and the abrasion resistance of the obtained tufted carpet were evaluated based on the following evaluation methods. These results are shown in Table 1.

<Relative viscosity measuring method>

[0220] Specimens were dissolved in a mixed solution of phenol/tetrachloroethane = 60/40 (mass ratio) so that the concentration became 1g/dL, and the relative viscosity was measured using an ubbelohde viscosity tube at 20 ˚C.

<Weight-average molecular weight measuring method>

[0221] Specimens were dissolved in chloroform so that the concentration became 10 mg/mL, and GPC analysis was executed using chloroform as a solvent with a measuring device HLC8120GPC manufactured by TOSO Corporation to measure the weight-average molecular weight Mw. An RI (infrared spectrograph) was used as a detector, and polystyrene was used as a reference material of a molecular weight.

<Ratio measurement of L-lactide>

[0222] Polylacted chips were hydrolyzed and the ratio of L-lactide was measured using methanol sodium hydroxide solution as a solvent with a high-performance liquid chromatography (HPLC: LC10AD type manufactured by SHIMADZU Corporation).

<Degree of deformation evaluation method>

[0223] After cutting a filament, a diameter A of an inscribed circle of the cross-section of the filament and a diameter B of a circumscribed circle thereof were measured using an optical microscope. The value B/A was defined as the degree of deformation (see Fig. 2).

<Tenacity and elongation measuring method>

[0224] Using a tensile testing machine TENSORAPID3 manufactured by USTER Corp., the tenacity cN and the elongation % were measured under the conditions of specimen length: 25 cm and the tensile rate: 30 cm/min. The tenacity cN/dtex is a value obtained by dividing the tenacity cN by the total fineness.

<Fineness measuring method>

[0225] Fineness was measured in accordance with JIS L1013.

<Hot water shrinkage ratio measuring method>

[0226] Hot water shrinkage ratio % was measured according to a JIS L1013 skein shrinkage percentage (A method). Initially, a spun-dyed polylacted textured filament yarn was took off from a bobbin package to obtain a specimen. A load for giving a tensile force of a total fineness dtex x 0.882 mM (90 mg/dtex) was applied to the specimen filament yarn and held for 10 seconds. Thereafter, the specimen length Ls1 was measured. In an unloaded condition, it was immersed in hot water having a temperature of 98 ˚C for 30 minutes, and then dried naturally for an entire day. This dried textured filament yarn was a hot water treated spun-dyed polylacted textured filament yarn. A load for giving a tensile force of a total fineness dtex x 0.882 mM (90 mg/dtex) was applied to the hot water treated spun-dyed polylacted textured filament yarn and held for 10 seconds. Thereafter, the specimen length Ls2 was measured. Hot water shrinkage ratio %={(Ls1-Ls2)/Ls1}x100
From the above equation, the hot water shrinkage ratio % was obtained.

<Dry heat crimp ratio measuring method>

[0227] A spun-dyed polylacted textured filament yarn took off from a bobbin package was treated with heated air of 100 ˚C for 10 minutes under no load and naturally left to obtain a dry heat treated spun-dyed textured polylacted filament yarn. After applying a certain load to the dry heat treated spun-dyed textured polylacted filament yarn to give a tensile force of a total fineness dtex x 0.882 mN (90 mg/detx) for 10 seconds, the specimen length Lc1 was measured. Subsequently, a certain load was applied to the dry heat treated spun-dyed textured polylacted filament yarn to give a tensile force of a total fineness dtex x 0.0176 mN (1.8 mg/detx) for 10 seconds, and then the specimen length was measured. Dry heat crimp ratio measuring method %={(Lc1-Lc2)/Lc1} x 100
From the above equation, the dry heat crimp ratio % was obtained.

<Bulkiness evaluation>

[0228] When observed the carpet from the right above, the state in which the base fabric could be observed via the gaps of the pile surface was visually evaluated as follows: "◎" denotes that the base fabric was hardly observed; "○" denotes that the base fabric was observed to some degree; and "×" denotes that the base fabric was clearly observed.

<Abrasion resistance evaluation>

[0229] The abrasion resistance of the carpet was evaluated using a Taber type abrasion test machine defined by JIS L1096.17.3. In detail, using an H-18 abrasion ring, a load of 9.8 N was applied to this abrasion ring and a test stand was rotated 1,000 times to wear the specimen. The abrasion state was visually observed to evaluate as follows: "◎" denotes that abrasion rate was very low; "○" denotes that abrasion rate was low: "Δ" denotes that abrasion was occurred to some extent; and "×" denotes that abrasion rate was high.

[0230] As will be apparent from Table 1, in the carpets of Examples 1 to 5 using the spun-dyed polylacted textured filament yarn of the first invention, sufficient bulkiness was obtained and the abrasion resistance was excellent. To the contrary, in the carpet of Comparative Examples 1 and 2, the abrasion resistance was poor.

[0231] Next, concrete examples of the second invention will be explained. Characteristics of each spun-dyed polylacted textured filament yarn were measured based on the aforementioned measuring methods. The loftiness and the abrasion resistance of the obtained tufted carpet were evaluated based on the following evaluation methods.

[Loftiness]

[0232] When observed the carpet from the right above, the carpet was visually observed in a state in which the base fabric could be observed via the gaps of the pile surface and evaluated as follows: "◎" denotes that the base fabric could not be observed; "○" denotes that the base fabric could be hardly observed; "Δ" denotes that the base fabric could be observed to some degree; and "×" denotes that the base fabric could be clearly observed.

[Abrasion resistance evaluation]

[0233] The evaluation of the abrasion resistance of the carpet was executed according to the Taber type abrasion test (defined by the Taber type abrasion test (JIS L1096.8.17.3, 2004 Edition), where an H-18 abrasion ring was used, and the number of abrasion was 2,500 times). That is, using an H-18 abrasion ring, a load of 9.8 N was applied to each abrasion ring and a test stand was rotated 2,500 times to wear the specimen. The abrasion amount of the pile yarn was measured. From the following equation, the Taber abrasion amount (mass%) was obtained.

[0234] Taber abrasion amount (mass%) =pile dropped-off mass of the abrasion ring portion after the test / pile portion mass of the abrasion ring portion before the test x 100%

<Examples 6 to 13>

[0235] A spun-dyed polylacted textured filament yarn, a pile yarn and a carpet were manufactured as follows, and the evaluation results are shown in Table 2.

[Manufacturing of a spun-dyed polylacted textured filament yarn]

[0236] Using the manufacturing apparatus shown in Table 1, a spun-dyed polylacted textured filament yarn was manufactured. Polylacted chips (polymer of lactide monomer consisting of L-lactide 98 mass% and D-lactide 2 mass%, weight-average molecular weight: 140, 000, relative viscosity: 3.2; melting point Tm: 170 ˚C) in the amount of 100 mass parts were thrown in through the polylacted chips inlet 10 and carbon black 25 mass% mixed master batch in the amount of 4 mass parts was thrown in through the coloring agent inlet 11. While expelling any remaining air, they were melt-blended in the biaxial extruder 12 at 230 ˚C. The content of the carbon black as a coloring agent was set to 1.0 mass%.

[0237] The spinning temperature of the spinning heat 14 was set to 225 ˚C, and 600 mesh filter was used as the spinning pack 15. Thereafter, they were extruded through a nozzle having a total of 64 holes each having a circular cross-section (round circular cross-section) into three packs filament yarns simultaneously.

[0238] The spun filaments were cooled and solidified with quench air (20 ˚C 70%) from the quench air blowing apparatus 16 to thereby obtain a total of 192 polylacted multi-filaments each having a circular cross-section.

[0239] After the cooling and solidifying them, a water emulsion type lubricant having a concentration of 15 mass% for polylacted filament yarns was applied to the filaments with the lubricant applying apparatus 17, and then the filaments were received by the non-heated receiving roller 1 rotating at a rotational rate of 423 m/min. Then, the filamens were

continuously pre-heated with the pre-heating roller 2 set to a rotational rate of 426 m/min. and a temperature of 70 ˚C. Thereafter, the spun filaments were introduced to the draw roller 3 set to a rotational rate of 444 m/min. and a temperature of 105 ˚C and the heat-set roller 4 set to a rotational rate of 2,000 m/min. and a temperature of 123 ˚C to execute drawing. The draw ratio was 4.5.

[0240] Next, the heat-set spun filaments were introduced in the texturing device 5 to execute crimping processing by heated and pressurized air of 115 ˚C and 0.6 MPa and then cooled on the cooling drum 20. Then, the textured filament yarns were subjected to entangle processing of 32 counts/m with the entangle processing device 21 and wounded with winding tensile tenacity of 0.05 cN/dtex and at the rotational rate of 1,737 m/min.

[0241] The obtained spun-dyed textured synthetic filament yarn was a circular cross-sectional filament yarn (circular in cross-section) having a total fineness of 1,674 dtex/192 filament (a filament fineness: 8.7 dtex), relative viscosity of 3.0, tenacity of 2.36 cN/dtex, elongation of 52.5 %, hot water shrinkage ratio of 3.5 %, and dry heat crimp ratio of 12.8 %.

[Manufacturing a pile yarn]

[0242] Using two obtained spun-dyed textured polylacted filament yarns, lower twisting: Z180 T/m and upper twisting: Z180 T/m were executed to obtain a twisted yarn. Thereafter, the twisted yarn was subjected to a heated air treatment at 115 ˚C with a Sussen heat-set device to fix the twists to thereby obtain a pile yarn for a tufted carpet.

[Manufacturing a carpet]

[0243] Using a tufting machine, the aforementioned pile yarn was tufted in a primary base fabric for a tufted carpet made of a polyester nonwoven fabric while changing conditions of the gauge (needle number/1 inch: 2.54 cm), stitch (stitch number/10 cm), average pile length (mm), and pile portion weight per unit area (g/m^2) to thereby produce tufted pile original fabric of Examples 1 to 8 shown in Table 1 under each standard.

[0244] Next, EVA pre-coating was performed on the rear surface of the pile yarn tufted original fabric to seal it. Thereafter, a polyethylene resin sheet as a backing agent was adhered on the rear surface of the original fabric together with a polyester needle punched nonwoven fabric layer (secondary base fabric, weight per unit area: 400 g/m^2) to obtain a tufted carpet.

[0245] The loftiness and the Taber abrasion test results of these carpets are shown in Table 2.

[0246]

[Table 2]

			EXAMPLE							
			6	7	8	9	10	11	12	13
Carpet surface	Pile shape	-	CL	CL	CL	PC	PC	PC	PC	PC
	Gauge	2.54 cm/ needle number	1/10	1/10	1/10	1/10	1/10	1/10	1/10	1/10
	Stitch	Stitch number /10 cm	52	52	46	52	52	46	40	32
	Average pile length	mm	12/7	9.5/5	8.5/4	12	10	9	6.5	6.5
	Pile weight per unit area	g/cm^2	2060	1570	1360	2200	1840	1460	920	730
Carpet characteristics	Loftiness	-	◎	○~◎	○	◎	○~◎	○	○	○
	Abrasion resistance	Mass%	20.9	19.1	21.0	18.4	15.8	19.6	24.3	26.8
CL: cut & loop PC: Plain cut										

<COMPARATIVE EXAMPLES 4 to 8>

[Manufacturing of a spun-dyed polylacted textured filament yarn]

[0247] A black spun-dyed polylacted textured filament yarn was manufactured in the same manner as in <Example 6> except that a nozzle having 32 holes each having a Y-cross-section was used.

[0248] The obtained black spun-dyed textured synthetic filament yarn was a Y-shaped cross-sectional filament yarn having a total fineness of 1,105 dtex/96 filament (a filament fineness: 11.5 dtex) and the degree of deformation of 2.2. The relative viscosity (RV) was 3.0, the tenacity was 1.67 cN/dtex, the elongation was 32.2 %, the hot water shrinkage ratio was 4.6 %, and the dry heat crimp ratio was 14.0 %.

[Manufacturing a pile yarn]

[0249] Using three obtained black spun-dyed textured polylacted filament yarns, lower twisting: Z180 T/m and upper twisting: Z180 T/m were executed to obtain a twisted yarn. Thereafter, the twisted yarn was subjected to a heated air treatment at 115 ˚C with a Sussen heat-set device to fix the twists to thereby obtain a pile yarn for a tufted carpet.

[Manufacturing a carpet]

[0250] Using a tufting machine, the aforementioned pile yarn was tufted in a primary base fabric for a tufted carpet made of a polyester nonwoven fabric while changing conditions of the gauge (needle number/1 inch: 2.54 cm), stitch (stitch number/10 cm), average pile length (mm), and pile portion weight per unit area (g/m^2) to thereby produce tufted pile original fabrics of Comparative Examples 4 to 8 shown in Table 3 under each standard.

[0251] In the same manner as in Examples, EVA pre-coating was performed on the rear surface of the pile yarn tufted original fabric. Thereafter, a polyethylene resin sheet as a backing agent was adhered on the rear surface of the original fabric together with a polyester needle punched nonwoven fabric layer (secondary base fabric, weight per unit area: 400 g/m^2) to obtain a tufted carpet. The loftiness and the Taber abrasion test results of these carpets of <Comparative Examples 4 to 8> are shown in Table 3.

[0252]

[Table 3]

			COMPARATIVE EXAMPLE				
			4	5	6	7	8
Carpet surface	Pile shape	-	PC	PC	PC	PC	PC
	Gauge	2.54 cm/needle number	1/8	1/8	1/8	1/8	1/8
	Stitch	Stitch number /10 cm	53	53	53	44	33
	Average pile length	mm	15	12	8	8	7
	Pile weight per unit area	g/cm^2	2010	1610	1070	890	600
Carpet characteristics	Loftiness	-	◎	○~◎	○	○	○
	Abrasion resistance	Mass%	33.3	32.5	34.2	37.5	40.8
CL: cut & loop PC: Plain cut							

[0253] Next, concrete examples of the third invention will be explained. Characteristics of each spun-dyed polylacted textured filament yarn were measured based on the aforementioned measuring methods. The loftiness and the abrasion resistance of the obtained tufted carpet were evaluated based on the following evaluation methods.

[Loftiness]

[0254] When observed the carpet from the right above, the carpet was visually observed in a state in which the base fabric could be observed via the gaps of the pile surface and evaluated as follows: "◎" denotes that the base fabric could not be observed; "○" denotes that the base fabric could be hardly observed; "Δ" denotes that the base fabric could

be observed to some degree; and "×" denotes that the base fabric could be clearly observed.

[Abrasion resistance evaluation]

[0255] The evaluation of the abrasion resistance of the carpet was executed according to the Taber type abrasion test (defined by the Taber type abrasion test (JIS L1096.8.17.3 (2004 Edition)), where an H-18 abrasion ring was used, and the number of abrasion was 5, 000 times). That is, using an H-18 abrasion ring, a load of 9.8 N was applied to each abrasion ring and a test stand was rotated 5,000 times to wear the specimen. The abrasion amount of the pile yarn was measured. From the following equation, the Taber abrasion amount (mass%) was obtained.

[0256] Taber abrasion amount (mass%) =pile dropped-off mass of the abrasion ring portion after the test / pile portion mass of the abrasion ring portion before the test x 100%

<Examples 14 to 17>

[Manufacturing of a spun-dyed textured polylacted filament yarn made from plant-derived material]

[0257] Polylacted chips (polymer of lactide monomer consisting of L-lactide 98 mass% and D-lactide 2 mass%, weight-average molecular weight: 140,000, relative viscosity: 3.2, melting point Tm: 170 ˚C) in the amount of 100 mass parts were thrown in through the polylacted chips inlet 10 of the manufacturing apparatus shown in Fig. 1 and carbon black 25 mass% mixed master batch in the amount of 4 mass parts were thrown in through the coloring agent inlet 11. While expelling any remaining air, they were melt-blended in the biaxial extruder 12 with vents 13 at 230 ˚C. The content of the carbon black as a coloring agent was set to 1.0 mass%.

[0258] The spinning temperature of the spinning heat 14 was set to 225 ˚C, and 600 mesh filter was used as the spinning pack 15. Thereafter, they were extruded through a nozzle having a total of 64 holes each having a circular cross-section (round circular cross-section) into three packs filament yarns simultaneously.

[0259] The spun filaments were cooled and solidified with quench air (20 ˚C x 70%) from the quench air blowing apparatus 16 to thereby obtain a total of 192 polylacted multi-filaments each having a circular cross-section.

[0260] After the cooling and solidifying them, a water emulsion type lubricant having a concentration of 15 mass% for polylacted filaments was applied to the filaments with the lubricant applying apparatus 17, and then the filaments were received by the non-heated receiving roller 1 rotating at a rotational rate of 423 m/min. Then, the filaments were continuously pre-heated with the pre-heating roller 2 set to a rotational rate of 426 m/min. and a temperature of 70 ˚C. Thereafter, the spun filaments were introduced to the draw roller 3 set to a rotational rate of 444 m/min. and a temperature of 105 ˚C and the heat-set roller 4 set to a rotational rate of 2,000 m/min. and a temperature of 123 ˚C to execute drawing. The draw ratio was 4.5.

[0261] Next, the heat-set spun filaments were introduced in the texturing device 5 to execute crimping processing by heated and pressurized air of 115 ˚C and 0.6 MPa and then cooled on the cooling drum 20. Then, the textured filament yarns were subjected to entangle processing of 32 counts/m with the entangle processing device 21 and wounded with winding tensile tenacity of 0.05 cN/dtex and at the rotational rate of 1,737 m/min.

[0262] The obtained spun-dyed textured polylacted filament yarn was a circular cross-sectional filament yarn (circular in cross-section) having a total fineness of 1,674 dtex/192 filament (a filament fineness: 8.7 dtex), relative viscosity of 3.0, tenacity of 2.36 cN/dtex, elongation of 52.5 %, hot water shrinkage ratio of 3.5 %, and dry heat crimp ratio of 12.8 %.

[Spun-dyed textured synthetic filament yarn made from petroleum-derived material]

[0263] As a spun-dyed textured synthetic filament yarn made from petroleum-derived material, a spun-dyed textured polyester filament yarn was used. The black spun-dyed textured polyester filament yarn has properties of tenacity: 3.22 cN/dtex, elongation: 35.1 %, hot water shrinkage ratio: 3.5 %; and dry heat crimp ratio: 23.7 % at the triloval cross-section of fineness: 1,471 dtex/96 filaments (a filament fineness: 15.3 dtex).

[Manufacturing a pile yarn made from plant-derived materials]

[0264] Using obtained two black spun-dyed textured polylacted filament yarns made from plant-derived materials, lower twisting: Z180 T/m and upper twisting: Z180 T/m were executed to obtain a twisted yarn comprising two filament yarns. Thereafter, the twisted yarn was subjected to a heated air treatment at 115 ˚C with a Sussen heat-set device to fix the twists to thereby obtain a pile yarn made from plant-derived materials for a tufted carpet.

[Manufacturing a pile yarn made from petroleum-derived materials]

[0265] Using obtained two black spun-dyed textured polyester filament yarns made from petroleum-derived materials, lower twisting: Z180 T/m and upper twisting: Z180 T/m were executed to obtain a twisted yarn comprising two filament yarns. Thereafter, the twisted yarn was subjected to a heated air treatment at 180 ˚C with a Sussen heat-set device to fix the twists to thereby obtain a pile yarn made from petroleum-derived materials for a tufted carpet.

[Manufacturing a carpet]

[0266] Using a tufting machine, the aforementioned two types of pile yarns were tufted alternatively in a primary base fabric for a tufted carpet made of a polyester nonwoven fabric while changing conditions of the gauge (needle number/1 inch: 2.54 cm), stitch (stitch number/10 cm), average pile length (mm), and pile portion weight per unit area (g/m^2) to thereby produce tufted pile original fabrics of Examples 14 to 17 shown in Table 4 under each standard.

[0267] Next, using SBR latex, pre-coating was performed on the rear surface of the pile yarn tufted original fabric. Thereafter, using a polyethylene resin sheet as a backing agent, a tufted carpet was manufactured.

[0268] The loftiness and the Taber abrasion test results of these carpets are shown in Table 4.

[0269]

[Table 4]

			Example			
			14	15	16	17
Carpet surface	Pile shape	-	PC	PC	PC	PC
	Gauge	25.4 cm/number of needle	1/10	1/10	1/10	1/10
	Stitch	Stitch number/10 cm	52.5	52	45	40
	Average pile length	mm	12	9	8	6.5
	Pile weight per unit area	g/m^2	2030	1540	1220	960
Carpet characteristics	Loftiness	-	◎	○~◎	○	○
	Abrasion resistance	mass%	16.8	15.0	13.5	17.5
CL: Cut and loop PC: Plain cut						

<Examples 18 to 22>

[Manufacturing a pile yarn made from plant-derived materials]

[0270] In the same manner as in <Example 14>, a black spun-dyed polylacted textured filament yarn was manufactured except that a nozzle having 32 holes each having a Y-cross-section was used.

[0271] The obtained black spun-dyed textured synthetic filament yarn made from plant-derived materials was a triloval cross-sectional filament yarn having a total fineness of 1,105 dtex/96 filament (a filament fineness: 11.5 dtex) and the degree of deformation of 2.2. The relative viscosity (RV) was 3.0, the tenacity was 1.67 cN/dtex, the elongation was 32.2 %, the hot water shrinkage ratio was 4.6 %, and the dry heat crimp ratio was 14.0 %.

[Manufacturing a pile yarn made from plant-derived materials]

[0272] Using three obtained black spun-dyed textured polylacted filament yarns made from plant-derived materials, lower twisting: Z180 T/m and upper twisting: Z180 T/m were executed to obtain a twisted yarn. Thereafter, the twisted yarn was subjected to a heated air treatment at 115 ˚C with a Sussen heat-set device to fix the twists to thereby obtain a pile yarn made from plant-derived materials for a tufted carpet.

[Manufacturing a pile yarn made from petroleum-derived materials]

[0273] Using obtained two black spun-dyed textured polyester filament yarns made from petroleum-derived materials, lower twisting: Z180 T/m and upper twisting: Z180 T/m were executed to obtain a twisted yarn comprising two filament yarns. Thereafter, the twisted yarn was subjected to a heated air treatment at 180 ˚C with a Sussen heat-set device to

fix the twists to thereby obtain a pile yarn made from petroleum-derived materials for a tufted carpet.

[Manufacturing a carpet]

[0274] Using a tufting machine, the aforementioned two types of pile yarns were tufted alternatively in a primary base fabric for a tufted carpet made of a polyester nonwoven fabric while changing conditions of the gauge (needle number/1 inch: 2.54 cm), stitch (stitch number/10 cm), average pile length (mm), and pile portion weight per unit area (g/m^2) to thereby produce tufted pile original fabrics of Examples 18 to 22 shown in Table 5 under each standard.

[0275] In the same manner as in <Examples 14 to 17>, using SBR latex, pre-coating was performed on the rear surface of the pile yarn tufted original fabric. Thereafter, using a polyethylene resin sheet as a backing agent, a tufted carpet was manufactured.

[0276] The loftiness and the Taber abrasion test results of these carpets of <Examples 18 to 22> are shown in Table 5.

[0277]

[Table 5]

			Example				
			18	19	20	21	22
Carpet surface	Pile shape	-	PC	PC	PC	PC	PC
	Gauge	25.4 cm/number of needle	1/8	1/8	1/8	1/8	1/8
	Stitch	Stitch number/10 cm	53	53	53	44	33
	Average pile length	mm	15	12	8	8	7
	Pile weight per unit area	9/m^2	1900	1560	1110	940	700
Carpet characteristics	Loftiness	-	◎	○~◎	○	○	○
	Abrasion resistance	mass%	24.1	24.0	15.0	23.4	28.9
CL: Cut and loop PC: Plain cut							

<Reference Examples 1 to 8>

(1) Manufacturing a carpet made of pile yarns 100% plant-derived materials

[Spun-dyed textured polylacted filament yarn made from plant-derived materials]

[0278] The same spun-dyed textured polylacted filament yarns as in <Examples 14 to 17> were used. The obtained back spun-dyed textured polylacted filament yarn was a circular cross-sectional filament cross-sectional filament yarn (circular in cross-section) having a total fineness of 1,674 dtex/192 filament (a filament fineness: 8.7 dtex), relative viscosity of 3.0, tenacity of 2.36 cN/dtex, elongation of 52.5 %, hot water shrinkage ratio of 3.5 %, and dry heat crimp ratio of 12.8 %.

[Manufacturing a pile yarn made from plant-derived materials]

[0279] The same spun-dyed textured polylacted filament yarns as in <Examples 14 to 17> were used. That is, using obtained black spun-dyed textured polylacted filament yarns made from plant-derived materials, lower twisting: Z180 T/m and upper twisting: Z180 T/m were executed to obtain a twisted yarn comprising two filament yarns. Thereafter, the twisted yarn was subjected to a heated air treatment at 115 ˚C with a Sussen heat-set device to fix the twists to thereby obtain a pile yarn made from plant-derived materials for a tufted carpet.

[Manufacturing a carpet]

[0280] In the same manner as in <Examples 14 to 17>, using a tufting machine, the aforementioned pile yarn was tufted in a primary base fabric for a tufted carpet made of a polyester nonwoven fabric while changing conditions of the gauge (needle number/1 inch: 2.54 cm), stitch (stitch number/10 cm), average pile length (mm), and pile portion weight

per unit area (g/m^2) to thereby produce tufted pile original fabrics of Reference Examples 1 to 8 shown in Table 6 under each standard.

[0281] In the same manner as in <Examples 14 to 17>, using SBR latex, pre-coating was performed on the rear surface of the pile yarn tufted original fabric. Thereafter, using a polyethylene resin sheet as a backing agent, a tufted carpet was manufactured.

[0282] The loftiness and the Taber abrasion test results of these carpets of <Reference Examples 1 to 8> are shown in Table 6.

[0283]

[Table 6]

			REFERENCE EXAMPLE							
			1	2	3	4	5	6	7	8
Carpet surface	Pile shape	-	CL	CL	CL	PC	PC	PC	PC	PC
	Gauge	2.54 cm/ needle number	1/10	1/10	1/10	1/10	1/10	1/10	1/10	1/10
	Stitch	Stitch number /10 cm	52	52	46	52	52	46	40	32
	Average pile length	mm	12/8	9.5/5	8.5/4	12	10	9	6.5	6.5
	Pile weight per unit area	g/cm^2	2060	1720	1410	2100	1720	1400	1010	700
Carpet characteristics	Loftiness	-	◎	○~◎	○	◎	○~◎	○	○	○
	Abrasion resistance	Mass%	41.8	38.3	41.9	36.7	35.6	39.2	48.6	51.5
CL: cut & loop PC: Plain cut										

<Reference Examples 9 to 13>

(2) Manufacturing a carpet made of pile yarns 100% plant-derived materials

[Spun-dyed textured polylacted filament yarn made from plant-derived materials]

[0284] The same spun-dyed textured polylacted filament yarns as in <Examples 18 to 22> were used. The obtained black spun-dyed textured synthetic filament yarn made from plant-derived materials was a triloval cross-sectional filament yarn having a total fineness of 1,105 dtex/96 filament (a filament fineness: 11.5 dtex) and the degree of deformation of 2.2. The relative viscosity (RV) was 3.0, the tenacity was 1.67 cN/dtex, the elongation was 32.2 %, the hot water shrinkage ratio was 4.6 %, and the dry heat crimp ratio was 14.0 %.

[0285] Hereinafter, in the same manner as in <Examples 18 to 22>, manufacturing of [a pile yarn made from plant-derived materials] and [manufacturing of a carpet] were performed. The loftiness and the Taber abrasion test results of these carpets are shown as <Reference Examples 9 to 13> in Table 7.

[0286]

[Table 7]

			Reference Example				
			9	10	11	12	13
Carpet surface	Pile shape	-	PC	PC	PC	PC	PC
	Gauge	25.4 cm/number of needle	1/8	1/8	1/8	1/8	1/8
	Stitch	Stitch number/10 cm	53	53	53	44	33
	Average pile length	mm	15	12	8	8	7
	Pile weight per unit area	g/m^2	2010	1660	1180	1000	700
Carpet characteristics	Loftiness	-	◎	○~◎	○	○	○
	Abrasion resistance	mass%	51.9	42.8	51.5	75.1	81.6
CL: Cut and loop PC: Plain cut							

[0287] This application claims priority to Japanese Patent Application No. 2005-258632 filed on September 7, 2005, Japanese Patent Application No. 2005-286444 filed on September 30, 2005, and Japanese Patent Application No. 2005-286452 filed on September 30, 2005,, the entire disclosures of which are incorporated herein by reference in their entireties.

[0288] It should be appreciated that the terms and descriptions herein are used only for explaining embodiments of the present invention, and the present invention is not limited to them. The present invention permits any design modifications within the scope of the present invention defined by the appended claims unless they deviate from its spirit of the present invention.

INDUSTRIAL APPLICABILITY

[0289] A spun-dyed textured polylacted filament yarn of the first invention and a spun-dyed textured polylacted filament yarn obtained by the manufacturing method of the first invention can be preferably used as, for example, a constituent yarn of a carpet. For example, it can be used as a constituent yarn for a roll carpet, a piece carpet, a tile carpet, an automobile carpet and an option carpet, and a household rug/mat. In cases where a pile of a carpet is constituted by the spun-dyed textured polylacted filament yarns of the first invention, the pile configuration is not specifically limited, and can be in any form such as, e.g., a cut pile, a loop file, and a cut-and-loop file. Furthermore, it can be used as a constituent yarn for, e.g., a woven carpet, a knitted carpet, an embroider carpet, and an adhesive carpet. The carpet constituted by using the spun-dyed textured polylacted filament yarns of the first invention can contribute to global environment protections since it can be decomposed by microorganisms, etc. , when discarded after the use.

Claims

1. A spun-dyed textured polylacted filament yarn, comprising a textured polylacted filament yarn,
wherein the textured polylacted filament yarn comprises a filament having an approximately circular or circular cross-section and has a relative viscosity of 2.5 to 3.8,
wherein the textured polylacted filament yarn contains a coloring agent in an amount of 0.01 to 3 mass%, and
wherein the textured polylacted filament yarn is 1.75 to 3.5 cN/dtex in tenacity, 35 to 60% in elongation, 500 to 3,500 dtex in total fineness, 2.5 to 25 dtex in a filament fineness, 2 to 8 % in hot water shrinkage ratio, and 5 to 25 % in dry heat crimp ratio.

2. The spun-dyed textured polylacted filament yarn as recited in claim 1, wherein the filament has an approximately circular or circular cross-section having a degree of deformation less than 1.5.

3. The spun-dyed textured polylacted filament yarn as recited in claim 1 or 2, wherein the coloring agent is at least one pigment selected from the group consisting of an inorganic pigment and an organic pigment.

4. A carpet in which the spun-dyed textured polylacted filament yarn as recited in any one of claims 1 to 3 is used as

at least a part of constituent yarn.

5. A method for manufacturing a spun-dyed textured polylacted filament yarn, comprising the steps of:

spinning a polylacted resin composition containing a coloring agent and a polylacted resin and having a coloring agent content of 0.01 to 3 mass% and a relative viscosity of 2.5 to 3.8 to obtain spun filaments comprising a filament having an approximately circular or circular cross-section and a degree of deformation less than 1.5;
drawing the spun filaments at a draw ratio of 3 times to 6 times with a draw roller set to 70 to 125 ˚C;
heat-setting the drawn spun filaments with a heat-set roller set to 100 to 150 ˚C;
giving crimps to the heat-set drawn spun filaments by bringing a heated fluid of 90 to 160 ˚C into contact with the heat-set drawn spun filaments using a texturing device; and
cooling the textured spun filaments after the crimping step to a temperature lower than a glass transition temperature of polylacted polymer.

6. A method for manufacturing a spun-dyed textured polylacted filament yarn, comprising the steps of:

obtaining spun filaments by extruding a polylacted resin composition containing a coloring agent and a polylacted resin and having a coloring agent content of 0.01 to 3 mass% and a relative viscosity of 2.5 to 3.8 through a spinning nozzle into filaments each having an approximately circular or circular cross-section and a degree of deformation less than 1.5, cooling the filaments with quench air, and then coating the filaments with lubricant;
drawing the spun filaments at a draw ratio of 3 times to 6 times with a draw roller set to 70 to 125 ˚C;
heat-setting the drawn spun filaments with a heat-set roller set to 100 to 150 ˚C;
giving crimps to the heat-set drawn spun filaments by bringing a heated fluid of 90 to 160 ˚C into contact with the heat-set drawn spun filaments using a texturing device; and
cooling the textured spun filaments after the crimping step to a temperature lower than a glass transition temperature of the polylacted polymer.

7. The method of manufacturing a spun-dyed textured polylacted filament yarn as recited in claim 5 or 6, wherein the following relational expression is met:

$$30\ ^{\circ}C \geqq S-R \geqq -10\ ^{\circ}C$$

where "S" is a temperature of the heat-set roller, and "R" is a temperature of the heated fluid in the texturing device.

8. The method of manufacturing a spun-dyed textured polylacted filament yarn as recited in any one of claims 5 to 7, wherein the drawn spun filaments are heat-set with a heat-set roller set to a temperature range of 100 ˚C to a softening point of the polylacted polymer.

9. The method of manufacturing a spun-dyed textured polylacted filament yarn as recited in any one of claims 5 to 8, wherein crimps are given to the heat-set drawn spun filaments by bringing the heated fluid set to a temperature range of 90 ˚C to a softening point of the polylacted polymer into contact with the filaments using the texturing device.

10. The method of manufacturing a spun-dyed textured polylacted filament yarn as recited in any one of claims 5 to 9, further comprising a step of subjecting the textured spun filaments went through the cooling step to an entangle process using a entangle processing device.

11. A spun-dyed textured polylacted filament yarn manufactured by the manufacturing method as recited in any one of claims 5 to 10.

12. A carpet in which at least a part of constituent yarns of the carpet is constituted by the spun-dyed textured polylacted filament yarn as recited in claim 11.

13. A carpet using a spun-dyed textured polylacted filament yarn comprising a filament having an approximately circular or circular cross-section as a pile yarn.

14. The carpet as recited in claim 13, wherein the spun-dyed textured polylacted filament yarn meets all of the following

characteristics (1) to (7):

(1) a filament has an approximately circular or circular cross-section having a degree of deformation less than 1.5, wherein the degree of deformation is expressed by a ratio (B/A) of a diameter B of an circumscribed circle of the filament cross-section to a diameter A of a inscribed circle of the filament cross-section;
(2) relative viscosity (RV) is 2.5 to 3.8;
(3) tenacity is 1.75 to 3.5 cN/dtex;
(4) elongation is 35 to 60 %;
(5) a filament fineness is 2.5 to 25 dtex;
(6) hot water shrinkage ratio is 2 to 8 %; and
(7) dry heat crimp ratio is 5 to 25 %.

15. The carpet as recited in claim 13 or 14, wherein the pile yarn comprises a single yarn and/or two or more doubled and twisted yarns made of a non-twisted and/or twisted spun-dyed textured polylacted filament yarn.

16. The carpet as recited in any one of claims 13 to 15, wherein an average length of piles forming a carpet is 5 to 15 mm, and a weight per unit area of the piles is 500 to 3, 000 g/m^2.

17. The carpet as recited in any one of claims 13 to 16, wherein an abrasion amount of pile yarns forming a carpet measured by a TABER abrasion test (abrasion ring: H-18, abrasion number: 2,500 times) is 5 to 30 mass%.

18. A carpet comprising a spun-dyed textured polylacted filament yarn and a spun-dyed textured synthetic filament yarn as a pile yarn, wherein an abrasion amount of the pile yarn forming a carpet measured by a TABER abrasion test (abrasion ring: H-18, abrasion number: 5,000 times) is 5 to 30 mass%.

19. The carpet as recited in claim 18, wherein the spun-dyed textured synthetic filament yarn is at least one of spun-dyed textured synthetic filament yarn selected from the group consisting of a spun-dyed textured polyester filament yarn, a spun-dyed textured nylon filament yarn, and a spun-dyed textured polypropylene filament yarn.

20. The carpet as recited in claim 18 or 19, wherein the spun-dyed textured polylacted filament yarn meets all of the following characteristics (1) to (7):

(1) a filament has an approximately circular or circular cross-section having a degree of deformation less than 1.5, wherein the degree of deformation is expressed by a ratio (B/A) of a diameter B of an circumscribed circle of the filament cross-section to a diameter A of a inscribed circle of the filament cross-section;
(2) relative viscosity (RV) is 2.5 to 3.8;
(3) tenacity is 1.75 to 3.5 cN/dtex;
(4) elongation is 35 to 60 %;
(5) a filament fineness is 2.5 to 25 dtex;
(6) hot water shrinkage ratio is 2 to 8 %; and
(7) dry heat crimp ratio is 5 to 25 %.

21. The carpet as recited in any one of claims 18 to 20, wherein an average length of piles forming a carpet is 5 to 15 mm, and a weight per unit area of the piles is 500 to 3,500 g/m^2.

22. The carpet as recited in any one of claims 18 to 21, wherein the spun-dyed textured polylacted filament yarn is made of plant-derived material, and the spun-dryed textured synthetic filament yarn is made of petroleum-derived material.

Fig. 1

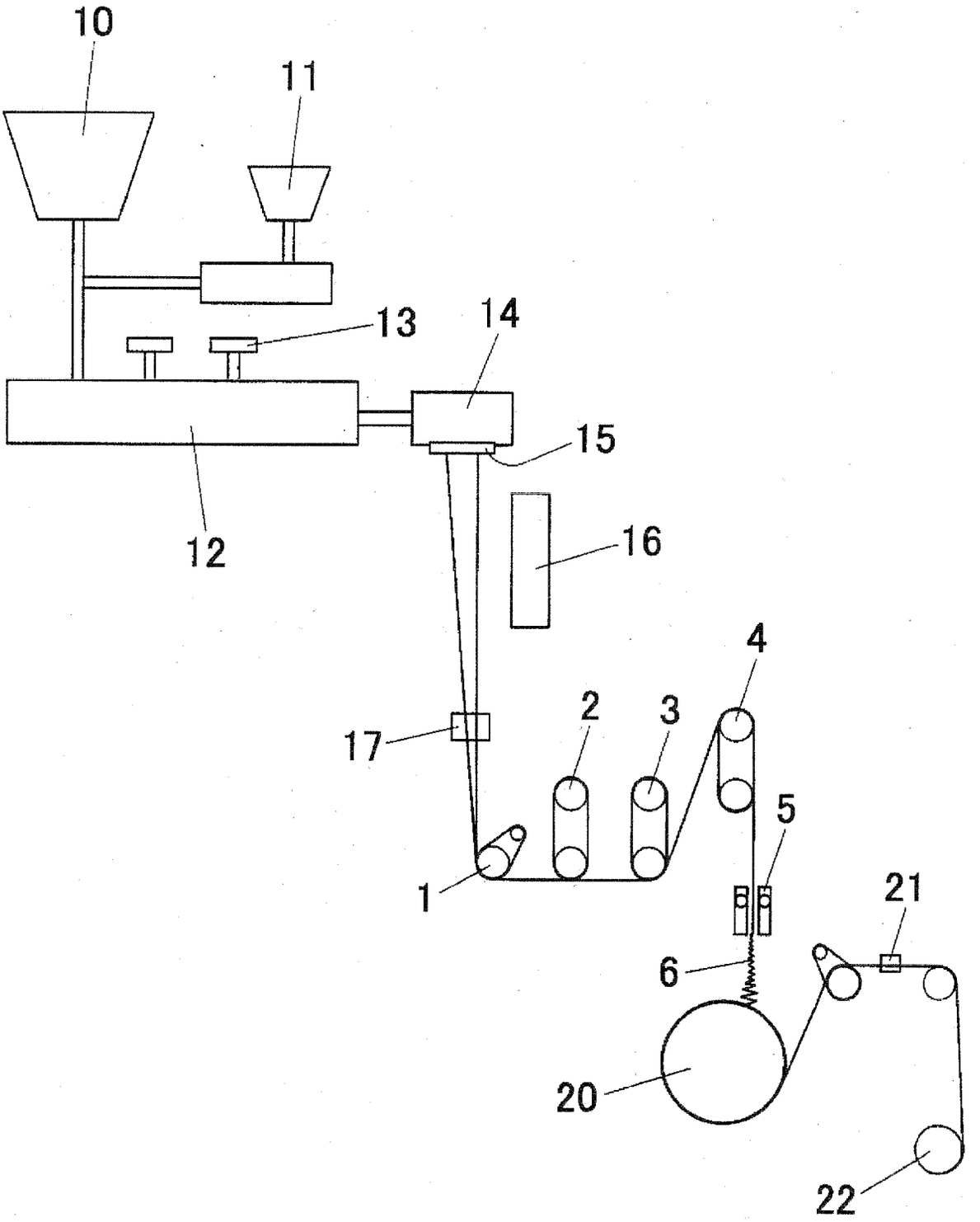


Fig. 2

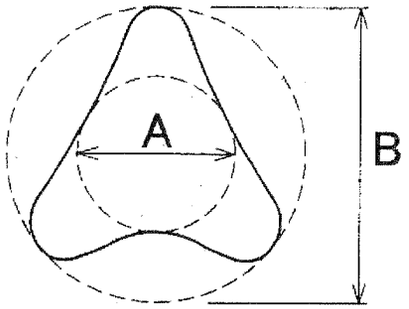


Fig. 3

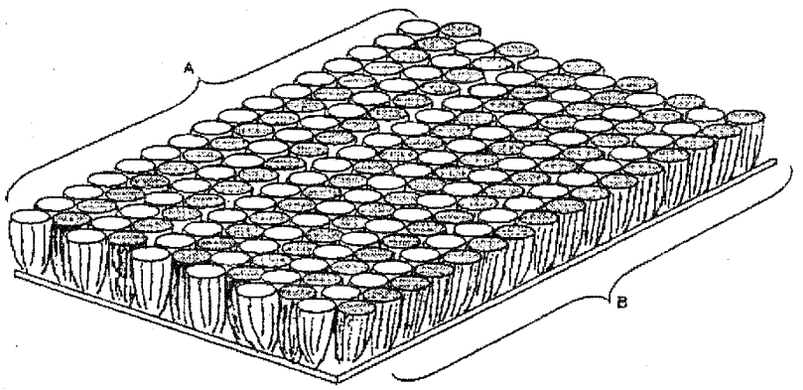
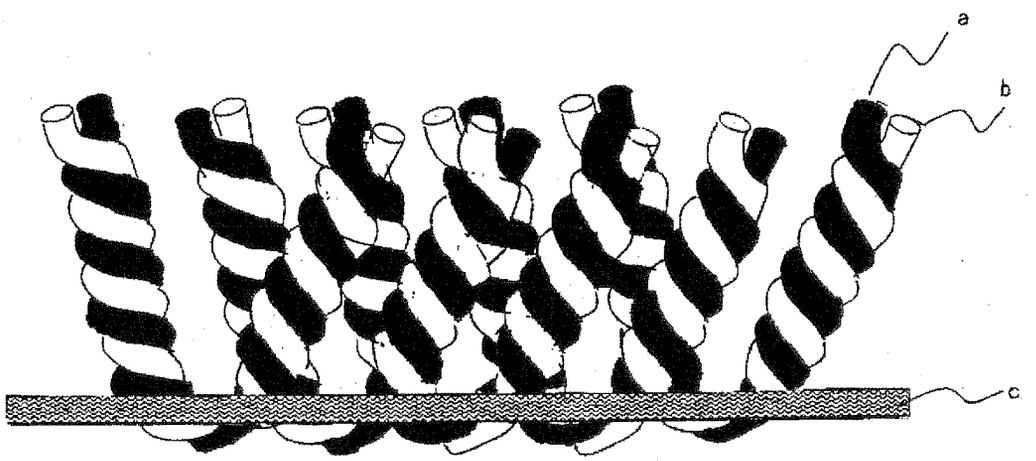


Fig. 4



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2006/317533

A. CLASSIFICATION OF SUBJECT MATTER
D02G3/02(2006.01)i, *A47G27/02*(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)
D02G1/00-3/48, D02J1/00-13/00, A47G27/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2006
Kokai Jitsuyo Shinan Koho 1971-2006 Toroku Jitsuyo Shinan Koho 1994-2006

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPIL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2002-180340 A (Toray Industries, Inc.), 26 June, 2002 (26.06.02), Claims; Par. Nos. [0015] to [0018], [0033], [0035] to [0036], [0049] to [0053]; examples (Family: none)	13,15-19, 21,22 1-12,14,20
Y	JP 2005-60850 A (Toray Industries, Inc.), 10 March, 2005 (10.03.05), Par. Nos. [0026] to [0031], [0083] (Family: none)	1-12,14,20
Y	JP 2003-293232 A (Toray Industries, Inc.), 15 October, 2003 (15.10.03), Par. No. [0028]; examples (Family: none)	1-12,14,20

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
01 December, 2006 (01.12.06)	12 December, 2006 (12.12.06)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2006/317533

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2004-204407 A (Toray Industries, Inc.), 22 July, 2004 (22.07.04), Examples; table 1 (Family: none)	1-12,14,20

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2005008997 A **[0011]**
- JP 2005048303 A **[0011]**
- JP 2005060850 A **[0011]**
- WO 0065140 A **[0011]**
- JP 2002248047 A **[0011]**
- JP 2003010030 A **[0011]**
- JP 2005258632 A **[0287]**
- JP 2005286444 A **[0287]**
- JP 2005286452 A **[0287]**