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(71) Applicant: **Toray Industries, Inc.**
Tokyo 103-8666 (JP)

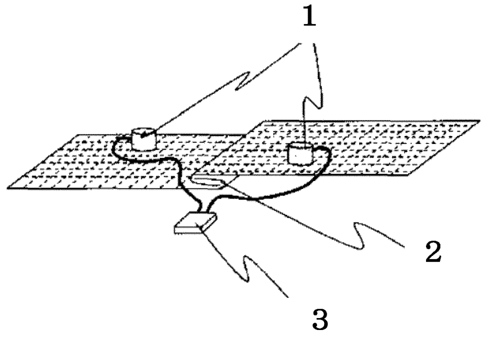
(72) Inventors:
- **SUYAMA, Hiroshi**
Osaka-shi, Osaka 530-8222 (JP)
- **KATSUBE, Teiichi**
Tokyo 103-8666 (JP)
- **NAKANO, Katsuya**
Tokyo 103-8666 (JP)

(74) Representative: **Mewburn Ellis LLP**
Aurora Building
Counterslip
Bristol BS1 6BX (GB)

(54) **CONDUCTIVE TEXTURED COMPOSITE YARN, AND FABRIC AND CLOTHING**

(57) In order to provide a conductive composite textured yarn excellent in electrical continuity and wearing durability thereof, there is provided a conductive composite textured yarn including a conductive yarn a and a non-conductive yarn b that are combined by entanglement, wherein the conductive yarn a is a non-crimped yarn and the non-conductive yarn b is a crimped yarn, the conductive composite textured yarn satisfying all following characteristics: crimp rate (%) of conductive composite textured yarn: 10 to 55, and degree of entanglement (entangled parts/m) of conductive composite textured yarn: 20 to 150.

Fig.1



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Description

TECHNICAL FIELD

[0001] The present invention relates to a conductive composite textured yarn having excellent conductivity and wearing durability, and a fabric and a garment using the same.

BACKGROUND ART

[0002] Conductive garments have been conventionally used for preventing electrostatic attraction of dust in a workplace or clean room for handling parts and chemicals to which static electricity is an obstacle. In the conductive garment, conductive yarns are woven into the garment for taking measures against static electricity. Specifically, electrostatic attraction of dust is prevented by weaving conductive yarns into the garment at a certain interval in a stripe or lattice and neutralizing static electricity using corona discharge. In general, the conductive yarn is often colored in black or gray, and thus, from the viewpoint of aesthetics, it has been proposed to expose a large amount of the conductive yarn on the inner surface of the garment (see Patent Document 1). However, in this method, when the conventional conductive yarn is used as it is, the surface electric resistance value on the outer side of the garment increases, thereby deteriorating the efficiency of diffusing the static electricity generated in the garment to the outer side of the garment.

[0003] In recent years, as required characteristics of electrostatic control, surface resistance values of conductive garments have been standardized in International Electrotechnical Commission (IEC) 61340-5-1, 5-2, and surface electrical continuity over the entire garment is required. In order to enhance the electrical continuity in the entire region of the garment, not only electrical continuity in the oblique direction of the fabric but also electrical continuity across the seam is required. In this case, it is necessary to weave the conductive yarns in a lattice such that the conductive yarns are in contact between different directions, and to bring the conductive yarns into contact with each other also at the sewn portion of the fabric.

[0004] In order to meet the requirements of IEC, for example, there is proposed a polyester fabric in which conductive yarns are regularly arranged as warp and weft yarns at intervals of 5 mm or more and 30 mm or less (see Patent Document 2). However, in this fabric, when operations such as bending, pulling, and flexion in long-term continuous use and washing assuming an actual wearing environment are repeatedly performed, the conductive yarn is buried in the fabric, and the conductive performance cannot be maintained.

[0005] In addition, there is proposed a fabric that has excellent surface conductivity by using a conductive yarn as a floating yarn for double weave (see Patent Document 3). However, since the conductive yarn in this fabric is in a state of floating on the surface for a long time, when the fabric is used continuously for a long time, there are problems that the conductive yarn deteriorates due to washing or friction and cannot maintain the conductive performance and the structure has large restrictions.

[0006] Furthermore, there is proposed a fabric using a conductive composite textured yarn obtained by subjecting a conductive yarn to relaxation heat treatment to reduce shrinkage and then mixing the conductive yarn with a non-conductive yarn (see Patent Document 4). In this method, degradation of conductive performance due to repeated washing is certainly considered, but the influence of operations such as bending, pulling, and flexion assuming an actual wearing environment is not considered. In actual long-term wearing, the conductive yarn deteriorates, and cannot maintain the conductive performance for a long period of time.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0007]

Patent Document 1: Japanese Patent Laid-open Publication No. 2001-73207
Patent Document 2: Japanese Patent Laid-open Publication No. 2005-350813
Patent Document 3: Japanese Patent Laid-open Publication No. 2009-185439
Patent Document 4: Japanese Patent Laid-open Publication No. 2017-106134

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0008] In view of the current state of the prior art, an object of the present invention is to provide a conductive composite textured yarn excellent in conductivity and wearing durability, and a fabric and a garment using the same.

SOLUTIONS TO THE PROBLEMS

[0009] The present invention has any of the following configurations for solving the above problems.

(1) A conductive composite textured yarn including a conductive yarn a and a non-conductive yarn b that are combined by entanglement, wherein the conductive yarn a is a non-crimped yarn, and the non-conductive yarn b is a crimped yarn, the conductive composite textured yarn satisfying all following characteristics:

crimp rate (%) of conductive composite textured yarn: 10 to 55, and
degree of entanglement (entangled parts/m) of conductive composite textured yarn: 20 to 150.

(2) The conductive composite textured yarn according to [1], wherein the conductive composite textured yarn is subjected to twisting, and a number of twists is 100 to 1500 (T/M).
(3) A fabric in which the conductive composite textured yarn according to [1] or [2] and a non-conductive textured yarn are arranged in a lattice pattern at intervals, the fabric satisfying all following characteristics:

crimp rate (%) of non-conductive textured yarn: 10 to 55, and
degree of entanglement (entangled parts/m) of non-conductive textured yarn: 30 to 100.

(4) The fabric according to [3], wherein a surface resistance value in a method described in IEC 61340-5-1, 5-2 after 100 times of industrial washing and after 100 times of repeated stretching in a bias direction is 10^{10} Q or less.
(5) A garment including the fabric according to [3] or [4].

EFFECTS OF THE INVENTION

[0010] According to the present invention, since the conductive yarn a and the non-conductive yarn b are entangled in a state of having a degree of entanglement and a crimp rate in a specific range, the conductive yarn a exists on the yarn surface even after repeated wearing and washing, and not only exhibits excellent conductivity immediately after weaving and sewing, but also can exhibit the conductivity for a long period of time. That is, according to the present invention, it is possible to obtain a conductive composite textured yarn having conductivity and wearing durability thereof, and a fabric and a garment using the same.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Fig. 1 is one example of how two pieces of fabrics are overlapped at the time of sewing the two pieces of fabrics to measure the surface resistance value.

EMBODIMENTS OF THE INVENTION

[0012] In the conductive composite textured yarn according to the present invention, it is important to provide a composite textured yarn in which a conductive yarn a and a non-conductive yarn b are combined by entanglement.
[0013] Here, the conductive yarn a is a non-crimped yarn, and is (i) a metal-coated yarn, or (ii) a conductive yarn obtained by composite spinning of a polyester-based or polyamide-based base polymer serving as a fiber substrate and a polymer in which conductive fine particles of carbon, metal, a metal compound, or the like are dispersed.
[0014] In the present invention, a conductive yarn containing carbon as a conductive component is preferably used from the viewpoints of durability in an acid or alkaline environment and washing durability. Examples of the method for combining the conductive component with the yarn include methods in which the yarn has a core-sheath structure, and the conductive component is disposed in the sheath portion to form a type in which the conductive component is exposed on the entire surface or a type in which the conductive component is exposed on a part of the surface. In addition, the cross-sectional shape, the exposed portion of the conductive component, and the like can be freely selected without any problems. However, from the viewpoints of the exposure rate of the conductive component on the surface in the case of a fabric and the transfer of charges between single fibers which constitute the conductive yarn, a type in which the conductive component is exposed on the entire surface is preferable.
[0015] Here, as the base polymer of the conductive yarn a, polyester, specifically polyethylene terephthalate is preferred from the viewpoints of spinning stability and long-term continuous use. Examples of the glycol component of the polyester include, but are not limited to, ethylene glycol, diethylene glycol, butanediol, neopentyl glycol, cyclohexanedimethanol,

polyethylene glycol, and polypropylene glycol. In addition, the polyester may contain a copolymerization component capable of forming another ester bond within a range in which the effect of the present invention is not inhibited. Examples of the copolymerizable compound include dicarboxylic acids such as isophthalic acid, cyclohexanedicarboxylic acid, adipic acid, dimer acid, sebacic acid, and sulfonic acid.

[0016] When carbon is used as the conductive component in the conductive yarn a, the carbon content is preferably 15 to 40 wt% with respect to the total weight of the constituent components of the conductive yarn a. Here, when the content of the conductive carbon is less than 15 wt%, sufficient conductive performance may not be exhibited. On the other hand, when the content is more than 40 wt%, the fluidity of the polymer is remarkably lowered, and the yarn-making properties may extremely deteriorate. When carbon is completely dispersed as particles, the conductivity is generally poor. When a carbon has a chain structure called a structure, the conductivity is improved and the carbon is a so-called conductive carbon. Thus, for making a polymer conductive with a conductive carbon, it is important to disperse the carbon black without destroying the structure. It is believed that the electric conduction mechanism of a composite of the conductive carbon and the polymer is based on contact of the carbon chain and the tunnel effect and is mainly based on the former. Accordingly, as the carbon chain is longer and the carbon is present in the polymer at higher density, the contact probability becomes higher, leading to a higher conductivity. Here, the specific resistance of the conductive yarn a in the present invention is preferably 10^{-1} to 10^{8} $\Omega\cdot$cm from the viewpoint of achieving both conductivity and cost.

[0017] The total fineness of the conductive yarn a is preferably 11 to 167 dtex from the viewpoint of imparting the conductive performance to the fabric. Here, when the total fineness is less than 11 dtex, the conductive performance may be insufficient, which is not preferable. When the total fineness exceeds 167 dtex, the crimpability of the non-conductive yarn b is easily inhibited, which is not preferable. The total fineness of the conductive yarn a is more preferably 22 to 56 dtex.

[0018] The single yarn fineness of each conductive yarn a is preferably 2 to 22 dtex from the viewpoints of maintaining the conductive performance and mixability with the non-conductive yarn b. Here, when the single yarn fineness is less than 2 dtex, fuzz is generated on the yarn which is subjected to repeated washing and abrasion and the conductivity is easily inhibited, which is not preferable. When the single yarn fineness is more than 22 dtex, breakage due to flexion tends to occur during wearing, which is not preferable. The single yarn fineness of the conductive yarn a is more preferably 3 to 10 dtex.

[0019] On the other hand, as the characteristics of the non-conductive yarn b, it is important that the non-conductive yarn b be a textured yarn having crimps in at least a part thereof. The non-conductive yarn b may be a polyester fiber or a nylon fiber, but is preferably a polyester fiber having high crimp durability. Specific examples of the non-conductive yarn b include, but are not limited to, fibers of aromatic polyesters such as polyethylene terephthalate, polypropylene terephthalate, and polybutylene terephthalate, and fibers of aliphatic polyesters such as polylactic acid and polyglycolic acid. Among these, fibers of polyethylene terephthalate, polypropylene terephthalate, and polybutylene terephthalate are preferable because they are excellent in mechanical properties and their crimps are durable. In addition, fibers of polyethylene terephthalate are preferable because washing durability inherent in polyester fibers can be obtained.

[0020] As polyethylene terephthalate, it is possible to use a polyester which contains terephthalic acid as the main acid component and ethylene glycol as the main glycol component and 90 mol% or more of which is composed of ethylene terephthalate repeating units. In addition, a copolymerization component capable of forming another ester bond may be contained within a range in which the effect of the present invention is not inhibited. Examples of the copolymerizable compound include dicarboxylic acids such as isophthalic acid, cyclohexanedicarboxylic acid, adipic acid, dimer acid, sebacic acid, and sulfonic acid.

[0021] The non-conductive yarn b can be selected from those having any cross section shape, for example, a polygonal shape, a diverse shape, or a hollow shape, such as a round shape, a triangular shape, a flat shape, a hexagonal shape, an L-shape, a T-shape, a W-shape, an octafoil shape, or a dog-bone shape.

[0022] The crimps to be imparted to the non-conductive yarn b may be imparted by any method such as a false twisting method, a stuffing box method, a knit de knit method, or a bimetal structure, but crimps by a false twisting method are preferable because of the high crimp durability during wearing. When crimps are imparted by using a bimetal structure, the non-conductive yarn b preferably has a bimetal structure of polyethylene terephthalate and polypropylene terephthalate or a bimetal structure of polyethylene terephthalate and polybutylene terephthalate.

[0023] The total fineness of the non-conductive yarn b is preferably 56 to 400 dtex from the viewpoint of imparting tension and elasticity to the fabric. Here, when the total fineness is less than 56 dtex, a load is applied to the conductive yarn during repeated wearing, and the conductive performance may deteriorate, which is not preferable. When the total fineness exceeds 400 dtex, the texture becomes hard and the wearing comfort is lowered, which is not preferable.

[0024] The single yarn fineness of each non-conductive yarn b is preferably 0.5 to 10 dtex from the viewpoint of imparting tension and elasticity to the fabric. Here, when the single yarn fineness is less than 0.5 dtex, fuzz is generated on the yarn which is subjected to repeated washing and abrasion and the conductivity is easily inhibited, which is not preferable. When the single yarn fineness exceeds 10 dtex, the fibers are too thick and the texture becomes too hard, which is not preferable.

[0025] In the conductive composite textured yarn of the present invention, it is important to provide a conductive composite textured yarn in which the conductive yarn a and the non-conductive yarn b is combined by entanglement, and the degree of entanglement is 20 to 150 (entangled parts/m). By continuously applying entanglement in the longitudinal direction of the yarn, the conductive yarn a and the non-conductive yarn b are mixed, and convergence and opening are repeated. Due to this effect, the number of contacts between the conductive yarns increases in the fabric, and the charge can be efficiently transferred. Furthermore, even after repeated washing, the conductive yarn is present on the fabric surface, so that the conductive performance can be maintained. Here, when the degree of entanglement is less than 20, the number of contacts between the conductive yarns is reduced, and the conductive yarns are easily buried in the fabric after washing, whereby the conductive performance deteriorates. On the other hand, when the degree of entanglement exceeds 150, the number of entanglements is too large, the conductive yarn tends to become fuzzy, and the conductive performance deteriorates, which is not preferable. The degree of entanglement is more preferably 30 to 130 (entangled parts/m).

[0026] Further, it is important that at least a part of the non-conductive yarn b have crimps. Here, the crimp rate of the non-conductive yarn b is preferably 10 to 60%. Thus, the conductive composite textured yarn can also have crimps.

[0027] It is important that the crimp rate of the conductive composite textured yarn be 10 to 55%. By imparting such a crimp rate, stress is not concentrated on the conductive yarn even during repeated stretching assuming the time of wearing, so that the conductive polymer does not deteriorate due to rubbing between yarns. As a result of which the conductive performance after long-term wearing can be maintained. Here, when the crimp rate of the conductive composite textured yarn is less than 10%, the stress applied to the conductive yarn during repeated stretching increases, and the conductive component is partially broken, whereby the conductive performance deteriorates. When the crimp rate of the conductive composite textured yarn exceeds 55%, the crimps are too strong, the conductive yarn protrudes from the fabric surface, the conductive yarn is cut by abrasion during repeated washing, whereby the conductive performance deteriorates. The crimp rate of the conductive composite textured yarn is more preferably 15 to 50%.

[0028] On the other hand, it is important that the conductive yarn a be a non-crimped yarn. Here, the non-crimped yarn is a yarn that is not crimped. When the conductive yarn a is a non-crimped yarn, the conductive yarn a easily comes out on the surface in the opening section as the conductive composite textured yarn, so that the conductive performance as the conductive composite textured yarn is improved. When crimping is applied to the conductive yarn a, the conductive component is often partially broken during crimping, the crimps of the conductive yarn are straightened during repeated stretching, and the conductive yarn is buried in the fabric, whereby the problem of deterioration of the conductive performance occurs.

[0029] In regard to the boiling-water shrinkage rate of the conductive yarn a and the non-conductive yarn b used in the present invention, it is preferable that the boiling-water shrinkage rate of the conductive yarn a be lower. In this way, even if thermal shrinkage of the conductive yarn occurs, it is avoidable the problem that the conductive yarn is buried in the conductive composite textured yarn, thereby deteriorating the surface electric resistance.

[0030] The mass mixing ratio between the conductive yarn a and the non-conductive yarn b in the conductive composite textured yarn is preferably from 5 : 95 to 50 : 50 from the viewpoint of achieving both conductive performance and cost.

[0031] The conductive composite textured yarn is preferably subjected to twisting. By performing twisting, the variation in crimp development of the conductive composite textured yarn in the fabric is reduced, and the frequency of the conductive yarn a to be exposed on the fabric surface can be stabilized even during repeated stretching. Here, the number of twists is preferably 100 to 1500 (T/M).

[0032] When false twisting is applied to the non-conductive yarn b, it is preferable that the twisting direction in the conductive composite textured yarn and the false twisting direction of the non-conductive yarn b be opposite because the development of the crimped coil is increased during dyeing, and the conductive yarn a is easily exposed on the fabric surface.

[0033] The conductive composite textured yarn of the present invention described above is preferably woven into, for example, a fabric. For the purpose of exhibiting conductivity, a fabric may be composed of only a conductive yarn, but in order to exhibit conductivity at low cost and obtain wearing comfort such as stretchability and texture, it is important to use both the conductive composite textured yarn and the non-conductive textured yarn and to arrange them in a lattice pattern at intervals.

[0034] As for the interval (pitch of the lattice interval arrangement) at which the conductive composite textured yarns are inserted and arranged, the conductive characteristics are better as the interval is narrower, but it is preferable to insert and arrange the conductive composite textured yarns at an interval of about 1 to 20 mm in consideration of the balance between the conductive characteristics and the texture, aesthetics, quality, cost, and the like. It is more preferable to insert and arrange the conductive composite textured yarns at intervals of about 2 to 10 mm. When the arrangement interval of the conductive composite textured yarns is less than 1 mm, the number of the conductive composite textured yarns arranged is large, the texture and appearance/quality deteriorate, and the production cost of the conductive composite textured yarn may be increased. In addition, when the arrangement interval exceeds 20 mm, it is necessary to widen the seam margin width in order not to deteriorate the surface resistance across the seam, which is not preferable from the viewpoint of the production cost of the fabric.

[0035] The non-conductive textured yarn used in the fabric of the present invention is preferably a yarn having crimps in at least a part thereof. The textured yarn may be a polyester fiber or a nylon fiber, but is preferably a polyester fiber having high crimp durability. Specific examples of the non-conductive textured yarn include, but are not limited to, fibers of aromatic polyesters such as polyethylene terephthalate, polypropylene terephthalate, and polybutylene terephthalate, and fibers of aliphatic polyesters such as polylactic acid and polyglycolic acid. Among these, fibers of polyethylene terephthalate, polypropylene terephthalate, and polybutylene terephthalate are preferable because they are excellent in mechanical properties and their crimps are durable. In addition, fibers of polyethylene terephthalate are preferable because washing durability inherent in polyester fibers can be obtained.

[0036] As polyethylene terephthalate which constitutes the non-conductive textured yarn, it is possible to use a polyester which contains terephthalic acid as the main acid component and ethylene glycol as the main glycol component and 90 mol% or more of which is composed of ethylene terephthalate repeating units. However, it may contain a copolymerization component capable of forming another ester bond within a range in which the effect of the present invention is not inhibited. Examples of the copolymerizable compound include dicarboxylic acids such as isophthalic acid, cyclohexanedicarboxylic acid, adipic acid, dimer acid, sebacic acid, and sulfonic acid.

[0037] In addition, the non-conductive textured yarn can be selected from those having any cross section shape, for example, a polygonal shape, a diverse shape, or a hollow shape, such as a round shape, a triangular shape, a flat shape, a hexagonal shape, an L-shape, a T-shape, a W-shape, an octafoil shape, or a dog-bone shape.

[0038] The crimps to be imparted to the non-conductive textured yarn may be imparted by any method such as a false twisting method, a stuffing box method, a knit de knit method, or a bimetal structure, but crimps by a false twisting method are preferable because of the high crimp durability during wearing. When crimps are imparted by using a bimetal structure, the textured yarn preferably has a bimetal structure of polyethylene terephthalate and polypropylene terephthalate or a bimetal structure of polyethylene terephthalate and polybutylene terephthalate.

[0039] The total fineness of the non-conductive textured yarn is preferably 56 to 400 dtex from the viewpoint of imparting minimum tension and elasticity to the fabric. Here, when the total fineness is less than 56 dtex, a load is applied to the conductive yarn during repeated wearing, and the conductive performance may deteriorate, which is not preferable. When it exceeds 400 dtex, the texture is too hard, which is not preferable.

[0040] The single yarn fineness of each non-conductive textured yarn is preferably 0.5 to 10 dtex from the viewpoint of imparting minimum tension and elasticity to the fabric. Here, when the single yarn fineness is less than 0.5 dtex, fuzz is generated on the yarn which is subjected to repeated washing and abrasion and the conductivity is easily inhibited, which is not preferable. When the single yarn fineness exceeds 10 dtex, the fibers are too thick and the texture tends to be hard, which is not preferable.

[0041] In the fabric of the present invention, the non-conductive textured yarn preferably has crimps in at least a part thereof. Since both the conductive composite textured yarn and the non-conductive textured yarn have crimps, stress is not concentrated on the conductive yarn even during repeated stretching assuming the time of wearing, so that deterioration due to rubbing between yarns can be prevented. As a result of which the conductive performance can be maintained. Here, the crimp rate of the non-conductive textured yarn is preferably 10 to 60%, and more preferably 10 to 55%.

[0042] The non-conductive textured yarn used in the fabric of the present invention is preferably entangled. By intermittently applying entanglement in the longitudinal direction of the yarn, the single yarns of the non-conductive textured yarn are more mixed with each other, and the charge of the conductive yarn can be efficiently transferred even during repeated stretching. A preferred degree of entanglement here is 30 to 100 (entangled parts/m).

[0043] The non-conductive textured yarn is preferably subjected to twisting. By applying twisting, the variation in crimp development of the non-conductive textured yarn in the fabric is reduced, and the frequency of the conductive yarn a to be exposed on the fabric surface can be stabilized. Here, the number of twists is preferably 100 to 1200 (T/M).

[0044] Further, the fabric of the present invention preferably satisfies the following relationship:

total fineness (dtex) of conductive composite textured yarn - total fineness (dtex) of non-conductive textured yarn > 0.

When this relationship is satisfied, the charge of the conductive yarn is efficiently transferred on the fabric surface, and the conductive performance is easily maintained. Here, when the total fineness (dtex) of the conductive composite textured yarn - the total fineness (dtex) of the non-conductive textured yarn is less than 0, the conductive yarn is buried in the non-conductive yarn as the base structure, whereby the conductive performance is also likely to deteriorate. When the total fineness (dtex) of the conductive composite textured yarn - the total fineness (dtex) of the non-conductive textured yarn exceeds 100, the convex portion of the conductive yarn becomes too large, whereby the conductive yarn is easily damaged due to friction during washing or wearing, and the conductive performance is also likely to deteriorate.

[0045] The fabric of the present invention preferably has a surface resistance value of 10^{10} Q or less in the method described in IEC 61340-5-1, 5-2 after 100 times of industrial washing and after 100 times of repeated stretching in the bias direction. Conventionally, as required characteristics of static electricity management, surface resistance values of conductive garments have been standardized in International Electrotechnical Commission (IEC) 61340-5-1, 5-2, and surface electrical continuity over the entire garments is required. In recent years, customer demands for the surface resistance value have increased, and customers require a highly durable fabric that satisfies the surface resistance value even in a state where wearing and washing are repeated. Thus, the surface resistance value after 100 times of industrial washing assuming repeated washing is also required as one of the results. In the fabric of the present invention, the surface resistance value in the method described in IEC 61340-5-1, 5-2 after 100 times of industrial washing can be 10^{10} Q or less, and high conductive performance can be exhibited even after industrial washing. The surface resistance value is more preferably 10^7 Q or less. Here, when the surface resistance value in the method described in IEC 61340-5-1, 5-2 after 100 times of industrial washing exceeds 10^{10} Q, industrial washing durability is poor, which is not preferable.

[0046] Further, the results after only repeated washing may not match the results after the actual repeated wearing evaluation. In the fabric after the actual wearing evaluation, a part of the conductive yarn is stretched and broken, and the conductive performance may deteriorate. The authors have found that the fabric test for reproducing the repeated wearing evaluation results is a repeated stretching test in the fabric bias direction. Thus, in the evaluation of the fabric, the industrial wash 100 time test and the repeated stretching 100 time test in the fabric bias direction are performed as pretreatment before the IEC surface resistance value test. In the present invention, when the surface resistance value in the method described in IEC 61340-5-1, 5-2 after these tests is 10^{10} Q or less, high conductive performance can be satisfied even after repeated wearing, which is preferable. The surface resistance value is more preferably 10^7 Q or less. When the surface resistance value in the method described in IEC 61340-5-1, 5-2 after the repeated stretching test in the fabric bias direction exceeds 10^{10} Q, the repeated wearing durability is poor, which is not preferable.

[0047] Next, a method for producing the conductive composite textured yarn of the present invention will be described.

[0048] The non-conductive yarn b and the non-conductive textured yarn used in the present invention are preferably crimped by false twisting. Any conditions can be selected for false twisting, and any one of a spindle type, a friction disk type, and a belt nip type may be used as the twister. The false twist temperature can be 170 to 220°C in the case of the contact type heater, and a higher false twist temperature is preferable in terms of crimp durability. The number of false twists can be set such that the false twist coefficient (the number of false twists (T/M) $\times$ fineness (dtex)$^{0.5}$) falls within the range of 18000 to 33000. A higher false twist coefficient is preferable in terms of crimp durability.

[0049] Although a higher yarn processing speed is preferred because of higher productivity, the yarn processing speed is preferably 100 to 800 (m/min) in consideration of stable processability.

[0050] In order to obtain the conductive composite textured yarn of the present invention, the conductive yarn a and the non-conductive yarn b can be combined using any mixing means such as interlacing or Taslan processing, but the interlacing is suitable because it can periodically impart opening and convergence and strong entanglement to the textured yarn. In the mixing in the interlacing method, the feed rate of each yarn (yarn feeding rate), the nozzle type for entanglement, and the pressure flow rate are appropriately set, but it is preferable that the feed rate be set to be equal between the conductive yarn a and the non-conductive yarn b, or the feed rate of the conductive yarn a be set to be higher than that of the non-conductive yarn b by about 0.1 to 3.0%. When the feed rate of the conductive yarn a is smaller than that of the non-conductive yarn b, the conductive component of the interlaced conductive yarn a is likely to be buried, whereby the surface electric resistance in the case of a fabric may deteriorate.

[0051] The entanglement pressure of interlacing is preferably 0.2 to 0.5 MPa. When the compressed air of the nozzle exceeds 0.5 MPa, excessive entanglement may occur, thereby increasing the rough and hard touch. When the compressed air of the nozzle is less than 0.2 MPa, the number of contacts between the conductive yarns decreases, and the surface electric resistance of the fabric may deteriorate, which is not preferable.

[0052] When the conductive composite textured yarn and the non-conductive textured yarn to be used in the present invention are subjected to twisting, any conditions can be selected, but it is preferable to use a double twister having high productivity.

[0053] Examples of the loom used for weaving include, but are not particularly limited to, looms such as ordinary looms, rapier looms, water jet looms, and air jet looms that are generally used.

[0054] Next, the dyeing processing of the fabric will be described. The dyeing processing step can be performed in accordance with a general polyester fabric dyeing step and conditions. In order to suppress washing shrinkage, the intermediate set temperature is preferably 160°C or more and 210°C or less. When it exceeds 210°C, the filaments may be fused, which is not preferable.

[0055] In addition to a method using a batch type dyeing machine such as a jet dyeing machine, an air flow dyeing machine, a jigger dyeing machine, a wince dyeing machine, or a beam dyeing machine, the dyeing can be performed using a well-known method such as continuous dyeing by a padding method or textile printing, for example, a flat screen, a rotary screen, or an inkjet.

[0056] The fabric of the present invention can also be improved in antistatic properties by performing durable antistatic finish. In the durable antistatic finish, for example, a film can be formed on the surface of the fabric using an antistatic polyurethane resin, an antistatic polyester resin, an antistatic acrylic resin, an antistatic polyolefin resin, or the like. As the means for applying the resin, for example, any means such as a padding method, a spraying method, a printing method, a coating method, a gravure processing method, or a foam processing method can be employed. After dyeing, heat resistant finish, shrink resistant finish, crease resistant finish, antibacterial finish, deodorizing finish, anti-soil finish, water absorbency finish, softening finish, and the like may be performed as necessary.

[0057] When a garment is made using the fabric of the present invention, stitches and seams at the time of sewing are not limited at all. Any stitches such as lock stitches, single chain stitches, double chain stitches, or overlock stitches can be selected. In regard to the seams, any seams such as rolled seams, flat felled seams, interlock, piping, or the like suitable for various applications can be used without limitation. Among them, rolled seams of four or more layers are effective for securing contacts between conductive yarns. Furthermore, it is also effective for improving the electrical continuity to use a thread having a lowered electric resistance value, for example, a conductive thread as the sewing thread.

EXAMPLES

[0058] Next, the present invention will be described specifically with reference to examples, but the present invention is not limited to these examples. Various measurement methods in the present invention are as follows.

1. Specific resistance value

[0059] The yarns were bundled to be 2000 dtex, sufficiently refined using a weak anionic detergent to remove an oil agent and the like, and then left to stand at 20°C and 43% RH (relative humidity) for 24 hours. Thereafter, a conductive coating material (Dotite) was applied to both ends of the yarns and the ends were fixed. Using the ends as electrodes, a current value at an applied voltage of 500 V was then measured to determine a specific resistance value.

2. Fineness

[0060] A skein was produced by using a skein winder having a frame circumference of 1.0 m and rotating it 100 times, and the fineness was measured according to the following formula.

$$\text{Fineness (dtex)} = 100 \text{ rotation skein weight (g)} \times 100$$

3. Degree of entanglement

[0061] The degree of entanglement is the number of entangled parts per 1 m under a tension of 0.1 cN/dtex. When a non-entangled part of the yarn is pierced with a pin under a tension of 0.02 cN/dtex and the pin is moved up and down in the longitudinal direction of the yarn with a tension of 0.1 cN/dtex over 1 m of the yarn, the part where the pin is moved with no resistance is defined as the non-entangled part, the moved distance is recorded, and the part where the pin stops is defined as the entangled part. This operation is repeated 30 times, and the degree of entanglement per 1 m is calculated from the average value of the distances of the non-entangled parts.

4. Crimp rate

[0062] The yarn is wound 10 times on a skein winder having a peripheral length of 0.8 m under a tension of 90 mg/dtex to form a skein, then hung on a bar having a diameter of 2 cm or less, and left for about 24 hours. The skein is wrapped in gauze, treated with hot water at 90°C for 20 minutes under a non-tensioned state, and then hung on a bar having a diameter of 2 cm or less and left for about 12 hours. One end of the skein after being left to stand is hooked, an initial load and a measurement load are applied to the other end, and the skein is suspended in water and left to stand for 2 minutes. The initial load (g) at this time is 1.8 mg/dtex, the measurement load (g) is 90 mg/dtex, and the water temperature is 20 12°C. The length of the inner side of the skein that has been left is measured and designated as L. The measurement load is removed, and only under the initial load the skein is left for another 2 minutes. The length of the inner side of the skein that has been left is measured and designated as L1. The crimp rate was determined by the following formula. This operation was repeated five times, and the average value was determined.

$$\text{Crimp rate (\%)} = \{(L - L1)/L\} \times 100$$

5. Surface resistance value (initial)

[0063] In accordance with International Electrotechnical Commission (IEC) 61340-5-1, 5-2 standards, measurement was performed as follows.

[0064] Predetermined sewing is performed with a lock stitch sewing machine to prepare a fabric sample of 50 × 50 cm including a seam. Thereafter, measurement probes of a surface resistance value meter (Model 152AP-5P manufactured by TREK JAPAN CO., LTD.) are placed on the fabric sample at an interval of 30 cm with a seam interposed therebetween, and a surface electric resistance value at an applied voltage of 100 V between two points is measured. At this time, two points are taken in the oblique direction so as not to include the coaxial conductive yarn of the fabric sample. This was repeated at arbitrary three points, and the arithmetic mean thereof was calculated. Fig. 1 shows a schematic diagram of surface resistance value measurement.

6. Surface resistance value (after 100 times of industrial washing)

[0065] Industrial washing is a washing method in which treatment is performed with high temperature water and hot air drying, and washing conditions are as follows. The detergent and the auxiliary agent are not particularly limited, but those used in this method are as follows. The operation of washing the fabric in accordance with JIS L 1096: 2010 F-3 method and then tumbler drying at 60°C for 30 minutes is defined as 1 industrial washing, and 100 times of industrial washing means that this operation is repeated 100 times. In this evaluation, two fabric samples of 50 × 50 cm are prepared, and the industrial washing is performed 100 times on the two fabric samples. Thereafter, the two fabric samples are subjected to predetermined sewing with a lock stitch sewing machine in accordance with the International Electrotechnical Commission (IEC) 61340-5-1, 5-2 standards, measurement probes are placed with a seam interposed therebetween at an interval of 30 cm, and the surface electric resistance value at an applied voltage of 100 V between the two points is measured. At this time, two points are taken in the oblique direction so as not to include the coaxial conductive yarn of the fabric sample. This was repeated at arbitrary three points, and the arithmetic mean thereof was calculated.

7. Surface resistance value (surface resistance value after repeated stretching)

[0066] A fabric sample of 50 × 50 cm is prepared, and the sample is stretched to 1.5 kg at a grip interval of 50 cm and a tensile speed of 20 cm/min in a right 45° bias direction on a diagonal line using a constant speed stretching type tensile tester, and the grip interval at that time is measured and defined as a stretch rate of 100%.

[0067] A new sample is prepared, and the sample is stretched to a length of a stretch rate of 80% at a grip interval of 50 cm and a tensile speed of 20 cm/min in a right 45° bias direction on a diagonal line, and left for 1 minute, and then returned to the original position at the same speed, and left for 1 minute. This operation is repeated 100 times.

[0068] Thereafter, the bias direction is switched to the left 45° bias direction, and the same operation described above is repeated 100 times.

[0069] Two 50 × 50 cm fabric samples subjected to this stretching treatment are prepared. Thereafter, the two fabric samples are subjected to predetermined sewing with a lock stitch sewing machine in accordance with the International Electrotechnical Commission (IEC) 61340-5-1, 5-2 standards, measurement probes are placed with a seam interposed therebetween at an interval of 30 cm, and the surface electric resistance value at an applied voltage of 100 V between the two points is measured. At this time, two points are taken in the oblique direction so as not to include the coaxial conductive yarn of the fabric sample. This was repeated at arbitrary three points, and the arithmetic mean thereof was calculated.

(Example 1)

[0070] PET was used as a base polymer, and conductive carbon was added thereto in an amount of 25 wt% with respect to the total amount after the addition to obtain a polymer A, and PET was used as a polymer B. The polymer A and the polymer B were combined such that the weight ratio of the polymer A to the polymer B was 20 : 80 and a core-sheath cross-sectional form in which the polymer A was exposed on the entire surface of the fiber was obtained. By spinning at a spinning speed of 1200 m/min, then drawing at a ratio of 3.0, and heat-treating at 150°C, a conductive yarn a (33 dtex, 6 filaments, boiling-water shrinkage rate: 6.5%, specific resistance: 450 Ω·cm) was obtained.

[0071] Next, PET as a polymer was spun at a spinning speed of 3300 m/min to obtain a highly oriented undrawn yarn of 300 dtex/48 filaments. Thereafter, the highly oriented undrawn yarn was false twisted in the S direction under the conditions of a processing speed of 500 m/min, a draw ratio of 1.8, a false twist coefficient of 31000, and a false twist temperature of 210°C by a belt nip false twisting machine MACH 33H manufactured by TMT MACHINERY, INC. to obtain a non-conductive yarn b (167 dtex, 48 filaments, boiling-water shrinkage rate: 7.5%, crimp rate: 48%).

[0072] Thereafter, an interlacing treatment (nozzle pressure: 0.3 MPa, processing speed: 400 m/min) was performed at a feed rate of the conductive yarn a of 1.0% and a feed rate of the non-conductive yarn b of 0.6% to obtain a conductive composite textured yarn having a degree of entanglement of 58 entangled parts/m and a crimp rate of 40%. The conductive composite textured yarn was then twisted at 800 T/M in the Z direction.

[0073] On the other hand, using a PET highly oriented undrawn yarn obtained in the same manner as in the production of the non-conductive yarn b described above, false twisting was performed in the S direction under the conditions of a processing speed of 500 m/min, a draw ratio of 1.8, a false twist coefficient of 31000, and a false twist temperature of 210°C by a belt nip false twisting machine MACH 33H manufactured by TMT MACHINERY, INC., and then interlacing treatment (nozzle pressure: 0.2 MPa) was performed to obtain a non-conductive textured yarn (yarn different from non-conductive yarn b, 167 dtex, 48 filaments, boiling-water shrinkage rate: 7.3%, crimp rate: 45%, degree of entanglement: 43 entangled parts/m). The non-conductive textured yarn was then twisted at 800 T/M in the Z direction.

[0074] Next, the non-conductive textured yarns were used as warp and weft yarns for forming the ground weave of the fabric, and a plain weave was woven by arranging the conductive composite textured yarns such that the arrangement interval of the conductive composite textured yarns was 5 mm for both warp and weft. In the dyeing processing, general scouring, intermediate setting, jet dyeing, and finish setting were performed by a standard method to obtain a plain fabric having a density of 90 × 76 yarns/2.54 cm.

[0075] Thereafter, the obtained fabric was sewn with a sewing machine, obtaining various data of the surface resistance value (see Table 1). In addition, a garment (blouson) made using the obtained fabric by predetermined sewing with a lock stitch sewing machine had outstanding conductive performance even after industrial washing or repeated stretching (repeated wearing evaluation).

(Example 2)

[0076] A fabric was obtained in the same manner as in Example 1 except that the conductive composite textured yarn and the non-conductive textured yarn were not twisted.

[0077] Thereafter, the obtained fabric was sewn with a sewing machine, obtaining various data of the surface resistance value (see Table 1). In addition, a garment (blouson) made using the obtained fabric by predetermined sewing with a lock stitch sewing machine had excellent conductive performance even after industrial washing or repeated stretching.

(Example 3)

[0078] A fabric was obtained in the same manner as in Example 1 except that the non-conductive textured yarn was not entangled.

[0079] Thereafter, the obtained fabric was sewn with a sewing machine, obtaining various data of the surface resistance value (see Table 1). In addition, a garment (blouson) made using the obtained fabric by predetermined sewing with a lock stitch sewing machine had excellent conductive performance even after industrial washing or repeated stretching.

(Example 4)

[0080] PET as a polymer was spun at a spinning speed of 3300 m/min to obtain a highly oriented undrawn yarn of 350 dtex/48 filaments. Thereafter, the highly oriented undrawn yarn was false twisted in the S direction under the conditions of a processing speed of 500 m/min, a draw ratio of 1.8, a false twist coefficient of 31000, and a false twist temperature of 210°C by a belt nip false twisting machine MACH 33H manufactured by TMT MACHINERY, INC. to obtain a non-conductive textured yarn (yarn different from non-conductive yarn b, 220 dtex, 48 filaments, boiling-water shrinkage rate: 8.7%, crimp rate: 55%, degree of entanglement: 50 entangled parts/m). The non-conductive textured yarn was then twisted at 500 T/M in the Z direction.

[0081] A fabric was obtained in the same manner as in Example 1 except for the above.

[0082] Thereafter, the obtained fabric was sewn with a sewing machine, obtaining various data of the surface resistance value (see Table 1). In addition, a garment (blouson) made using the obtained fabric by predetermined sewing with a lock stitch sewing machine had excellent conductive performance even after industrial washing or repeated stretching.

(Example 5)

[0083] A conductive yarn a was obtained in the same manner as in Example 1. Further, PET as a polymer was spun at a spinning speed of 3300 m/min to obtain a highly oriented undrawn yarn of 300 dtex/48 filaments. Thereafter, the highly oriented undrawn yarn was false twisted in the S direction under the conditions of a processing speed of 100 m/min, a draw ratio of 1.8, a false twist coefficient of 33000, and a false twist temperature of 215°C by a pin false twisting machine TH 312 manufactured by Aiki Seisakusyo Ltd, thereby obtaining a non-conductive yarn b (167 dtex, 48 filaments, boiling-water shrinkage rate: 7.2%, crimp rate: 58%). Thereafter, an interlacing treatment (nozzle pressure: 0.35 MPa, processing speed: 400 m/min) was performed at a feed rate of the conductive yarn a of 1.4% and a feed rate of the non-conductive yarn b of 1.0% to obtain a conductive composite textured yarn having a degree of entanglement of 128 entangled parts/m and a crimp rate of 49%. The conductive composite textured yarn was then twisted at 800 T/M in the

Z direction.

[0084] On the other hand, a PET highly oriented undrawn yarn obtained in the same manner as in the production of the non-conductive yarn b was false twisted, and then subjected to an interlacing treatment (nozzle pressure: 0.3 MPa) to obtain a non-conductive textured yarn (yarn different from non-conductive yarn b, 167 dtex, 48 filaments, boiling-water shrinkage rate: 7%, crimp rate: 56%, degree of entanglement: 80 entangled parts/m). The non-conductive textured yarn was then twisted at 800 T/M in the Z direction.

[0085] A fabric was obtained in the same manner as in Example 1 except for the above.

[0086] Thereafter, the obtained fabric was sewn with a sewing machine, obtaining various data of the surface resistance value (see Table 1). In addition, a garment (blouson) made using the obtained fabric by predetermined sewing with a lock stitch sewing machine had outstanding conductive performance even after industrial washing or repeated stretching.

(Example 6)

[0087] A conductive yarn a was obtained in the same manner as in Example 1. Further, PET as a polymer was spun at a spinning speed of 3300 m/min to obtain a highly oriented undrawn yarn of 300 dtex/48 filaments. Thereafter, the highly oriented undrawn yarn was false twisted in the S direction under the conditions of a processing speed of 500 m/min, a draw ratio of 1.8, a false twist coefficient of 27000, and a false twist temperature of 180°C by a belt nip false twisting machine MACH 33H manufactured by TMT MACHINERY, INC. to obtain a non-conductive yarn b (167 dtex, 48 filaments, boiling-water shrinkage rate: 9.3%, crimp rate: 26%). Thereafter, an interlacing treatment (nozzle pressure: 0.15 MPa, processing speed: 400 m/min) was performed at a feed rate of the conductive yarn a of 0.5% and a feed rate of a non-conductive yarn b of 0.5% to obtain a conductive composite textured yarn having a degree of entanglement of 24 entangled parts/m and a crimp rate of 15%. The conductive composite textured yarn was then twisted at 150 T/M in the S direction.

[0088] On the other hand, a PET highly oriented undrawn yarn obtained in the same manner as in the production of the non-conductive yarn b was false twisted, and then subjected to an interlacing treatment (nozzle pressure: 0.3 MPa) to obtain a non-conductive textured yarn (yarn different from non-conductive yarn b, 167 dtex, 48 filaments, boiling-water shrinkage rate: 9.3%, crimp rate: 25%, degree of entanglement: 14 entangled parts/m). The non-conductive textured yarn was then twisted at 150 T/M in the S direction.

[0089] A fabric was obtained in the same manner as in Example 1 except for the above.

[0090] Thereafter, the obtained fabric was sewn with a sewing machine, obtaining various data of the surface resistance value (see Table 1). In addition, a garment (blouson) made using the obtained fabric by predetermined sewing with a lock stitch sewing machine had excellent conductive performance even after industrial washing or repeated stretching.

(Comparative Example 1)

[0091] A conductive yarn a and a non-conductive yarn b were obtained in the same manner as in Example 1. Thereafter, the conductive yarn a and the non-conductive yarn b were aligned, and twisted at 800 T/M in the Z direction with a down twister to obtain a conductive twisted yarn. Note that the interlacing treatment was not performed.

[0092] A fabric was obtained in the same manner as in Example 1 except for the above.

[0093] Thereafter, the obtained fabric was sewn with a sewing machine to obtain various data of the surface resistance value (see Table 2). In addition, a garment (blouson) made using the obtained fabric by predetermined sewing with a lock stitch sewing machine had favorable initial conductive performance, but had significantly deteriorated conductive performance after industrial washing.

(Comparative Example 2)

[0094] A conductive yarn a was obtained in the same manner as in Example 1. Further, PET as a polymer was spun at a spinning speed of 3300 m/min to obtain a highly oriented undrawn yarn of 300 dtex/48 filaments. Thereafter, the highly oriented undrawn yarn was drawn by a drawing machine under the conditions of a processing speed of 800 m/min, a draw ratio of 1.8, and a hot plate temperature of 210°C to obtain a non-conductive yarn b (167 dtex, 48 filaments, boiling-water shrinkage rate: 7%, crimp rate: 0%). Thereafter, an interlacing treatment (nozzle pressure: 0.3 MPa, processing speed: 400 m/min) was performed at a feed rate of the conductive yarn a of 1.0% and a feed rate of the non-conductive yarn b of 0.6% to obtain a conductive composite textured yarn having a degree of entanglement of 38 entangled parts/m and a crimp rate of 0%. The conductive composite textured yarn was then twisted at 800 T/M in the Z direction.

[0095] A fabric was obtained in the same manner as in Example 1 except for the above.

[0096] Thereafter, the obtained fabric was sewn with a sewing machine to obtain various data of the surface resistance value (see Table 2). In addition, a garment (blouson) made using the obtained fabric by predetermined sewing with a lock stitch sewing machine had favorable initial conductive performance, but had significantly deteriorated conductive performance after the repeated stretching test.

(Comparative Example 3)

[0097] A conductive yarn a was obtained in the same manner as in Example 1. Further, PET as a polymer was spun at a spinning speed of 3300 m/min to obtain a highly oriented undrawn yarn of 300 dtex/48 filaments. Thereafter, the highly oriented undrawn yarn was false twisted in the S direction under the conditions of a processing speed of 500 m/min, a draw ratio of 1.8, a false twist coefficient of 31000, and a false twist temperature of 210°C by a belt nip false twisting machine MACH 33H manufactured by TMT MACHINERY, INC., and then subjected to reheat setting under the condition of 180°C to obtain a non-conductive yarn b (167 dtex, 48 filaments, boiling-water shrinkage rate: 4.5%, crimp rate: 20%). Thereafter, an interlacing treatment (nozzle pressure: 0.2 MPa, processing speed: 400 m/min) was performed at a feed rate of the conductive yarn a of 1.0% and a feed rate of the non-conductive yarn b of 0.6% to obtain a conductive composite textured yarn having a degree of entanglement of 25 entangled parts/m and a crimp rate of 8%. The conductive composite textured yarn was then twisted at 800 T/M in the Z direction.

[0098] On the other hand, a non-conductive textured yarn (167 dtex, 48 filaments, boiling-water shrinkage rate: 4.5%, crimp rate: 20%) was obtained in the same manner as in the production of the non-conductive yarn b. The non-conductive textured yarn was then twisted at 800 T/M in the Z direction.

[0099] A fabric was obtained in the same manner as in Example 1 except for the above.

[0100] Thereafter, the obtained fabric was sewn with a sewing machine to obtain various data of the surface resistance value (see Table 2). In addition, a garment (blouson) made using the obtained fabric by predetermined sewing with a lock stitch sewing machine had favorable initial conductive performance, but had significantly deteriorated conductive performance after the repeated stretching test.

(Comparative Example 4)

[0101] A non-conductive textured yarn was obtained in the same manner as in Example 1. Thereafter, the non-conductive textured yarn was twisted at 800 T/M in the S direction. A plain weave was woven using the non-conductive textured yarns as warp and weft yarns for forming the ground weave of the fabric. In the dyeing processing, general scouring, intermediate setting, jet dyeing, and finish setting were performed by a standard method to obtain a plain fabric having a density of 90 × 76 yarns/2.54 cm.

[0102] Thereafter, the obtained fabric was sewn with a sewing machine to obtain various data of the surface resistance value (see Table 2). In addition, a garment (blouson) made using the obtained fabric by predetermined sewing with a lock stitch sewing machine had low initial conductive performance.

(Comparative Example 5)

[0103] A conductive yarn a was obtained in the same manner as in Example 1. Next, a non-conductive yarn b was obtained in the same manner as in Comparative Example 2. Thereafter, the conductive yarn a and the non-conductive yarn b were aligned, and false twisted in the Z direction under the conditions of a processing speed of 500 m/min, a draw ratio of 1.02, a false twist coefficient of 31000, and a false twist temperature of 180°C by a belt nip false twisting machine MACH 33H manufactured by TMT MACHINERY, INC., and then interlacing treatment (nozzle pressure: 0.3 MPa) was performed at a feed rate of 0.6% to obtain a conductive composite textured yarn having 203 dtex/54 filaments, a degree of entanglement of 43 entangled parts/m, and a crimp rate of 37%. The conductive composite textured yarn was then twisted at 800 T/M in the Z direction.

[0104] On the other hand, a non-conductive textured yarn having 167 dtex/48 filaments, a boiling-water shrinkage rate of 7.3%, and a crimp rate of 45% was obtained in the same manner as in the production method of Example 1. The non-conductive textured yarn was then twisted at 800 T/M in the Z direction.

[0105] A fabric was obtained in the same manner as in Example 1 except for the above.

[0106] Thereafter, the obtained fabric was sewn with a sewing machine to obtain various data of the surface resistance value (see Table 2). In addition, a garment (blouson) made using the obtained fabric by predetermined sewing with a lock stitch sewing machine had favorable initial conductive performance, but had significantly deteriorated conductive performance after the repeated stretching test.

(Comparative Example 6)

[0107] A conductive yarn a was obtained in the same manner as in Example 1. PBT as a polymer was spun at a spinning speed of 3300 m/min to obtain a highly oriented undrawn yarn of 300 dtex/48 filaments. Thereafter, the highly oriented undrawn yarn was false twisted in the S direction under the conditions of a processing speed of 100 m/min, a draw ratio of 1.8, a false twist coefficient of 35000, and a false twist temperature of 215°C by a pin false twisting machine TH 312 manufactured by Aiki Seisakusyo Ltd, thereby obtaining a non-conductive yarn b (167 dtex, 48 filaments, boiling-water shrinkage rate: 8.5%, crimp rate: 64%). Thereafter, an interlacing treatment (nozzle pressure: 0.2 MPa, processing speed: 400 m/min) was performed at a feed rate of the conductive yarn a of 1.0% and a feed rate of the non-conductive yarn b of 0.6% to obtain a conductive composite textured yarn having a degree of entanglement of 55 entangled parts/m and a crimp rate of 57%. The conductive composite textured yarn was then twisted at 800 T/M in the Z direction.

[0108] On the other hand, a PET highly oriented undrawn yarn obtained in the same manner as in the production of the non-conductive yarn b was false twisted, and then subjected to an interlacing treatment (nozzle pressure: 0.2 MPa) to obtain a non-conductive textured yarn (yarn different from non-conductive yarn b, 167 dtex, 48 filaments, boiling-water shrinkage rate: 8.5%, crimp rate: 64%, degree of entanglement: 48 entangled parts/m). The non-conductive textured yarn was then twisted at 800 T/M in the Z direction.

[0109] A fabric was obtained in the same manner as in Example 1 except for the above.

[0110] Thereafter, the obtained fabric was sewn with a sewing machine to obtain various data of the surface resistance value (see Table 2). In addition, a garment (blouson) made using the obtained fabric by predetermined sewing with a lock stitch sewing machine had favorable initial conductive performance, but had significantly deteriorated conductive performance after industrial washing.

(Comparative Example 7)

[0111] A conductive yarn a and a non-conductive yarn b were obtained in the same manner as in Example 1. Thereafter, an interlacing treatment (nozzle pressure: 0.55 MPa, processing speed: 400 m/min) was performed at a feed rate of the conductive yarn a of 1.5% and a feed rate of the non-conductive yarn b of 1.5% to obtain a conductive composite textured yarn having a degree of entanglement of 155 entangled parts/m and a crimp rate of 32%. The conductive composite textured yarn was then twisted at 800 T/M in the Z direction.

[0112] On the other hand, a PET highly oriented undrawn yarn obtained in the same manner as in the production of the non-conductive yarn b was false twisted, and then subjected to an interlacing treatment (nozzle pressure: 0.4 MPa) to obtain a non-conductive textured yarn (yarn different from non-conductive yarn b, 167 dtex, 48 filaments, boiling-water shrinkage rate: 7%, crimp rate: 39%, degree of entanglement: 108 entangled parts/m). The non-conductive textured yarn was then twisted at 800 T/M in the Z direction.

[0113] A fabric was obtained in the same manner as in Example 1 except for the above.

[0114] Thereafter, the obtained fabric was sewn with a sewing machine to obtain various data of the surface resistance value (see Table 2). In addition, a garment (blouson) made using the obtained fabric by predetermined sewing with a lock stitch sewing machine had low initial conductive performance.

[Table 1]

[0115]

Table 1

	Item	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6
Conductive composite textured yarn	Processing details	Interlacing	Interlacing	Interlacing	Interlacing	Interlacing	Interlacing
	Fineness (dtex)	202	202	202	202	202	202
	crimp rate (%)	40	40	40	40	49	15
	Degree of entanglement (entangled parts/m)	58	58	58	58	128	24
	Number of twists (T/m)	Z800	0	Z800	Z800	Z800	S150
Conductive yarn a	Base polymer of polymer A	PET	PET	PET	PET	PET	PET
	Conductive component/content (wt%)	Carbon 25%	Carbon 25%	Carbon 25%	Carbon 25%	Carbon 25%	Carbon 25%
	Polymer A : Polymer B (weight ratio)	20:80	20:80	20:80	20:80	20:80	20:80
	Fineness (dtex)	33	33	33	33	33	33
	Number of filaments	6	6	6	6	6	6
	Boiling-water shrinkage rate (%)	6.5	6.5	6.5	6.5	6.5	6.5
	Specific resistance (Ω·cm)	450	450	450	450	450	450
Non-conductive yarn b	Type	False twisted yarn	False twisted yarn	False twisted yarn	False twisted yarn	False twisted yarn	False twisted yarn
	Fineness (dtex)	167	167	167	167	167	167
	Number of filaments	48	48	48	48	48	48
	Boiling-water shrinkage rate (%)	7.5	7.5	7.5	7.5	7.2	9.3
	crimp rate (%)	48	48	48	48	58	26
Non-conductive textured yarn	Type	False twisted yarn	False twisted yarn	False twisted yarn	False twisted yarn	False twisted yarn	False twisted yarn
	Fineness (dtex)	167	167	167	220	167	167
	Number of filaments	48	48	48	48	48	48
	Boiling-water shrinkage rate (%)	7.3	7.3	7.5	8.7	7	9.3
	crimp rate (%)	45	45	50	55	56	25
	Degree of entanglement (entangled parts/m)	43	43	0	50	80	14
	Number of twists (T/m)	Z800	0	Z800	Z500	Z800	S150
Conductive performance	Surface resistance value (Ω) (initial)	1.1×10^6	1.2×10^6	1.3×10^6	2.1×10^7	1.0×10^6	8.8×10^7
	Surface resistance value (Ω) (after industrial washing 100 times)	1.5×10^6	1.6×10^6	1.6×10^6	7.5×10^7	1.3×10^6	2.1×10^8
	Surface resistance value (Ω) (after bias stretching)	2.3×10^6	7.8×10^7	4.5×10^6	2.5×10^7	1.5×10^6	2.3×10^8

[Table 2]

[0116]

Table 2

	Item	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5	Comparative Example 6	Comparative Example 7
Conductive composite textured yarn	Processing details	Alignment	Interlacing	Interlacing		Combining by false-twisting	Interlacing	Interlacing
	Fineness (dtex)	200	202	202		203	202	202
	crimp rate (%)	18	0	8		37	57	32
	Degree of entanglement (entangled parts/m)	0	38	25		43	55	155
	Number of twists (T/m)	Z800	Z800	Z800		Z800	Z800	Z800
Conductive yarn a	Base polymer of polymer A	PET	PET	PET		PET	PET	PET
	Conductive component/content (wt%)	Carbon 25%	Carbon 25%	Carbon 25%		Carbon 25%	Carbon 25%	Carbon 25%
	Polymer A : Polymer B (weight ratio)	20:80	20:80	20:80		20:80	20:80	20:80
	Fineness (dtex)	33	33	33		33	33	33
	Number of filaments	6	6	6		6	6	6
	Boiling-water shrinkage rate (%)	6.5	6.5	6.5		6.5	6.5	6.5
	Specific resistance (Ω·cm)	450	450	450		450	450	450
Non-conductive yarn b	Type	False twisted yarn	Drawn yarn	False twisted yarn		Drawn yarn	False twisted yarn	False twisted yarn
	Fineness (dtex)	167	167	167		167	167	167
	Number of filaments	48	48	48		48	48	48
	Boiling-water shrinkage rate (%)	7.5	7	4.5		7	8.5	7.5
	crimp rate (%)	48	0	20		0	64	48
Non-conductive textured yarn	Type	False twisted yarn	False twisted yarn	False twisted yarn	False twisted yarn	False twisted yarn	False twisted yarn	False twisted yarn
	Fineness (dtex)	167	167	167	167	167	167	167
	Number of filaments	48	48	48	48	48	48	48
	Boiling-water shrinkage rate (%)	7.3	7.3	4.5	7.3	7.3	8.5	7
	crimp rate (%)	45	45	20	45	45	64	39
	Degree of entanglement (entangled parts/m)	43	43	0	43	43	48	108
	Number of twists (T/m)	Z800	Z800	Z800	S800	Z800	Z800	Z800
Conductive performance	Surface resistance value (Ω) (initial)	2.5×10^7	8.5×10^7	5.3×10^7	1.3×10^{12}	6.4×10^7	2.4×10^6	2.1×10^{11}
	Surface resistance value (Ω) (after industrial washing 100 times)	3.3×10^{11}	2.2×10^8	1.8×10^8	2.1×10^{12}	2.1×10^8	5.3×10^{11}	5.2×10^{12}
	Surface resistance value (Ω) (after bias stretching)	5.1×10^8	9.0×10^{12}	3.2×10^{11}	2.2×10^{12}	7.0×10^{11}	9.2×10^8	7.5×10^{12}

INDUSTRIAL APPLICABILITY

[0117] According to the present invention, a fabric excellent in conductivity and wearing durability thereof can be provided. As a result, the fabric can be suitably used for garments such as uniforms, hats, dust-proof garments, and other antistatic applications.

DESCRIPTION OF REFERENCE SIGNS

[0118]

1: Measurement probe (linear distance between probes: 30 cm)
2: Flat felled seam part
3: Surface resistance detector

Claims

1. A conductive composite textured yarn comprising a conductive yarn a and a non-conductive yarn b that are combined by entanglement, wherein the conductive yarn a is a non-crimped yarn, and the non-conductive yarn b is a crimped yarn, the conductive composite textured yarn satisfying all following characteristics:

   crimp rate (%) of conductive composite textured yarn: 10 to 55, and
   degree of entanglement (entangled parts/m) of conductive composite textured yarn: 20 to 150.

2. The conductive composite textured yarn according to claim 1, wherein the conductive composite textured yarn is subjected to twisting, and a number of twists is 100 to 1500 (T/M).

3. A fabric in which the conductive composite textured yarn according to claim 1 or 2 and a non-conductive textured

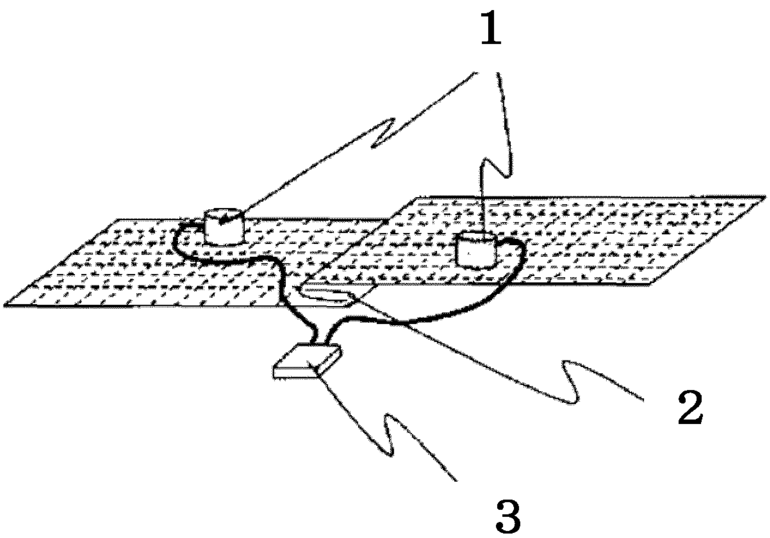
yarn are arranged in a lattice pattern at intervals, the fabric satisfying all following characteristics:

crimp rate (%) of non-conductive textured yarn: 10 to 55, and
degree of entanglement (entangled parts/m) of non-conductive textured yarn: 30 to 100.

4. The fabric according to claim 3, wherein a surface resistance value in a method described in IEC 61340-5-1, 5-2 after 100 times of industrial washing and after 100 times of repeated stretching in a bias direction is 10^{10} Ω or less.

5. A garment comprising the fabric according to claim 3 or 4.

Fig.1



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2021/004547

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. D02G3/04(2006.01)i, D03D15/47(2021.01)i, D03D15/533(2021.01)i
FI: D02G3/04, D03D15/00 D, D03D15/00 101

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)
Int. Cl. D02G1/00-3/48, D02J1/00-13/00, D03D1/00-27/18

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	1971-2021
Registered utility model specifications of Japan	1996-2021
Published registered utility model applications of Japan	1994-2021

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

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 4-73224 A (TORAY INDUSTRIES, INC.) 09 March 1992, claims	1 1-5
Y	JP 4-194041 A (KURARAY CO., LTD.) 14 July 1992, example 1, Field of the Invention	1-5
Y	JP 3-11894 B2 (ASAHI KASEI TEXTILE KK) 19 February 1991, claims, example 1	3-5
A	JP 59-3574 B2 (TORAY INDUSTRIES, INC.) 25 January 1984, claims, example 1	1-5

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

* Special categories of cited documents:
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"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
06.04.2021	20.04.2021

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2021/004547

Patent Documents referred to in the Report	Publication Date	Patent Family	Publication Date
JP 4-73224 A	09.03.1992	(Family: none)	
JP 4-194041 A	14.07.1992	(Family: none)	
JP 3-11894 B2	19.02.1991	JP 63-307938 A	
JP 59-3574 B2	25.01.1984	JP 54-73942 A	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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- JP 2001073207 A **[0007]**
- JP 2005350813 A **[0007]**
- JP 2009185439 A **[0007]**
- JP 2017106134 A **[0007]**