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(54) **THREAD AND FABRIC**

(57) A yarn (1, 2) includes a fiber (10) that generates a potential on a surface of the fiber by energy from the outside, and generates a potential of 0.1 V or more on the surface by performing measurement under the following conditions (a) to (d).
(a) the yarn (1, 2) is stretched by a predetermined amount

in a uniaxial direction
(b) a core material made of conductive fibers is covered with the fiber (10)
(c) the core material is grounded
(d) a surface potential of the fiber (10) is measured with an electric force microscope

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FIG. 1A

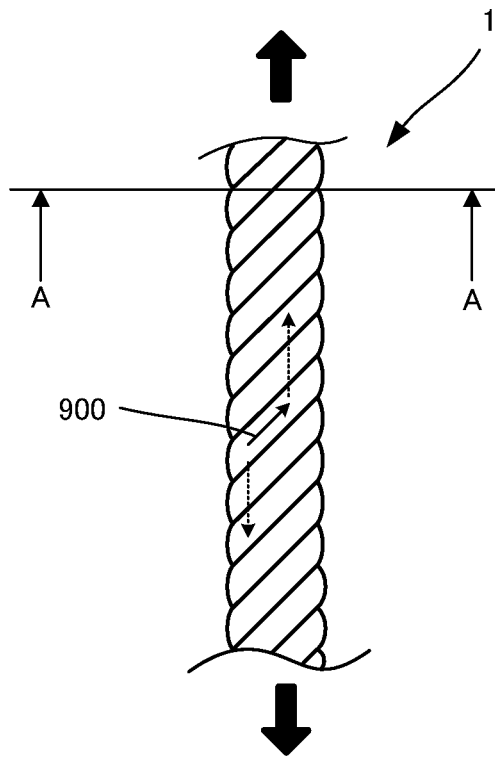
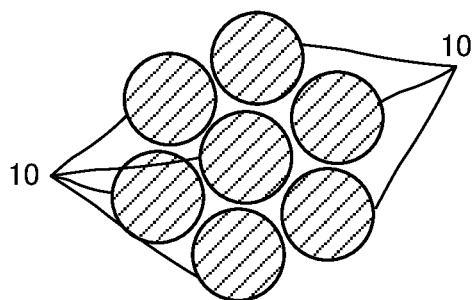


FIG. 1B



Description

Technical Field

5 [0001] The present invention relates to a yarn and a fabric that generate a charge.

Background Art

10 [0002] For example, Patent Literature 1 discloses a yarn and a fabric including a charge generating fiber that generates a charge by energy from the outside. The yarn and the fabric of Patent Literature 1 exhibit an antibacterial effect by the generated charge.

Citation List

15 Patent Literature

[0003] [Patent Literature 1]
Japanese Patent Unexamined Publication No. 2018-090950 bulletin

20 **Summary of Invention**

Technical Problem

25 [0004] However, Patent Literature 1 does not disclose how much potential is generated on a surface of the charge generating fiber. If the generated potential is too low, a desired effect may not be produced.

[0005] Therefore, an object of the present invention is to provide a yarn and a fabric that exhibit the desired effect.

Solution to Problem

30 [0006] A yarn of the present invention includes a fiber that generates a potential on a surface of the fiber by energy from the outside, and the yarn generates a potential of 0.1 V or more on the surface by performing measurement under the following conditions (a) to (d).

- 35 (a) the yarn is stretched by a predetermined amount in a uniaxial direction
- (b) a core material made of conductive fibers is covered with the fiber
- (c) the core material is grounded
- (d) a surface potential of the fiber is measured with an electric force microscope

40 [0007] Examples of the fiber that generates a potential on the surface by the energy from the outside include a substance having a piezoelectric effect (for example, polylactic acid, a substance having a photoelectric effect, or a substance having a pyroelectric effect (for example, polyvinylidene difluoride (PVDF)), and a substance that generates a charge by chemical change. The yarn of the present invention exhibits an antibacterial effect by the generated potential. Further, the yarn of the present invention can also charge a substance by generating a potential defined by the above conditions. Alternatively, the yarn of the present invention can adsorb the substance by generating the potential defined by the above conditions.

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Advantageous Effects of Invention

50 [0008] According to the present invention, a desired effect such as antibacterial, charging, or adsorption is exhibited by generating a potential defined under a predetermined condition.

Brief Description of Drawings

55 [0009]

FIG. 1(A) is a partially exploded view illustrating a configuration of a yarn 1, and FIG. 1(B) is a cross-sectional view taken along a line A-A of FIG. 1(A).

FIG. 2 is a partially exploded view illustrating a configuration of a yarn 2.

FIG. 3 is a simulation result illustrating a potential when 2% displacement is applied to the yarn 1 in an axial direction thereof.

FIG. 4(A) is a simulation result illustrating an electric field in a certain cross-section in the yarn 1 that is a Z yarn, and FIG. 4(B) is a simulation result illustrating an electric field in a certain cross-section in the yarn 2 that is an S yarn.

FIG. 5 is a cross-sectional view illustrating a state of the electric field when the yarn 1 and the yarn 2 are brought close to each other.

Description of Embodiment

[0010] Hereinafter, an embodiment of the present invention will be described. FIG. 1(A) is a partially exploded view illustrating a configuration of a yarn 1, and FIG. 1(B) is a cross-sectional view taken along a line A-A of FIG. 1(A).

[0011] The yarn 1 is a multifilament yarn formed by twisting a plurality of fibers 10. The fiber 10 is a fiber having a circular cross-section. The yarn 1 is a left-spiraled yarn (hereinafter, referred to as a Z yarn) in which the fibers 10 are leftward spiraled and twisted.

[0012] The fiber 10 is made of, for example, a piezoelectric polymer. The fiber 10 is manufactured by, for example, a method of extruding and molding the piezoelectric polymer into the fiber. Alternatively, the fiber 10 is manufactured by a method in which the piezoelectric polymer is melt-spun to be formed into the fiber (examples thereof include a spinning/stretching method in which a spinning step and a stretching step are separately performed, a straight stretching method in which the spinning step and the stretching step are connected, a POY-DTY method in which a false twisting step can also be performed at the same time, and an ultrahigh speed spinning method in which a spinning speed is increased), a method in which the piezoelectric polymer is formed into the fiber by dry or wet spinning (examples thereof include a phase separation method or a dry-wet spinning method in which a polymer as a raw material is dissolved in a solvent and extruded from a nozzle to form the fiber, a gel spinning method in which the fiber is uniformly formed into a gel while containing the solvent, and a liquid crystal spinning method in which the fiber is formed using a liquid crystal solution or a melt), a method in which the piezoelectric polymer is formed into the fiber by electrostatic spinning, or the like. Note that the cross-sectional shape of the fiber 10 is not limited to a circular shape.

[0013] As the piezoelectric polymer, there are a piezoelectric polymer having pyroelectricity and a piezoelectric polymer having no pyroelectricity, but both can be used. For example, PVDF has pyroelectricity, and is also polarized by a temperature change to generate a potential on a surface of the fiber. A piezoelectric body having pyroelectricity such as PVDF is polarized by thermal energy of a human body. In this case, the thermal energy of the human body is energy from the outside.

[0014] Polylactic acid (PLA) is the piezoelectric polymer having no pyroelectricity. Polylactic acid is uniaxially stretched to generate piezoelectricity. Examples of polylactic acid include poly-L-lactic acid obtained by polymerizing L-lactic acid and L-lactide, poly-D-lactic acid obtained by polymerizing D-lactic acid and D-lactide, and stereocomplex polylactic acid having a hybrid structure thereof, depending on crystal structure, but any of them can be used as long as it exhibits piezoelectricity. From a viewpoint of high piezoelectric modulus, poly-L-lactic acid or poly-D-lactic acid is preferably used. Poly-L-lactic acid and poly-D-lactic acid each have opposite polarization polarities for the same deformation.

[0015] Polylactic acid exhibits piezoelectricity when molecules are uniaxially stretched and oriented. Piezoelectric constant of polylactic acid can be increased by further heat treating polylactic acid to increase crystallinity. Since the piezoelectricity occurs by molecular orientation treatment by stretching in polylactic acid, it is not necessary to perform polling processing unlike other piezoelectric polymers such as PVDF, or piezoelectric ceramics.

[0016] The piezoelectric constant of uniaxially stretched polylactic acid is about 5 to 30 pC/N, and has a very high piezoelectric constant among polymers. Furthermore, the piezoelectric constant of polylactic acid does not vary with time and is extremely stable.

[0017] When a thickness direction is defined as a first axis, a stretching direction 900 is defined as a third axis, and a direction perpendicular to both the first axis and the third axis is defined as a second axis, the fiber 10 containing uniaxially stretched polylactic acid has tensor components of d_{14} and d_{25} as piezoelectric strain constants. Therefore, the fiber 10 containing uniaxially stretched polylactic acid generates a potential when shear deformation occurs in a direction intersecting a uniaxially stretched direction.

[0018] In FIG. 1(A), the stretching direction 900 of each fiber 10 coincides with an axial direction of each fiber 10. By twisting the fibers 10, the stretching direction 900 of the fibers 10 is inclined with respect to an axial direction of the yarn 1.

[0019] When the yarn 1 of such a Z yarn is tensioned and stretched, the fiber 10 is strained in the axial direction of the yarn 1, and the shear deformation occurs in the axial direction of the yarn 1. Therefore, a positive potential is generated on the surface of the fiber 10, and a negative potential is generated on an inner side thereof. Note that as illustrated in FIG. 2, in a case of a right-spiraled yarn (hereinafter, referred to as an S yarn) in which the fibers 10 are rightward spiraled and twisted, when the yarn is stretched, the negative potential is generated on the surface of the fiber 10, and the positive potential is generated on the inner side thereof.

[0020] Therefore, the positive potential is generated on the surface of the yarn 1, and the negative potential is generated

on the inner side thereof. The negative potential is generated on the surface of the yarn 2, and the positive potential is generated on the inner side thereof. However, a twist angle of the fiber 10 varies depending on a site thereof, and thicknesses of the yarn 1 and the yarn 2 are not uniform as a whole. Therefore, the fibers 10 do not always generate a uniform surface potential.

5 [0021] FIG. 3 is a simulation result illustrating a potential when 2% displacement is applied to the yarn 1 in the axial direction. However, in the simulation result, it is assumed that the fibers 10 slide with each other when the displacement in the axial direction occurs in the yarn 1. In the simulation result, an average twist angle changes from 6.5° to 5.5° by applying 2% displacement in the axial direction.

10 [0022] As illustrated in the simulation result of FIG. 3, the fiber 10 has a portion where the positive potential is generated and a portion where the negative potential is generated. The yarn 1 generates an electric field between the portion where the positive potential is generated and the portion where the negative potential is generated.

[0023] FIG. 4(A) is a simulation result illustrating an electric field in a certain cross-section in the yarn 1 that is the Z yarn. FIG. 4(B) is a simulation result illustrating an electric field in a certain cross-section in the yarn 2 that is the S yarn. As illustrated in these simulation results, it can be seen that each of the yarn 1 and the yarn 2 has a portion where the electric field of several MV/m is generated even alone.

15 [0024] In this manner, the yarn of the present invention includes the fibers 10 that generates the potential on the surface by the energy from the outside, and generates the electric field between the fibers 10 when the displacement is applied.

20 [0025] More specifically, the fibers 10 have positive potential portions and negative potential portions (portions having different potentials), and the electric fields are generated between the positive portions and the negative portions of the fibers 10.

[0026] Note that the stretching direction 900 of the fiber 10 may intersect at least the axial direction of the yarn. The average twist angle is preferably 10° to 50°. The average twist angle is more preferably 20° to 40°.

25 [0027] Of course, the electric field is generated between the yarn 1 and other substances, between the yarn 2 and other substances, and between the yarn 1 and the yarn 2. FIG. 5 is a cross-sectional view illustrating a state of the electric field when the yarn 1 and the yarn 2 are brought close to each other. In the yarn 1 alone, the surface has the positive potential and the inside has the negative potential when a tension in the axial direction is applied. In the yarn 2 alone, the surface has the negative potential and the inside has the positive potential when the tension in the axial direction is applied.

30 [0028] When the yarn 1 and the yarn 2 approach each other, approaching portions (surfaces) tend to have the same potential. In this case, the approaching portion between the yarn 1 and the yarn 2 becomes 0 V, and the negative potential inside the yarn 1 is further reduced so as to maintain an original potential difference. Similarly, the positive potential inside the yarn 2 is further increased.

35 [0029] In the cross-section of the yarn 1, the electric field directed mainly from the outside to the inside of the yarn 1 is generated, and in the cross-section of the yarn 2, the electric field directed mainly from the inside to the outside of the yarn 2 is generated. When the yarn 1 and the yarn 2 are brought close to each other, these electric fields leak out into the air and are synthesized, and the electric field is generated between the yarn 1 and the yarn 2 due to a potential difference between the yarn 1 and the yarn 2.

40 [0030] Furthermore, even when the yarn 1 and an object having a predetermined potential such as a human body approach each other, the electric field is generated between the yarn 1 and the object approaching. Even when the yarn 2 and the object having the predetermined potential such as the human body approach each other, the electric field is generated between the yarn 2 and the object approaching.

[0031] The electric field as described above exerts an antibacterial effect of suppressing growth of, for example, viruses, bacteria, fungi, archaea, and microorganisms such as mites and fleas.

45 [0032] Note that when moisture containing an electrolyte is present in the yarn 1 or the yarn 2, a current flows through the moisture. The yarn 1 or the yarn 2 may directly exhibit the antibacterial effect or a sterilizing effect even by this current. Alternatively, the antibacterial effect or the sterilizing effect may be indirectly exhibited by an active oxygen species in which oxygen contained in the moisture is changed by an action of current or voltage, a radical species generated by an interaction with an additive contained in the fiber or a catalytic action, or other antibacterial chemical species (amine derivative or the like). Alternatively, oxygen radicals may be generated in cells of bacteria by a stress environment due to a presence of the electric field or the current. As the radical, generation of a superoxide anion radical (active oxygen) or a hydroxy radical is considered.

50 [0033] In conventional materials having antibacterial properties, such as drugs, their effects do not last for a long time. In addition, the conventional materials having antibacterial properties may cause an allergic reaction due to the drug or the like. In contrast, the antibacterial effect of the yarn of the present embodiment lasts longer than the antibacterial effect by the drug or the like. In addition, the yarn of the present embodiment is less likely to cause the allergic reaction than the drug. Furthermore, since the piezoelectric constant of polylactic acid does not vary with time and is extremely stable as described above, the antibacterial effect of the yarn is also stably exhibited for a long time.

[0034] Further, the yarn 1 or the yarn 2 can charge other substances by the generated potential. Alternatively, the yarn 1 or the yarn 2 can adsorb a substance by the generated potential. For example, since the positive potential is generated on the surface of the yarn 1, the yarn 1 can adsorb the substance having the negative potential. Since the negative potential is generated on the surface of the yarn 2, the yarn 2 can adsorb the substance having the positive potential.

[0035] The yarn 1 or the yarn 2 can efficiently adsorb the substance by constituting a filter. Such a filter is suitable for a mask or an air purifier. Furthermore, the substance can be more efficiently adsorbed by positively or negatively charging the substance with the yarn 1 or the yarn 2 as a pre-filter of a preceding stage, and using the yarn 1 or the yarn 2 which generates a potential of opposite polarity as the filter of a subsequent stage. The substance may be positively or negatively charged with the yarn 1 or the yarn 2 as the pre-filter of the preceding stage, and an electret filter having the potential of opposite polarity may be used as the filter of the subsequent stage.

[0036] Here, if the potential generated on the surface of the yarn 1 or the yarn 2 is too low, various desired effects described above may not occur. However, the yarn of the present invention includes the fiber that generates the potential on the surface by the energy from the outside, and generates the potential of 0.1 V or more on the surface of the yarn by measuring under the following conditions (a) to (d). The yarn of the present invention can exhibit a desired effect by generating the potential defined under such conditions.

- (a) the yarn is stretched by a predetermined amount in a uniaxial direction
- (b) a core material made of conductive fibers is covered with the fiber
- (c) the core material is grounded
- (d) the surface potential of the yarn is measured with an electric force microscope.

[0037] Note that as the predetermined amount of the above (a), strain of the yarn is preferably 0.1% or more. The strain is more preferably 0.5% or more. The potential of the surface is preferably 0.3 V or more, and more preferably 1.0 V or more.

[0038] The thickness (single fiber fineness) of the yarn is preferably 0.005 to 10 dtex. When the single fiber fineness is small, the number of filaments is too large, and fluffing tends to occur. On the other hand, when the single fiber fineness is large and the number of filaments is too small, texture is impaired. Note that the single fiber fineness referred to herein is the single fiber fineness of one twisted yarn. Even when the twisted yarn is further combined, it means the single fiber fineness of one twisted yarn before being combined.

[0039] Furthermore, fiber strength of the yarn is preferably 1 to 5 cN/dtex. Thus, even if greater deformation occurs due to generation of a high potential, the yarn can withstand without breaking. The fiber strength is more preferably 2 to 10 cN/dtex, still more preferably 3 to 10 cN/dtex, and most preferably 3.5 to 10 cN/dtex. For the same purpose, elongation of the yarn is preferably 10 to 50%.

[0040] The crystallinity of polylactic acid is preferably 15 to 55%. Thus, the piezoelectricity derived from polylactic acid crystal is increased, and polarization due to the piezoelectricity of the polylactic acid can be more effectively generated.

[0041] Hereinafter, examples will be described. The yarn of Example 1 to 3 is a twisted yarn using polylactic acid having a crystallinity of 45%, a crystal size of 12 nm, and an orientation of 79%, and using 84 dtex-24 filament. The yarn of Example 1 to 3 is formed by covering the core material made of conductive fibers with a filament of polylactic acid. Further, the core material is grounded. Therefore, the inner side of the yarn of Example 1 to 3 has a potential of 0 V.

[0042] In Example 1, the number of twists is 500 T/m, in Example 2, the number of twists is 1150 T/m, and in Example 3, the number of twists is 3000 T/m. When the number of twists is 500 T/m, the average twist angle is 10°, when the number of twists is 1150 T/m, the average twist angle is 28°, and when the number of twists is 3000 T/m, the average twist angle is 47°.

[0043] Table 1 shows the results of sandwiching both ends of the yarn of Examples 1 to 3 with rigid jigs, stretching the yarn of 40 mm to 40.2 mm, neutralizing the yarn with an ionizer, then stretching the yarn by 0.5% (40.2 mm to 40.4 mm) in the axial direction, and measuring the potential on the surface of the yarn with the electric force microscope. Potential values shown in Table 1 are positive or negative peak values.

[Table 1]

	40.2 → 40.4 mm (0.5%) stretch		
Twist direction	500 times	1150 times	3000 times
S	-0.15V	-1.22V	-0.35V
Z	0.12V	0.96V	0.40V

[0044] As shown in Table 1, the S yarn of Example 1 generates a potential of -0.15 V. The Z yarn of Example 1 generates a potential of 0.12 V. The S yarn of Example 2 generates a potential of -1.22 V. The Z yarn of Example 2 generates a potential of 0.96 V. The S yarn of Example 3 generates a potential of -0.35 V. The Z yarn of Example 3 generates a potential of 0.40 V.

[0045] Table 2 shows the results of measuring the surface potential of the yarn with the electric force microscope when the yarn was further stretched and contracted to 0.25% (stretched and contracted between 40.4 mm and 40.5 mm) in the axial direction after the measurement under the conditions of Table 1 above. When the S yarn is stretched, the negative potential is generated on the surface, and when the S yarn is contracted, the positive potential is generated on the surface. When the Z yarn is stretched, the positive potential is generated on the surface, and when the Z yarn is contracted, the negative potential is generated on the surface. Therefore, when the yarn is stretched and contracted, the positive potentials and the negative potentials are alternately generated. Values of the surface potential shown in Table 2 are differences between minimum values and maximum values (differences between a peak value to a peak value).

[Table 2]

	40.4 ↔ 40.5 mm (0.25%) stretch and contract		
Twist direction	500 times	1150 times	3000 times
S	0.28V	2.83V	0.80V
Z	0.33V	2.42V	0.75V

[0046] As shown in Table 1, the S yarn of Example 1 generates a potential of 0.28 V. The Z yarn of Example 1 generates a potential of 0.33 V. The S yarn of Example 2 generates a potential of 2.83 V. The Z yarn of Example 2 generates a potential of 2.42 V. The S yarn of Example 3 generates a potential of 0.80 V. The Z yarn of Example 3 generates a potential of 0.75 V.

[0047] From the results of Tables 1 and 2, it was confirmed that when the number of twists was 500 to 3000 Tm, the potential of about 0.1 V or more was generated on the surface of the yarn. It has been confirmed that all of the examples produce the antibacterial effect. Therefore, the yarn of the present invention can exhibit the desired effect by generating the potential (0.1 V or more) defined under the above conditions (a) to (d).

[0048] From the measurement results of these examples, it can be said that the average twist angle is preferably 10° to 50°. Further, in the above measurement results, since the highest potential is generated when the twist angle is 30°, it can be said that the average twist angle is more preferably 20° to 40°.

[0049] The yarn of the present invention can be used by combining a plurality of types of twisted yarns as necessary. For example, an S-twisted yarn mainly using poly-L-lactic acid and a Z-twisted yarn mainly using poly-L-lactic acid can be used. When these yarns are brought close to each other, the electric field between the fibers increases, and the antibacterial properties increase.

[0050] The same applies to a case of using an S-twisted yarn mainly using poly-L-lactic acid and an S-twisted yarn mainly using poly-D-lactic acid, a case of using a Z-twisted yarn mainly using poly-L-lactic acid and a Z-twisted yarn mainly using poly-D-lactic acid, and a case of using an S-twisted yarn using poly-D-lactic acid and a Z-twisted yarn mainly using poly-D-lactic acid.

[0051] These twisted yarns may be combined and used, or any two types of twisted yarns among the above-described twisted yarns may be used in combination as the yarns constituting a fabric. The fabric of the present invention includes, for example, the yarn 1 or the yarn 2 described above. Note that in the present invention, the fabric refers to a textile product such as a woven fabric, a knitted fabric, a braided fabric, a nonwoven fabric, and a lace.

[0052] Each of the yarns constituting the fabric may generate a potential of 0.1 V or more on the surface under the above-described conditions (a) to (d), but the fabric itself of the present invention may generate a potential of 0.1 V or more on the surface of the fabric by measurement under the following conditions (a) to (d). The fabric of the present invention can also exhibit the desired effect by generating the potential defined under such conditions.

- (a) the fabric is stretched by a predetermined amount in a uniaxial direction
- (b) a core material made of conductive fibers is covered with the fiber
- (c) the core material is grounded
- (d) the surface potential of the fabric is measured with the electric force microscope

[0053] As in the case of the yarn, as the predetermined amount of the above (a), strain of the fabric is preferably 0.1% or more. The strain is more preferably 0.5% or more. The potential of the surface is preferably 0.3 V or more, and more

preferably 1.0 V or more.

[0054] Parameters of the fiber constituting the fabric are the same as those of the above-mentioned yarn. That is, the thickness (single fiber fineness) of the fiber is preferably 0.005 to 10 dtex. Furthermore, the fiber strength is preferably 1 to 5 cN/dtex. The fiber strength is more preferably 2 to 10 cN/dtex, still more preferably 3 to 10 cN/dtex, and most preferably 3.5 to 10 cN/dtex. The elongation of the fiber is preferably 10 to 50%. The crystallinity of the polylactic acid is preferably 15 to 55%.

[0055] When the fiber constituting the fabric is the twisted yarn, the average twist angle of the twisted yarn is preferably 10 to 50°, and the average twist angle is more preferably 20 to 40°.

[0056] A basis weight of the fabric is preferably 20 to 200 g/m², and a porosity is preferably 50 to 95%. Further, when the fabric is used as the filter, the filter preferably has a collection rate of fine particles of 0.3 μm of 40% or more and a pressure loss of less than 250 Pa at an air velocity of 5.1 cm/sec or more in order to improve collection performance and collection stability.

[0057] The fabric of the present invention is applicable to various products such as clothing and medical members. For example, the fabric of the present invention can be applied to underwear (in particular, socks), towels, insoles for shoes and boots, sportswear in general, hats, bedding (including beds, mattresses, sheets, pillows, pillows covers, and the like), toothbrushes, flosses, various filters (filter and the like of water purifier, air conditioner, or air purifier), stuffed animals, pet-related products (mat for pet, clothing for pet, and inner of clothing for pet), various mat products (foot, hand, toilet seat, or the like), curtains, kitchen utensils (sponges, cloths, or the like), seats (seats of cars, trains, airplanes or the like), cushioning materials for motorbike helmets and exterior materials thereof, sofas, bandages, gauzes, masks, sutures, clothes for doctors and patients, supporters, sanitary items, sporting goods (inner of wear and glove, gauntlet used in martial arts, or the like), packaging materials, and the like.

[0058] Among clothing, in particular, the socks (or supporters) always expand and contract along joints due to movement such as walking, and thus polarization occurs frequently. In addition, the socks absorb moisture such as sweat and serve as a hotbed for the growth of bacteria, but the fabric of the present invention can suppress the growth of the bacteria, and thus produces a remarkable effect as a bacterium-countermeasure application.

[0059] Note that the yarn of the present invention may be a non-twisted yarn or a false twisted yarn. The yarn constituting the fabric of the present invention may also be the non-twisted yarn or the false twisted yarn. Various desired effects such as the antibacterial effect can be exhibited as long as the fiber is provided which generates the potential on the surface by the energy from the outside, and the potential of 0.1 V or more is generated under the above conditions.

[0060] The description of the present embodiment is to be considered in all respects as illustrative and not restrictive. The scope of the present invention is defined not by the above-described embodiment but by the claims. Furthermore, the scope of the present invention is intended to include all modifications within the meaning and scope equivalent to the claims.

Reference Signs List

[0061]

1, 2 yarn
 10 fiber
 900 stretching direction

Claims

1. A yarn comprising a fiber that generates a potential on a surface of the fiber by energy from the outside, wherein the yarn generates a potential of 0.1 V or more on the surface by performing measurement under the following conditions (a) to (d):
 - (a) the yarn is stretched by a predetermined amount in a uniaxial direction
 - (b) a core material made of conductive fibers is covered with the fiber
 - (c) the core material is grounded
 - (d) a surface potential of the yarn is measured with an electric force microscope.
2. The yarn according to claim 1, wherein strain of the yarn is 0.1% or more as the predetermined amount.
3. The yarn according to claim 1 or 2, wherein a thickness of the yarn is 0.005 to 10 dtex.

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4. The yarn according to any one of claims 1 to 3, wherein the fiber contains polylactic acid.

5. The yarn according to any one of claims 1 to 4, wherein the fiber is twisted.

5 6. The yarn according to claim 5, wherein an average twist angle of the yarn is 10 to 50°.

7. The yarn according to any one of claims 1 to 6, wherein the yarn satisfies the following requirements (A) to (C):

(A) fiber strength is 1 to 5 cN/dtex

10 (B) elongation is 10 to 50%

(C) crystallinity is 15 to 55%.

8. A fabric comprising a fiber that generates a potential on a surface of the fiber by energy from the outside, wherein the fabric generates a potential of 0.1 V or more on the surface by performing measurement under the following conditions (a) to (d):

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(a) the fabric is stretched by a predetermined amount in a uniaxial direction

(b) a core material made of conductive fibers is covered with the fiber

(c) the core material is grounded

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(d) a surface potential of the fabric is measured with an electric force microscope.

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FIG. 1A

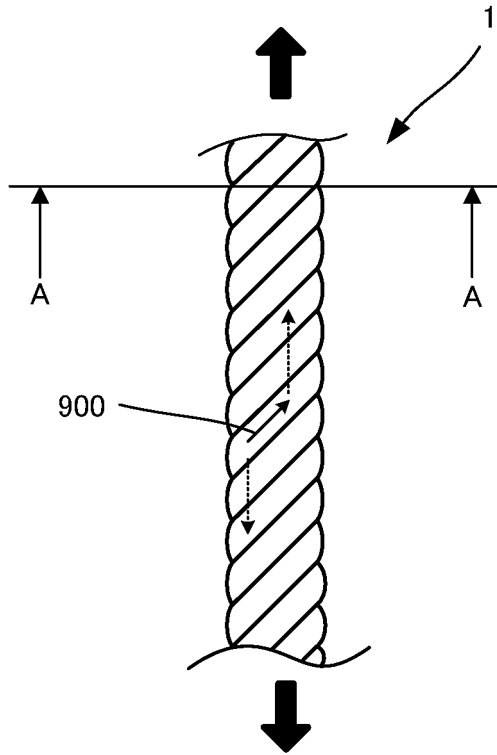


FIG. 1B

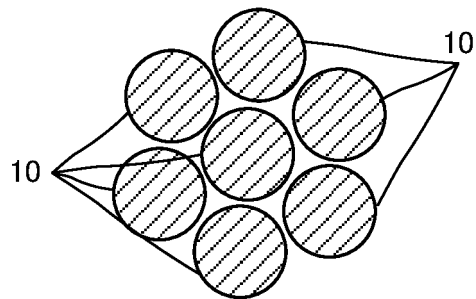


FIG. 2

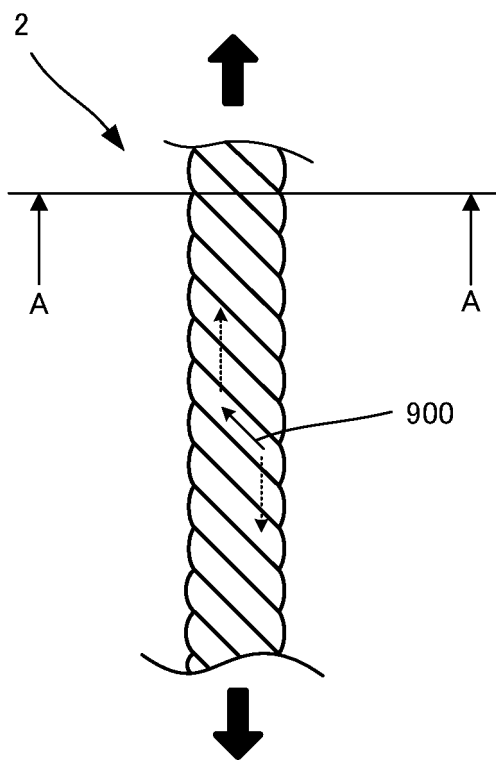


FIG. 3

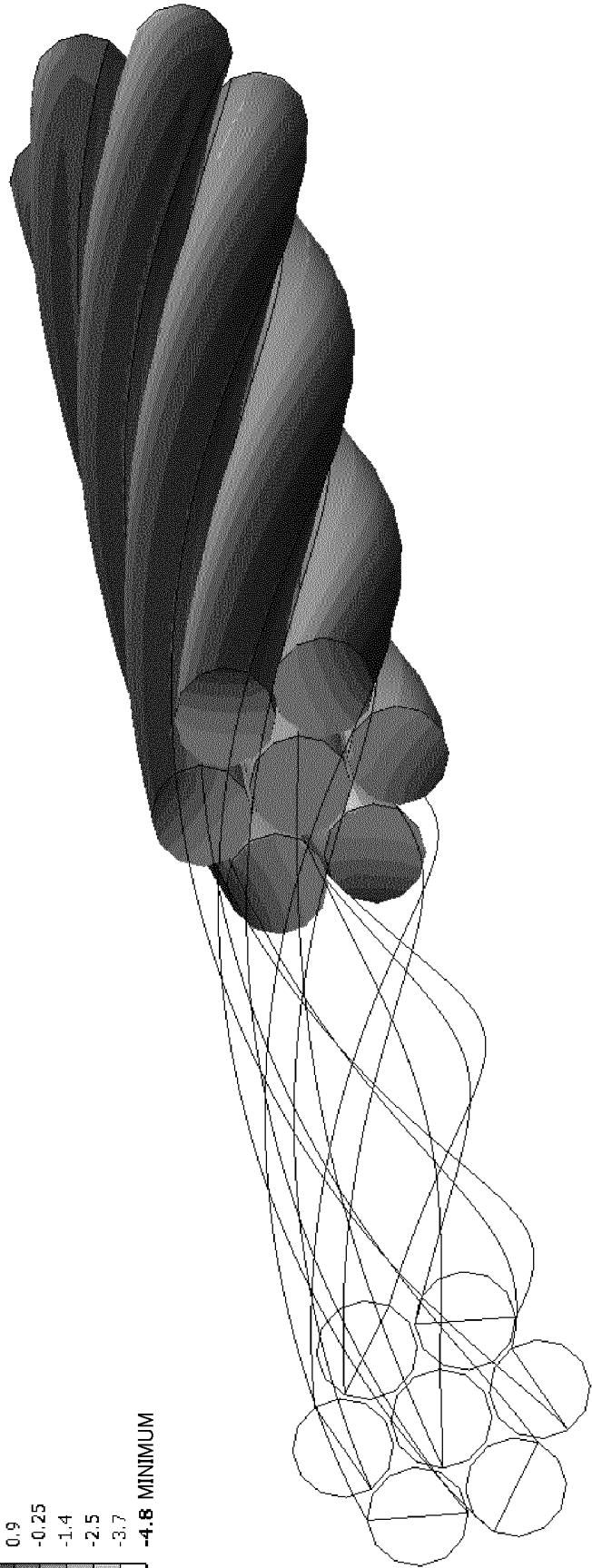
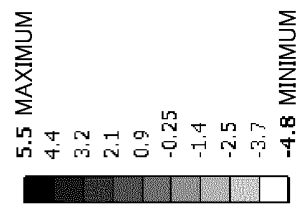


FIG. 4A

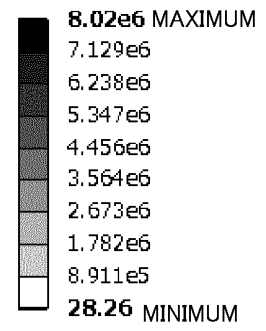
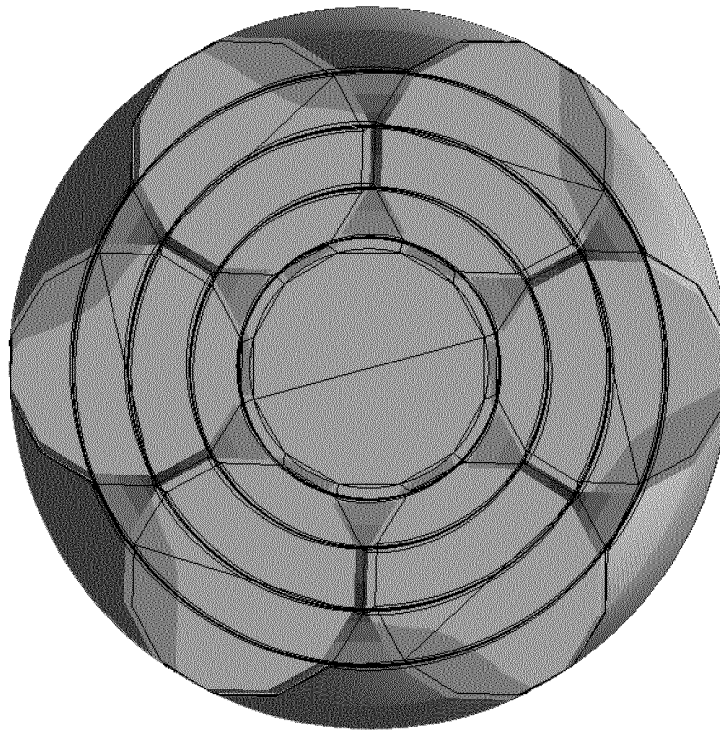
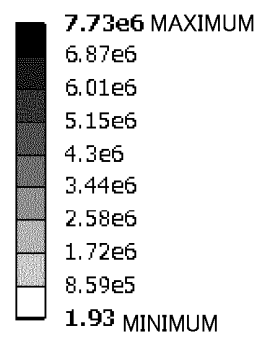
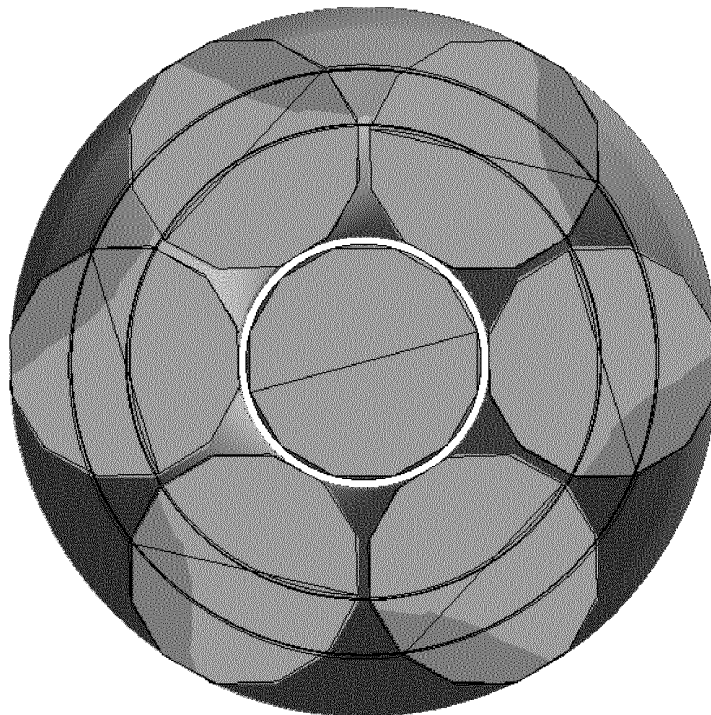
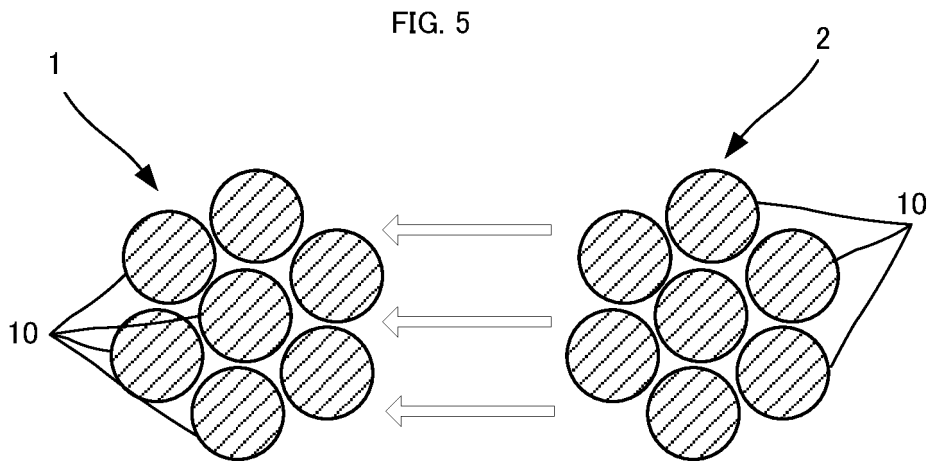


FIG. 4B





INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2020/020041

A. CLASSIFICATION OF SUBJECT MATTER D02G 3/36 (2006.01)i; D03D1/00 (2006.01)i; D03D 15/00 (2006.01)i FI: D02G3/36; D03D1/00 Z; D03D15/00 A		
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, D03D1/00-27/18, H01L27/20, H01L41/00-41/47		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Published examined utility model applications of Japan	1922-1996	
Published unexamined utility model applications of Japan	1971-2020	
Registered utility model specifications of Japan	1996-2020	
Published registered utility model applications of Japan	1994-2020	
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) JSTPlus/JMEDPlus/JST7580 (JDreamIII)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2017-201487 A (TEIJIN LTD.) 09.11.2017 (2017-11-09) claims 1, 5-7, 9, paragraphs [0039]-[0042], [0048], [0049], [0076]	1-6, 8
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A	WO 2018/116970 A1 (MURATA MANUFACTURING CO., LTD.) 28.06.2018 (2018-06-28)	1-8
<input type="checkbox"/> Further documents are listed in the continuation of Box C.		<input checked="" type="checkbox"/> See patent family annex.
* Special categories of cited documents:	"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	
"A" document defining the general state of the art which is not considered to be of particular relevance	"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	
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"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		
Date of the actual completion of the international search 04 August 2020 (04.08.2020)	Date of mailing of the international search report 18 August 2020 (18.08.2020)	
Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.	

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No. PCT/JP2020/020041
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REFERENCES CITED IN THE DESCRIPTION

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