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

(11) **EP 2 835 455 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
11.02.2015 Bulletin 2015/07

(21) Application number: **13772737.6**

(22) Date of filing: **13.03.2013**

(51) Int Cl.:
D01F 6/90 *(2006.01)* ***D02G 1/02*** *(2006.01)*

(86) International application number:
PCT/JP2013/056923

(87) International publication number:
WO 2013/150870 (10.10.2013 Gazette 2013/41)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **03.04.2012 JP 2012084682**

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

(72) Inventors:
- **TAKANAGA, Hidetoshi**
  Nagoya-shi
  Aichi 451-8666 (JP)
- **IDA, Takashi**
  Nomi-shi
  Ishikawa 923-1294 (JP)
- **KONO, Takeaki**
  Nagoya-shi
  Aichi 451-8666 (JP)
- **MIZOTA, Junichi**
  Nagoya-shi
  Aichi 451-8666 (JP)
- **YAMANAKA, Kenji**
  Nagoya-shi
  Aichi 451-8666 (JP)

(74) Representative: **Webster, Jeremy Mark**
Mewburn Ellis LLP
33 Gutter Lane
London
EC2V 8AS (GB)

(54) SPUN-DYED BLACK POLYAMIDE YARN, FALSE-TWISTED YARN, COVERED ELASTIC YARN, AND HOSIERY

(57) A spun-dyed polyamide yarn wherein carbon black produced by a furnace method and having an average particle diameter of μm to 20 μm is contained in an amount of 1% to 5% by mass in a polyamide and which has a single fiber fineness of 0.8 dtex to 2 dtex; a false-twisted yarn produced by falsely twisting the spun-dyed black polyamide yarn; a covered elastic yarn, in which the spun-dyed black polyamide yarn or the false-twisted yarn is used as a covering yarn; and hosiery, in which at least one of the spun-dyed black polyamide yarn, the false-twisted yarn and the covered elastic yarn is used in part of a leg portion. Provided are stockings or tights which have a soft texture and are capable of developing a dark black color.

EP 2 835 455 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a spun-dyed black polyamide yarn, a false-twisted yarn, a covered elastic yarn and hosiery which have a soft texture and are capable of developing a dark black color.

BACKGROUND ART

[0002] Hosiery, e.g., stockings and tights, are mainly made of polyamide yarns such as Nylon 6 and Nylon 66. For the purpose of achieving the softness of hosiery products, conventionally, the single fiber fineness of polyamide yarns has been generally reduced. However, although a small single fiber fineness gives softness, there are the following problems in appearance, for example: a hosiery product looks whitish due to irregular reflections of light and thus hardly develops a dark color; or a filament is broken when the product is worn and pilling or the like occurs and thus durability decreases and appearance is deteriorated. In particular, important factors for consumers' needs for tights are not only soft texture, durability and reasonable market prices but also color (color-developing property). There has been a need for polyamide yarns capable of developing a dark black color which is a major color of tights.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0003] In order to solve these problems, Patent Document 1 shows that it is possible to obtain, from a polyamide yarn containing carbon black, an ultra-fine fiber that develops a good black color.

[0004] Patent Document 1: Japanese Patent Laid-open Publication No. 2002-146624

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0005] According to the method described in Patent Document 1, an ultra-fine polyamide yarn having a single fiber fineness of 0.0001 dtex to 0.06 dtex is obtained by removing a sea component of a sea island composite yarn. The ultra-fine polyamide yarn gives a soft texture when used in a hosiery product such as stockings or tights. On the other hand, however, it has problems that, for example, a dark black color cannot be obtained, pilling occurs (durability, appearance), and cost increases due to the removal of the sea component. Furthermore, since it is necessary to elute, with toluene or the like, PE which is the sea component, there is another problem that an elastic yarn such as spandex which serves as a core yarn for a covered yarn deteriorates and thus the covered yarn decreases in strength and stretchability.

[0006] An object of the present invention is to solve the above-mentioned conventional problems and to provide a spun-dyed black polyamide yarn that has a soft texture and is capable of developing a dark black color. Another object is to provide a spun-dyed black polyamide false-twisted yarn, a covered elastic yarn, and hosiery which are capable of developing a dark black color.

SOLUTIONS TO THE PROBLEMS

[0007] In order to attain the above-mentioned objects, a spun-dyed black polyamide yarn of the present invention has the following configuration. That is, it is
a spun-dyed black polyamide yarn containing 1% to 5% by mass of carbon black, wherein the average particle diameter of the carbon black in a polyamide is 1 μm to 20 μm and the single fiber fineness of the spun-dyed black polyamide yarn is 0. 8 dtex to 2 dtex.

[0008] Furthermore, a false-twisted yarn of the present invention has the following configuration. That is, it is
a false-twisted yarn obtained by false-twisting the spun-dyed black polyamide yarn.

[0009] A covered elastic yarn of the present invention has the following configuration. That is, it is
a covered elastic yarn including, as a covering yarn, the spun-dyed black polyamide yarn or the false-twisted yarn.

[0010] Hosiery of the present invention has the following configuration. That is, it is
hosiery including, in at least part of a leg portion, at least one of the spun-dyed black polyamide yarn, the false-twisted yarn, and the covered elastic yarn.

[0011] It should be noted that, in the spun-dyed black polyamide yarn of the present invention, the polyamide is preferably Nylon 6.

[0012] In the spun-dyed Toray 13060 de yarn of the present invention, the CV of the dry heat shrinkage stress preferably is 4.0% or less.

EFFECTS OF THE INVENTION

[0013] According to the present invention, it is possible to obtain a spun-dyed black polyamide yarn, a false-twisted yarn, and a covered elastic yarn which have a soft texture, are capable of developing a dark black color and are suitable for hosiery such as stockings and tights.

EMBODIMENTS OF THE INVENTION

[0014] In the following, the present invention will be described in more detail.

[0015] A polyamide constituting a spun-dyed black polyamide yarn of the present invention is, what is called, a resin made of a polymer in which hydrocarbon groups are bound to a main chain via amide bonds. Such a polyamide is preferably excellent in spinnability and mechanical properties and composed mainly of polycaproamide (Nylon 6) or polyhexamethylene adipamide (Nylon 66). In the case where the polyamide is to contain carbon black, polycaproamide (Nylon 6) is more preferable because polycaproamide is unlikely to turn into a gel and has good spinnability. As used herein, the term "mainly" means that ε-caprolactam units constituting polycaproamide account for 80 mol% or more of all the monomer units. It is more preferable that the ε-caprolactam units account for 90 mol% or more. There is no particular limitation on other components. Examples thereof include units such as aminocarboxylic acids, dicarboxylic acids and diamines which are monomers constituting polydodecanoamide, polyhexamethylene adipamide, polyhexamethylene azelamide, polyhexamethylene sebacamide, polyhexamethylene dodecanoamide, polymethaxylylene adipamide, polyhexamethylene terephthalamide, polyhexamethylene isophthalamide and the like.

[0016] Furthermore, the degree of polymerization of a polyamide for use in the spun-dyed black polyamide yarn may be appropriately selected from a range suitable for achieving desired properties of a false twisting process and woven/knitted goods and textile goods, or appropriately selected from a range suitable for stably achieving the desired properties. The degree of polymerization in terms of relative viscosity in 98% sulfuric acid at 25°C is preferably in the range of 2.0 to 3.6, and is more preferably in the range of 2.4 to 3.3.

[0017] There is no particular limitation on the types of carbon black for use in the spun-dyed black polyamide yarn of the present invention. Examples thereof include furnace black, channel black, thermal black, acetylene black and lamp black. The carbon black is preferably furnace black. Carbon black production methods are categorized into a thermal decomposition method for acetylene black, thermal black and the like and a partial combustion method for collecting greasy fumes (so-called lamp black), furnace black and the like. This difference in methods provides a difference in properties of carbon black. The thermal decomposition method, in which a reaction environment of around 2,000°C needs to be maintained, requires a lot of energy for production and thus is of less practical use in terms of costs and production environment. On the other hand, the partial combustion method is of much practical use in terms of costs and production environment. Furthermore, in the furnace method, which is a typical partial combustion method, it is easy to control the particle diameter and the size of structures. In terms of color tone and spinnability of the spun-dyed black polyamide yarn, it is preferable to use furnace black obtained by the furnace method. In particular, in the case of producing furnace black having a small particle diameter, furnace black obtained by an oil furnace method is more preferable.

[0018] As for the carbon black, its structures are formed during production. The structures are minimum units of the carbon black. The indicator of the structure can be represented by DBP oil absorption. As used herein, the oil absorption is a value determined according to JIS K 6217-4 (2008). The DBP oil absorption of the carbon black for use in the spun-dyed black polyamide yarn of the present invention is preferably 10 ml/100g to 300 ml/100g. In the case where the DBP oil absorption is within the above-mentioned preferable range, when the carbon black is used in the spun-dyed black polyamide yarn, a dark black color is easily developed. Meanwhile, the carbon black is well dispersed in a polyamide polymer, and coarse particles do not increase when the spun-dyed black polyamide yarn is produced. The spun-dyed black polyamide yarn has good spinnability and excellent strength which is a mechanical property of the spun-dyed black polyamide yarn.

[0019] The carbon black contained in the spun-dyed black polyamide yarn of the present invention should have an average particle diameter of 1 μm to 20 μm. As used herein, the average particle diameter is a structure having a large particle diameter which is generally called a coarse grain, and is a value obtained by: placing a 0.1 g sample of the spun-dyed black polyamide yarn on a prepared slide heated to 20°C above the melting point of the spun-dyed black polyamide yarn; sandwiching the sample with a glass slide to spread the sample into a film and taking a photo of the sample at ×500 with the use of an optical microscope; measuring the largest diameters of any 20 carbon black structures per sample; and calculating the average of the 20 diameters. Here, the photos taken may be enlarged to the size in which particle diameter can be easily measured. In the case where the average particle diameter is more than 20 μm, not only yarn breakages increase and the spinnability is deteriorated when the spun-dyed black polyamide yarn is produced and

the product quality decreases due to fluff or the like when the spun-dyed black polyamide yarn is formed into hosiery, but also the strength which is a mechanical property of the spun-dyed black polyamide yarn decreases. In the case where the average particle diameter is less than 1 μm, the coefficient of dynamic friction of the yarn increases and this causes, when the hosiery is worn, a lot of pilling in toes, heels, knees and the like where there is great friction. It is preferable that the average particle diameter be 1 μm to 10 μm. The average particle diameter of the carbon black contained in the spun-dyed black polyamide yarn of the present invention can be controlled to 1 μm to 20 μm by filtering a carbon-black-containing molten polymer when producing spun-dyed black polyamide chips and when producing the spun-dyed black polyamide yarn. There is no particular limitation on how to filter the molten polymer. It is preferable to provide a filter in a passage for the molten polymer, in a spin pack or the like. It is more preferable to provide a filter in a spin pack, and the filter for use in the spin pack is more preferably a 10 to 20 μm mesh filter.

[0020] Furthermore, when the carbon black is added to the molten polyamide polymer, the carbon black particles are likely to become coarse grains such as secondary and tertiary particles. Therefore, when a filter is provided only in the spin pack, the filter easily becomes clogged with the carbon black and filtration pressure greatly increases, and the life of the pack decreases and productivity is likely to decrease. As a preferable melt spinning method by which the carbon black is added to a polyamide, it is preferable to perform melt spinning by providing a filter in a spin pack and, in addition, by blending master chips composed of a polyamide containing a high concentration of carbon black with polyamide chips containing no carbon black. Moreover, by providing a filter when producing the master chips, it is possible to remove coarse grains and to suppress an increase in filtration pressure in the production of the spun-dyed black polyamide yarn, and to increase the life of the pack and to improve productivity. It should be noted that the filter for use in the production of the master chips is preferably a 20 μm to 50 μm mesh filter.

[0021] The carbon black content of the spun-dyed black polyamide yarn of the present invention should be 1% to 5% by mass. As used herein, the content is the carbon black content of the spun-dyed black polyamide yarn, which is obtained by measuring, by TG-DTA, changes in weight of the spun-dyed black polyamide yarn in the conditions in which the temperature range is room temperature to 900°C, heating rate is 100°C/min and airflow rate is 20 ml/min and using, as the amount of lost carbon black, a value calculated from a rate of decrease occurred in the range of 650°C to 900°C. In the case where the content is less than 1% by mass, it is not possible to obtain a dark black color when the yarn is made into a hosiery product such as stockings or tights. In the case where the content is more than 5% by mass, not only yarn breakages increase and the spinnability is deteriorated when the spun-dyed black polyamide yarn is produced, but also the strength which is a mechanical property of the spun-dyed black polyamide yarn decreases. The content is preferably 2% to 4% by mass.

[0022] Furthermore, an additive for improving productivity such as that for improving heat resistance may be added, or additives for imparting functions such as matting, moisture absorption, antibacterial action, UV blocking and heat retention may be added, provided that their amounts and types are within the ranges in which the objects of the present invention are not impaired. However, it is not preferable to add inorganic particles of greater than 1 μm, because these particles cause a decrease in spinnability or decreases in durability and black color developing property of products, e.g., hosiery such as stockings and tights. There is no particular limitation on inorganic particles to be added including white pigments, but the amount of the particles with respect to the spun-dyed black polyamide yarn is preferably 2.0% by mass or less, more preferably less than 1.0% by mass.

[0023] In the spun-dyed black polyamide yarn of the present invention, the CV of the dry heat shrinkage stress of the spun-dyed black polyamide yarn is preferably 4.0% or less. The CV of the dry heat shrinkage stress is a variation in lengthwise shrinkage of the spun-dyed black polyamide yarn. In the case where the CV of the dry heat shrinkage stress is within the above-mentioned preferable range, tension for processing is not likely to vary during the false twisting process, uneven crimp such as a not untwisted portion does not occur, and the quality of the fabric surface of a product such as hosiery improves. Meanwhile, uneven shrinkage does not occur in heat treatments such as refinement and foot shape setting, and the quality of the fabric surface improves. In order to control the CV to 4.0% or less, it is preferable to reduce variations in carbon black content of the spun-dyed black polyamide yarn. As for a reduction of variations in carbon black content of the spun-dyed black polyamide yarn, for example, in the case where melt spinning is performed by blending master chips composed of a polyamide containing a high concentration of carbon black with polyamide chips containing no carbon black, the high-concentration carbon black can be thoroughly kneaded by performing kneading with a twin screw extruder or with the use of a kneader or the like such as a static mixer or a high mixer provided in a polymer pipe. In this way, it is possible to reduce variations in carbon black content. Variations in carbon black content are found by measuring the carbon black content of a filament by the above-mentioned TG-DTA. A preferable range in CV is 10% or less.

[0024] The spun-dyed black polyamide yarn of the present invention should have a single fiber fineness of 0.8 dtex to 2 dtex. Conventionally, the single fiber fineness has been generally reduced to obtain a soft texture of hosiery products. However, in the case where the single fiber fineness is less than 0.8 dtex, although a soft texture is obtained, a filament is broken when the product is worn and pilling or the like occurs and thus durability decreases and appearance is deteriorated. Furthermore, a lot of yarn breakages occur when the spun-dyed black polyamide yarn is produced, and

spinnability is deteriorated. In the case where the single fiber fineness is more than 2 dtex, the texture becomes hard. The single fiber fineness is preferably 0.8 dtex to 1.5 dtex. There is no particular limitation on total fineness. In the case where the yarn is used for a hosiery product, the total fineness is preferably 8 dtex to 155 dtex.

[0025] The spun-dyed black polyamide yarn of the present invention preferably has a strength of 2 cN/dtex or greater, and more preferably 2 cN/dtex to 6 cN/dtex. When the strength is controlled to 2 cN/dtex or greater, yarn breakages during processing in the subsequent steps such as steps for a false-twisted yarn and a covered elastic yarn reach practical levels, and the durability (anti-pilling property) when the yarn is made into a hosiery product reaches a practical level. There is no limitation on the upper limit of the strength of the spun-dyed black polyamide yarn. However, when the strength is high, the elongation decreases and a lot of yarn breakages occur and spinnability is deteriorated in the production of the spun-dyed black polyamide yarn. Therefore, in terms of spinnability, the strength is preferably 6 cN/dtex or less.

[0026] A method for producing the spun-dyed black polyamide yarn of the present invention will be described.

[0027] In terms of productivity and costs, the best method to produce the spun-dyed black polyamide yarn of the present invention is melt spinning. As for the method for production by melt spinning, any method can be employed such as a method having a continuous spinning-drawing step (direct spinning-drawing method), a method by which to take up an undrawn yarn and then draw the yarn (two step method), or a method in which the spinning rate is as high as 3, 000 m/min or greater and the drawing step is substantially omitted (high-speed spinning method). In the case where the yarn is used as a false-twisted yarn, the high-speed spinning method is preferable which makes the yarn highly crimpy and can be performed at low cost. The following provides an example of production by the high-speed spinning method.

[0028] First, a melting section is described. A polyamide can be melted by, for example, a pressure melter method or an extruder method. However, there is no particular limitation on both methods. The temperature for melting is preferably 20°C to 60°C above the melting point of the polyamide polymer. For example, in the case where a Nylon 6 polymer is used, since the melting point is 225°C, the temperature for melting is preferably 245°C to 285°C.

[0029] Carbon black can be added by, for example, a method by which to melt-spin a blend of master chips composed of a polyamide containing a high concentration of carbon black and polyamide chips containing no carbon black, or a method by which to directly add carbon black with a feeder or the like. The carbon black content of the master chips is preferably 10% to 30% by mass. A carbon black content of the master chips of 10% by mass or more is preferable in terms of production cost for the spun-dyed black polyamide yarn, and a carbon black content of 30% by mass or less is preferable in consideration of carbon black aggregation.

[0030] The polyamide containing carbon black, which has flowed into the spin pack, is discharged through a known spinneret. Furthermore, the spinning temperature (that is, the maintained temperature of the polymer pipe, spinneret or the like) is preferably 20°C to 60°C above the melting point of the polyamide polymer.

[0031] As described earlier, since carbon black easily aggregates even in the molten polymer, it is preferable to provide a filter in the spin pack.

[0032] The spun-dyed black polyamide yarn discharged through the spinneret is cooled for solidification, provided with an oil, and thereafter taken up. It is preferable that the draw ratio be appropriately determined so that a spun-dyed polyamide yarn will have a elongation within the range of 50% to 70% and preferable that the yarn be taken up at a take-up speed in the range of 3, 000 m/min to 5, 000 m/min without heat setting in the spinning step. Furthermore, before the taking up of the yarn, the yarn can be interlaced with the use of a known interlacing apparatus. If needed, the yarn can be interlaced a plurality of times to increase the number of interlacing points. Moreover, an additional oil can be provided immediately before taking up the yarn.

[0033] A false-twisted yarn of the present invention and a method for producing the false-twisted yarn will be described.

[0034] The false-twisted yarn of the present invention can be obtained by false-twisting the above-mentioned spun-dyed black polyamide yarn. There is no particular limitation on a method for false-twisting the spun-dyed black polyamide yarn to obtain the false-twisted yarn. The method of twisting is not particularly limited either, and can be of a spindle type, triaxial twister type, belt nip type or the like. When strong crimp is needed, the spindle type is preferable. When a high processing speed and low production cost are needed, the triaxial twister or belt nip which is a frictional false-twisting method is preferable. There is no particular limitation on how to perform heating, and a heating plate or a high-temperature short heater may be used. The temperature can be freely set according to the desired texture. As a guide, in the case where a heating plate is used, 170°C to 190°C is recommended for polycaproamide (Nylon 6) and 180°C to 200°C is recommended for polyhexamethylene adipamide (Nylon 66) . There is no limitation on how to perform cooling, and, for example, a cooling plate can be used or air cooling or water cooling can be employed. In consideration of efficiency and damage to yarns, it is preferable to use a cooling plate. The crimp property of the false-twisted yarn is preferably 3% to 50%. In the case where the crimp property of the finished yarn is within the above-mentioned preferable range, the yarn is very soft when made into hosiery. Meanwhile, it is not necessary to twist the yarn many times in the false twisting process, and fluff is not likely to be generated. It should be noted that, as used herein, the crimp property is a value calculated by performing a measurement by the later-described measuring method, and serves as an indicator of the bulking power of the false-twisted yarn.

[0035] A covered elastic yarn of the present invention and a method for producing the covered elastic yarn will be described.

[0036] A covering yarn for the covered elastic yarn of the present invention can be selected from spun-dyed black polyamide yarns and false-twisted yarns obtained by false-twisting the spun-dyed black polyamide yarns.

[0037] Examples of an elastic yarn serving as a core yarn of the covered elastic yarn include polyurethane elastic yarns, polyamide elastomer elastic yarns, polyester elastomer elastic yarns, natural rubber yarns, synthetic rubber yarns, and butadiene yarns. More preferred for hosiery in terms of elastic property, heat characteristic, durability and the like are polyurethane elastic yarns and polyamide elastomer elastic yarns. Furthermore, adding carbon black or the like to an elastic yarn and using this black elastic yarn is preferable, because, when the black elastic yarn is made into hosiery, a darker black color can be obtained.

[0038] The thickness of the covered elastic yarn differs depending on the purpose and desired compression pressure of hosiery. Generally, a preferable thickness is approximately 8 dtex to 80 dtex. A more preferable thickness is 11 dtex to 44 dtex. In the case where the thickness of the covered elastic yarn is within the above-mentioned preferable range, yarn tenacity is high enough, and thus troubles such as core yarn breakages are not likely to occur during the production of the covered elastic yarn and knitting of hosiery, and the hosiery has enough stretch properties and durability. Meanwhile, compression pressure is not too strong and the hosiery does not give a feeling of tightness or roughness.

[0039] The number of turns of the covering yarn may be designed in consideration of fineness of the covering yarn which is a spun-dyed black polyamide yarn or a false-twisted yarn obtained by false-twisting the spun-dyed black polyamide yarn, degree of shrinkage and product texture, anti-pilling property and anti-snagging property. When the false-twisted yarn obtained by false-twisting the spun-dyed black yarn is used for single covering, the number of turns is preferably designed to be approximately (56/fineness of finished yarn)$^{1/2}$ $\times$ 500 T/m to (56/fineness of finished yarn) $^{1/2}$ $\times$ 1000 T/m. For example, when a false-twisted yarn of 56 dtex is used for single covering, the number of turns is preferably 500 T/m to 1,000 T/m. The draft ratio may also be designed according to a target compression pressure. It is preferable that the draft ratio be set to, for example, 2.5$\times$ to 3.5$\times$. In terms of the softness of texture and stretch properties, the covering is preferably single covering.

[0040] The spun-dyed black polyamide yarn, the false-twisted yarn obtained by false-twisting the spun-dyed black polyamide yarn, and the covered elastic yarn of the present invention thus obtained can be suitably used for hosiery.

[0041] Hosiery of the present invention will be described.

[0042] The knit structure constituting the hosiery of the present invention is not limited, and can be plain knit, rib knit, purl knit or any of structures derived from the above-mentioned knit structures. It is more preferable that the hosiery have a portion constituted by a basic structure, and even more preferable that the hosiery have a portion constituted by a plain knit structure.

[0043] It is preferable that at least one selected from spun-dyed black polyamide yarns, false-twisted yarns and covered elastic yarns be used in at least part of a leg portion of the hosiery of the present invention. It should be noted that the leg portion means a portion from the base of a leg (garter portion) to the toe (sole portion).

[0044] The yarn to be used may either be: of a so-called Zokki type composed only of covered elastic yarns whose covering yarn is a spun-dyed black polyamide yarn or a false-twisted yarn obtained by false-twisting the spun-dyed black polyamide yarn; or of a union (Kohhen) type composed of alternately arranged covered elastic yarns whose covering yarn is a spun-dyed black polyamide yarn or a false-twisted yarn obtained by false-twisting the spun-dyed black polyamide yarn, and spun-dyed black polyamide yarns or false-twisted yarns obtained by false-twisting the spun-dyed black polyamide yarn. It should be noted that there is no limitation on using, as a yarn that constitutes hosiery, a yarn such as sewing thread according to need.

[0045] Furthermore, there is no limitation on a knitting machine to be used. It is preferable to use a sock knitting machine.

[0046] Examples of hosiery which is encompassed in the present invention include stockings, tights, leggings, stirrup pants, short leggings, foot covers and socks. Examples include: socks made up of three parts: rib top, body part and foot part; stockings whose body part is much longer than stockings; and tights and pantyhose with a pantie portion at the top.

[0047] Furthermore, in the case where hosiery is made up of a pantie portion and a leg portion and where the spun-dyed black polyamide yarn, false-twisted yarn or covered elastic yarn of the present invention is used in the entire pantie portion or leg portion, or in the case where hosiery is made up only of a leg portion and where the spun-dyed black polyamide yarn, false-twisted yarn or covered elastic yarn of the present invention is used in the entire leg portion, a dyeing step can be omitted. The dyeing step is subdivided into a refining step, a dyeing step and a finishing step. This dyeing step can be omitted. The production cost for this dyeing step includes not only the cost for the dye but also the costs for the time and process for high-temperature, long-period dyeing. Since not only the time is shortened but also the production costs including the costs for the dye and fuel are reduced, it is possible to provide hosiery to consumers at reasonable market prices. Conventionally, in the case where a polyamide yarn is to be dyed in black and a dark black color is desired, it is necessary to increase the concentration of the dye. However, if the single fiber fineness is reduced to obtain softness and the concentration of the dye is increased, washing fastness is deteriorated. This has been a

problem. In this regard, according to the present invention, not only the dyeing step can be omitted but also a reduction in washing fastness due to the use of a high-concentration dye is not caused. It is possible to obtain hosiery that develops a long-lasting dark black color.

[0048] As for finishing, a product may be treated with a known finishing agent (softener). Here, a functional agent having a function such as an antibacterial action or UV blocking action may be added.

EXAMPLES

[0049] In the following, the present invention will be described in more detail with reference to examples. The present invention is not limited to the following examples in any way unless they go beyond the scope of the present invention. Furthermore, the physical properties of a spun-dyed black polyamide yarn of the present invention are measured in the following manner.

A. Average particle diameter (μm) of carbon black

[0050] A 0.1 g sample of a spun-dyed black polyamide yarn was placed on a prepared slide heated to 245°C in the case of Nylon 6 or to 275°C in the case of Nylon 66, the sample was sandwiched with a glass slide to spread into a film, a photo of the sample was taken at $\times$500 with the use of an optical microscope, the largest diameters of any 20 carbon black structures per sample were measured, and the average of the 20 diameters was calculated.

B. Carbon black content (% by mass)

[0051] Carbon black content is a value obtained by measuring, with the use of TG-DTA (apparatus for thermogravimetry SII TG/DTA 6200 available from SII NanoTechnology Inc.) and a 1.4 mg sample of a spun-dyed black polyamide yarn, changes in weight of the spun-dyed black polyamide yarn in the conditions in which the temperature range is room temperature to 900°C, heating rate is 100°C/min, and airflow rate is 20 ml/min, and calculating the value from the rate of decrease occurred in the range of 650°C to 900°C. The measurement was performed 4 times, and the average was used as a carbon black content.

C. Relative viscosity in sulfuric acid (η_r)

[0052] First, 0.25 g of polyamide chips (sample) were dissolved in 100 ml of 98% by mass sulfuric acid, and the efflux time (T_1) at 25°C was measured with the use of an Ostwald viscometer. Subsequently, the efflux time (T_2) for 98% by mass sulfuric acid only was measured. The ratio of T_1 to T_2, i.e., T_1/T_2, was used as a relative viscosity in sulfuric acid.

D. Spinnability

[0053] The number of yarn breakages per ton of spun-dyed black polyamide yarn when the spun-dyed black polyamide yarn is spun was indicated by the following criteria:

a: the number of yarn breakages is less than 2,
b: the number of yarn breakages is 2 or more but less than 4,
c: the number of yarn breakages is 4 or more but less than 6,
d: the number of yarn breakages is 6 or more but less than 8,
e: the number of yarn breakages is 8 or more.

E. Fineness, single fiber fineness

[0054] With the use of a wrap reel having a circumference of 1.125 m, a hank of 200 turns of yarn was made with a tension of 0.35 mN $\times$ target fineness (dtex) in the case of a spun-dyed black polyamide yarn and with a tension of 8.82 mN $\times$ target fineness (dtex) in the case of a false-twisted yarn obtained by false-twisting the spun-dyed black polyamide yarn. The hank was dried with a hot air drier (105 $\pm$ 2°C $\times$ 60 minutes). After that, the weight of the hank was measured with a balance and the weight was multiplied by official moisture regain. From this, a fineness was calculated. The measurement was performed 4 times, and the average was used as a fineness. Furthermore, a value obtained by dividing the obtained fineness by the number of filaments was used as a single fiber fineness.

F. Strength, elongation

[0055] A sample of a spun-dyed black polyamide yarn or a false-twisted yarn obtained by false-twisting the spun-dyed black polyamide yarn was measured at a constant rate of specimen extension stated in JIS L 1013 (a method for testing chemical fiber filament yarn, 2010) with the use of TENSILON UCT-100 available from ORIENTEC Co. , LTD. The elongation was found from the extension at the point of a tensile strength-extension curve where the tenacity was largest. As for strength, a value obtained by dividing the largest tenacity by a fineness was used as a strength. The measurement was performed 10 times, and the averages were used as a strength and a elongation. It should be noted that the length of specimen between grips is 50 cm and tension speed is 50 cm/min.

G. Crimp property

[0056] While a tension of 0.098 cN/dtex is given, 5 hanks of 10 turns of a false-twisted yarn obtained by false-twisting a spun-dyed black polyamide yarn, each of which has a circumference of 1.125 m, are prepared. The hanks are allowed to stand for 24 hours in an environment of 20°C and 60% RH. The hanks are treated for 20 minutes in hot water of 98 $\pm$ 1°C while a treating load of 1.76 $\times$ 10^{-3} cN/dtex (a load in water) is applied. The hanks thus heat treated are allowed to stand for 24 hours in an environment of 20°C and 60% RH and dried. In advance, water is put in a cylinder and allowed to stand for 24 hours in an environment of 20°C and 60% RH. All the hank samples are placed in the water while an initial load of 1.76 $\times$ 10^{-3} cN/dtex (a load in water) is applied. After that, a further load of 0.088 cN/dtex (a load in water) is applied so that the load becomes a constant load of 0.08976 cN/dtex (a load in water), and the length a (mm) of each hank in 2 minutes is measured. The constant load is quickly removed, and the length b (mm) of each hank only with the initial load is measured in 2 minutes. The crimp property is calculated through the following equation, and the average of the 5 hanks is used for evaluation.

$$\text{Crimp property (\%)} = [(a - b)/a] \times 100$$

H. Degree of shrinkage in boiling water

[0057] While a tension of 0.098 cN/dtex is given, 5 hanks of 10 turns of a false-twisted yarn obtained by false-twisting a spun-dyed black polyamide yarn, each of which has a circumference of 1.125 m, are prepared. The hanks are allowed to stand for 24 hours in an environment of 20°C and 60% RH. The initial length L0 is found under a load of 0.09 cN/dtex. Next, the hanks are treated for 30 minutes in boiling water without load, and thereafter air dried. Next, the length L_1 after treatment is found under a load of 0.09 cN/dtex, and calculation is performed through the following equation. The average of the 5 hanks is used for evaluation.

$$\text{Degree of shrinkage in boiling water (\%)} = [(L_0 - L_1)/L_0] \times 100$$

I. Softness

[0058] A part 10 cm below the garter portion of a sample of Zokki tights was touched by testers (30 testers), and softness (soft texture) was evaluated by the testers on a scale of a to c.

a: Softness equivalent to Comparative Example 7
b: Softness somewhat poorer than Comparative Example 7
c: Softness much poorer than Comparative Example 7 J. Color tone

[0059] A part 10 cm below the garter portion of a sample of Zokki tights was visually checked by testers (30 testers), and color tone (dark black color developing property) was evaluated by the testers on a scale of a to e.

a: Darker black than Comparative Example 7 and color tone is very good
b: More black than Comparative Example 7 and color tone is good
c: Color tone equivalent to Comparative Example 7
d: Somewhat whitish as compared to Comparative Example 7 and color tone is not very good

e: Whitish as compared to Comparative Example 7 and color tone is bad

K. Anti-pilling property

[0060] A part 10 cm below the garter portion of a sample of Zokki tights was evaluated for pilling according to the Appearance Retention C method of JIS L 1076 (2012), whereby the grade was determined.

N: Number of pills is substantially the same as standard photo N
L: Number of pills is substantially the same as standard photo L
M: Number of pills is substantially the same as standard photo M
H: Number of pills is substantially the same as or larger than standard photo H

L. CV (%) of dry heat shrinkage stress

[0061] With the use of FTA-500 available from Toray Engineering Co., Ltd., at a feeding rate of 10 m/min in a 1% relaxed state, a polyamide filament was passed through a dry heat treatment apparatus having a length of 15.5 cm and heated to 100°C, and measurement was performed for 10 minutes, whereby a dry heat shrinkage stress was found. The CV (%) of the dry heat shrinkage stress was represented as a value obtained by dividing the standard deviation of the dry heat shrinkage stress by the average.

[Example 1]

(Production of spun-dyed black polyamide yarn)

[0062] As a polyamide, Nylon 6 chips having a relative viscosity in sulfuric acid (η_r) of 2.6 and a titanium oxide content of 0.02% by mass were dried by a standard method known in the art so that the moisture content would be 0.03% by mass or less.

[0063] Carbon black obtained by the furnace method was kneaded with the obtained Nylon 6 chips with a twin screw kneader so that the carbon black content would be 15% by mass, the mixture was passed through a 30 μm mesh filter, and thereafter discharged, whereby master chips were produced. The master chips were dried by a standard method known in the art so that the moisture content would be 300 ppm or less. The obtained carbon-black-containing Nylon 6 master chips were blended with Nylon 6 chips containing no carbon black at a ratio of 1 : 4 (carbon black content in spun-dyed black yarn was 3% by mass), melted at a temperature for melting of 265°C, passed through a polymer pipe in which a static mixer with 25 elements was provided, filtered through a spin pack in which a 10 μm mesh metal filter was provided, and discharged through a spinneret at a spinning temperature of 260°C. The spinneret used was a 68-hole round spinneret producing one yarn. After discharged through the spinneret, the yarn was air cooled at 18°C, provided with an oil, and thereafter interlaced, and thereafter drawn to 1.2 times the original length via a first godet roll and a second godet roll, and taken up at a take-up speed of 4, 000 m/min, whereby a Nylon 6 spun-dyed black yarn of 96 dtex having 68 filaments was obtained. The obtained spun-dyed black yarn was evaluated for its spinnability, carbon black content, average particle diameter of carbon black, fineness, strength and elongation. The results are shown in Table 1.

(Production of false-twisted yarn)

[0064] The Nylon 6 spun-dyed black yarn was false-twisted with the use of a false-twisting machine IVF805 available from Ishikawa Seisakusho, LTD. configured such that the processing speed was 500 m/min, draw ratio was 1,23×, heater temperature was 180°C, and D/Y ratio was 1.7 (untwisting tension/twisting tension = 1.04), whereby a false-twisted yarn of 78.1 dtex having 68 filaments was obtained. The obtained false-twisted yarn was evaluated for its fineness, strength, elongation, degree of shrinkage in boiling water, and crimp property. The results are shown in Table 1.

(Production of covered elastic yarn)

[0065] Using the false-twisted yarn as a covering yarn and using "MOBILON" (registered trademark) 22 dtex, G type (available from Nisshinbo Textile Inc.) as a core yarn, an S twist single covered yarn and a Z twist single covered yarn were prepared in the conditions in which the number of turns of covering yarn was 600 T/m and the draft was 3.0×.

(Production of Zokki tights)

[0066] The single covered yarn was set to MODEL KT-S4 (with 380 needles) available from NAGATA SEIKI CO., LTD., and Zokki tights were knitted. The knitted Zokki tights were subjected to presetting in a vacuum at 80°C for 10 minutes, refined at 98°C for 30 minutes, softened, and thereafter heat-set with an aluminum plate foot pattern at 110°C for 30 seconds, whereby Zokki tights were obtained. The obtained Zokki tights were evaluated for their softness, color tone, and anti-pilling property. The results are shown in Table 1.

[Example 2]

[0067] A Nylon 6 spun-dyed black yarn was produced in the same manner as in Example 1, except that the carbon-black-containing Nylon 6 master chips and the Nylon 6 chips were blended at a ratio of 1 : 14 (carbon black content in spun-dyed black yarn was 1% by mass). The obtained spun-dyed black yarn was evaluated for its spinnability, carbon black content, average particle diameter of carbon black, fineness, strength, and elongation. The results are shown in Table 1.

[0068] A false-twisted yarn, a covered elastic yarn, and tights were produced from the obtained Nylon 6 spun-dyed black yarn in the same manner as in Example 1. The obtained false-twisted yarn was evaluated for its fineness, strength, elongation, degree of shrinkage in boiling water, and crimp property, and the obtained Zokki tights were evaluated for their softness, color tone, and anti-pilling property. The results are shown in Table 1.

[Example 3]

[0069] A Nylon 6 spun-dyed black yarn was produced in the same manner as in Example 1, except that the carbon-black-containing Nylon 6 master chips and the Nylon 6 chips were blended at a ratio of 33 : 67 (carbon black content in spun-dyed black yarn was 5% by mass). The obtained spun-dyed black yarn was evaluated for its spinnability, carbon black content, average particle diameter of carbon black, fineness, strength, and elongation. The results are shown in Table 1.

[0070] A false-twisted yarn, a covered elastic yarn, and tights were produced from the obtained Nylon 6 spun-dyed black yarn in the same manner as in Example 1. The obtained false-twisted yarn was evaluated for its fineness, strength, elongation, degree of shrinkage in boiling water, and crimp property, and the obtained Zokki tights were evaluated for their softness, color tone, and anti-pilling property. The results are shown in Table 1.

[Example 4]

[0071] A Nylon 6 spun-dyed black yarn was produced in the same manner as in Example 1, except that the filtering was performed with a spin pack in which a 15 μm mesh metal filter was provided. The obtained spun-dyed black yarn was evaluated for its spinnability, carbon black content, average particle diameter of carbon black, fineness, strength, and elongation. The results are shown in Table 1.

[0072] A false-twisted yarn, a covered elastic yarn, and tights were produced from the obtained Nylon 6 spun-dyed black yarn in the same manner as in Example 1. The obtained false-twisted yarn was evaluated for its fineness, strength, elongation, degree of shrinkage in boiling water, and crimp property, and the obtained Zokki tights were evaluated for their softness, color tone, and anti-pilling property. The results are shown in Table 1.

[Example 5]

[0073] A Nylon 6 spun-dyed black yarn was produced in the same manner as in Example 1, except that the filtering was performed with a spin pack in which a 20 μm mesh metal filter was provided. The obtained spun-dyed black yarn was evaluated for its spinnability, carbon black content, average particle diameter of carbon black, fineness, strength, and elongation. The results are shown in Table 1.

[0074] A false-twisted yarn, a covered elastic yarn, and tights were produced from the obtained Nylon 6 spun-dyed black yarn in the same manner as in Example 1. The obtained false-twisted yarn was evaluated for its fineness, strength, elongation, degree of shrinkage in boiling water, and crimp property, and the obtained Zokki tights were evaluated for their softness, color tone, and anti-pilling property. The results are shown in Table 1.

[Example 6]

[0075] A Nylon 6 spun-dyed black yarn was produced in the same manner as in Example 1, except that the spinneret used was a 96-hole round spinneret, whereby a Nylon 6 spun-dyed black yarn of 96 dtex having 96 filaments was

obtained. The obtained spun-dyed black yarn was evaluated for its spinnability, carbon black content, average particle diameter of carbon black, fineness, strength, and elongation. The results are shown in Table 1.

[0076] A false-twisted yarn, a covered elastic yarn, and tights were produced from the obtained Nylon 6 spun-dyed black yarn in the same manner as in Example 1. The obtained false-twisted yarn was evaluated for its fineness, strength, elongation, degree of shrinkage in boiling water, and crimp property, and the obtained Zokki tights were evaluated for their softness, color tone, and anti-pilling property. The results are shown in Table 1.

[Example 7]

[0077] A Nylon 6 spun-dyed black yarn was produced in the same manner as in Example 1, except that the spinneret used was a 52-hole round spinneret, whereby a Nylon 6 spun-dyed black yarn of 96 dtex having 52 filaments was obtained. The obtained spun-dyed black yarn was evaluated for its spinnability, carbon black content, average particle diameter of carbon black, fineness, strength, and elongation. The results are shown in Table 1.

[0078] A false-twisted yarn, a covered elastic yarn, and tights were produced from the obtained Nylon 6 spun-dyed black yarn in the same manner as in Example 1. The obtained false-twisted yarn was evaluated for its fineness, strength, elongation, degree of shrinkage in boiling water, and crimp property, and the obtained Zokki tights were evaluated for their softness, color tone, and anti-pilling property. The results are shown in Table 1.

[Example 8]

[0079] A Nylon 6 spun-dyed black yarn was produced in the same manner as in Example 1, except that the spinneret used was a 68-hole round spinneret producing two yarns, whereby a Nylon 6 spun-dyed black yarn of 48 dtex having 34 filaments was obtained. The obtained spun-dyed black yarn was evaluated for its spinnability, carbon black content, average particle diameter of carbon black, fineness, strength, and elongation. The results are shown in Table 1.

[0080] A false-twisted yarn, a covered elastic yarn, and tights were produced from the obtained Nylon 6 spun-dyed black yarn in the same manner as in Example 1. The obtained false-twisted yarn was evaluated for its fineness, strength, elongation, degree of shrinkage in boiling water, and crimp property, and the obtained Zokki tights were evaluated for their softness, color tone, and anti-pilling property. The results are shown in Table 1.

[Example 9]

[0081] A Nylon 6 spun-dyed black yarn was produced in the same manner as in Example 1, except that the spinneret used was a 78-hole round spinneret producing three yarns, whereby a Nylon 6 spun-dyed black yarn of 43 dtex having 26 filaments was obtained. The obtained spun-dyed black yarn was evaluated for its spinnability, carbon black content, average particle diameter of carbon black, fineness, strength, and elongation. The results are shown in Table 1.

[0082] A false-twisted yarn, a covered elastic yarn, and tights were produced from the obtained Nylon 6 spun-dyed black yarn in the same manner as in Example 1. The obtained false-twisted yarn was evaluated for its fineness, strength, elongation, degree of shrinkage in boiling water, and crimp property, and the obtained Zokki tights were evaluated for their softness, color tone, and anti-pilling property. The results are shown in Table 1.

[Example 10]

[0083] As a polyamide, Nylon 66 chips having a relative viscosity in sulfuric acid (η_r) of 2.8 and a titanium oxide content of 0.02% by mass were dried by a standard method known in the art so that the moisture content would be around 0.11% by mass.

[0084] Carbon black obtained by the furnace method was kneaded with the obtained Nylon 66 chips so that the carbon black content would be 15% by mass, master chips were produced by providing a 30 μm mesh filter, and the master chips were dried by a standard method known in the art so that the moisture content would be around 0.11% by mass. A Nylon 66 spun-dyed black yarn was produced in the same manner as in Example 1, except that the obtained carbon-black-containing Nylon 66 master chips and Nylon 66 chips were blended at a ratio of 1 : 4 (carbon black content in spun-dyed black yarn was 3% by mass), melted at a temperature for melting of 290°C, filtered through a spin pack in which a 10 μm mesh metal filter was provided, and discharged through a spinneret at a spinning temperature of 290°C. In this way, a Nylon 66 spun-dyed black yarn of 96 dtex having 68 filaments was obtained. The obtained spun-dyed black yarn was evaluated for its spinnability, carbon black content, average particle diameter of carbon black, fineness, strength and elongation. The results are shown in Table 1.

[0085] A false-twisted yarn, a covered elastic yarn, and tights were produced from the obtained Nylon 66 spun-dyed black yarn in the same manner as in Example 1, except that the heater temperature for the false-twisting was 190°C. The obtained false-twisted yarn was evaluated for its fineness, strength, elongation, degree of shrinkage in boiling water,

and crimp property, and the obtained Zokki tights were evaluated for their softness, color tone, and anti-pilling property. The results are shown in Table 1.

[Table 1]

		Unit	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Example 7	Example 8	Example 9	Example 10
CarbonBlack	Average particle diameter	**	3	3	3	8	15	3	3	3	3	3
	Content	wt*	3	1	5	3	3	3	3	3	3	3
Polyamide			Nylon6	Nylon6	Nylon6	Nylon6	Nylon6	Nylon6	Nylon6	Nylon6	Nylon6	Nylon66
Propertiesof fiber	Fineness	dtex	96	96	96	96	96	96	96	48	43	96
	Number of filaments		68	68	68	68	68	96	52	34	26	68
	Strength	cN/dtex	3	3.5	2.5	2.4	2	2.9	3.1	3.2	3	3.2
	Elongation	%	65.3	66.2	64.2	65.8	64.2	64.1	63	66.3	65.5	65.5
	Single filament fineness	dtex	1.4	1.4	1.4	1.4	1.4	1.0	1.8	1.4	1.7	1.4
	Dry heat shrinkage stress	CV%	2.2	1.9	2.4	2.5	3.1	2.2	2.2	2.2	2.1	2.0
	Spinnability		a	a	b	b	*	b	a	a	a	c
Properties of finished yarn	Fineness	dtex	78.1	78.3	78	77.9	78.1	78.2	78	41	35.1	78.1
	Strength	cN/dtex	3.4	4	3	3.1	2.4	3.5	3.6	3.7	3.3	3.3
	Elongation	%	39.3	40.2	35.2	38.4	36.1	35.2	39	37.5	42.2	41.2
	Single filament fineness	dtex	1.1	1.2	1.1	1.1	1.1	0.8	1.5	1.2	1.4	1.1
	Degree of shrinkagein boiling water	%	6.4	7.5	6	6.2	6.3	5.9	6.8	6.4	6.1	5.4
	Crimpproperty	%	6	6.5	5.8	6.1	6	5.8	6.3	6	6.5	8.2
Propertiesof tights	Softness		a	a	a	a	a	a	b	a	b	a
	Color tone		a	b	a	a	a	a	a	a	a	a

(continued)

		Unit	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Example 7	Example 8	Example 9	Example 10
	Anti-pilling property	Grade	N	N	L	N	L	L	N	N	N	N
	Notes											

[Comparative Example 1]

[0086] A Nylon 6 spun-dyed black yarn was produced in the same manner as in Example 1, except that the filtering was performed with a spin pack in which a 1 μm mesh metal filter was provided. The obtained spun-dyed black yarn was evaluated for its spinnability, carbon black content, average particle diameter of carbon black, fineness, strength, and elongation. The results are shown in Table 2.

[0087] A false-twisted yarn, a covered elastic yarn, and tights were produced from the obtained Nylon 6 spun-dyed black yarn in the same manner as in Example 1. The obtained false-twisted yarn was evaluated for its fineness, strength, elongation, degree of shrinkage in boiling water, and crimp property, and the obtained Zokki tights were evaluated for their softness, color tone, and anti-pilling property. The results are shown in Table 2.

[Comparative Example 2]

[0088] A Nylon 6 spun-dyed black yarn was produced in the same manner as in Example 1, except that the filtering was performed with a spin pack in which a 30 μm mesh metal filter was provided. The obtained spun-dyed black yarn was evaluated for its spinnability, carbon black content, average particle diameter of carbon black, fineness, strength, and elongation. The results are shown in Table 2.

[0089] A false-twisted yarn, a covered elastic yarn, and tights were produced from the obtained Nylon 6 spun-dyed black yarn in the same manner as in Example 1. The obtained false-twisted yarn was evaluated for its fineness, strength, elongation, degree of shrinkage in boiling water, and crimp property, and the obtained Zokki tights were evaluated for their softness, color tone, and anti-pilling property. The results are shown in Table 2.

[Comparative Example 3]

[0090] A Nylon 6 spun-dyed black yarn was produced in the same manner as in Example 1, except that the spinneret used was a 320-hole round spinneret, whereby a Nylon 6 spun-dyed black yarn of 96 dtex having 320 filaments was obtained. The obtained spun-dyed black yarn was evaluated for its spinnability, carbon black content, average particle diameter of carbon black, fineness, strength, and elongation. The results are shown in Table 2.

[0091] A false-twisted yarn, a covered elastic yarn, and tights were produced from the obtained Nylon 6 spun-dyed black yarn in the same manner as in Example 1. The obtained false-twisted yarn was evaluated for its fineness, strength, elongation, degree of shrinkage in boiling water, and crimp property, and the obtained Zokki tights were evaluated for their softness, color tone, and anti-pilling property. The results are shown in Table 2.

[Comparative Example 4]

[0092] A Nylon 6 spun-dyed black yarn was produced in the same manner as in Example 1, except that the spinneret used was a 20-hole round spinneret, whereby a Nylon 6 spun-dyed black yarn of 96 dtex having 20 filaments was obtained. The obtained spun-dyed black yarn was evaluated for its spinnability, carbon black content, average particle diameter of carbon black, fineness, strength, and elongation. The results are shown in Table 2.

[0093] A false-twisted yarn, a covered elastic yarn, and tights were produced from the obtained Nylon 6 spun-dyed black yarn in the same manner as in Example 1. The obtained false-twisted yarn was evaluated for its fineness, strength, elongation, degree of shrinkage in boiling water, and crimp property, and the obtained Zokki tights were evaluated for their softness, color tone, and anti-pilling property. The results are shown in Table 2.

[Comparative Example 5]

[0094] A Nylon 6 spun-dyed black yarn was produced in the same manner as in Example 1, except that the carbon-black-containing Nylon 6 master chips and the Nylon 6 chips were blended at a ratio of 3 : 97 (carbon black content in spun-dyed black yarn was 0.5% by mass). The obtained spun-dyed black yarn was evaluated for its spinnability, carbon black content, average particle diameter of carbon black, fineness, strength, and elongation. The results are shown in Table 2.

[0095] A false-twisted yarn, a covered elastic yarn, and tights were produced from the obtained Nylon 6 spun-dyed black yarn in the same manner as in Example 1. The obtained false-twisted yarn was evaluated for its fineness, strength, elongation, degree of shrinkage in boiling water, and crimp property, and the obtained Zokki tights were evaluated for their softness, color tone, and anti-pilling property. The results are shown in Table 2.

[Comparative Example 6]

[0096] A Nylon 6 spun-dyed black yarn was produced in the same manner as in Example 1, except that the carbon-black-containing Nylon 6 master chips and the Nylon 6 chips were blended at a ratio of 47 : 53 (carbon black content in spun-dyed black yarn was 7% by mass). The obtained spun-dyed black yarn was evaluated for its spinnability, carbon black content, average particle diameter of carbon black, fineness, strength, and elongation. The results are shown in Table 2.

[0097] A false-twisted yarn, a covered elastic yarn, and tights were produced from the obtained Nylon 6 spun-dyed black yarn in the same manner as in Example 1. The obtained false-twisted yarn was evaluated for its fineness, strength, elongation, degree of shrinkage in boiling water, and crimp property, and the obtained Zokki tights were evaluated for their softness, color tone, and anti-pilling property. The results are shown in Table 2.

[Comparative Example 7]

[0098] A Nylon 6 yarn was produced in the same manner as in Example 1, except that, as a polyamide, Nylon 6 chips having a relative viscosity in sulfuric acid (η_r) of 2.6 and a titanium oxide content of 0.02% by mass (carbon black content was 0% by mass) only were used. The obtained Nylon 6 yarn was evaluated for its spinnability, fineness, strength, and elongation. The results are shown in Table 2.

[0099] A false-twisted yarn and a covered elastic yarn were produced from the obtained Nylon 6 yarn in the same manner as in Example 1. Furthermore, Zokki tights were knitted in the same manner as in Example 1. The knitted Zokki tights were subjected to presetting in a vacuum at 80°C for 10 minutes, refined at 98°C for 30 minutes, dyed in the conditions of 4% by mass of Mitsui Nylon Black GL (available from Mitsui Toatsu Chemicals, Inc.), 98°C, and 60 minutes, softened, and thereafter heat-set with an aluminum plate foot pattern at 110°C for 30 seconds, whereby Zokki tights were obtained. The obtained false-twisted yarn was evaluated for its fineness, strength, elongation, degree of shrinkage in boiling water, and crimp property, and the obtained Zokki tights were evaluated for their softness, color tone, and anti-pilling property. The results are shown in Table 2.

[Table 2]

		Unit	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5	Comparative Example 6	Comparative Example 7
Carbon Black	Average particle diameter	μm	0.5	30	3	3	3	3	-
	Content	wt%	3	3	3	3	0.5	7	0
Polyamide			Nylon6	Nylon6	Nylon6	Nylon6	Nylon6	Nylon6	Nylon6
Properties of fiber	Fineness	dtex	96	96	96	96	96	96	96
	Number of filaments		68	68	320	20	68	68	68
	Strength	cN/dtex	3.2	1.5	2.5	2.9	4.2	0.9	4
	Elongation	%	65.1	62.1	58.1	64.5	65.5	67.2	65.4
	Single filament fineness	dtex	1.4	1.4	0.3	4.8	1.4	1.4	1.4
	Dry heat shrinkage stress	CV%	2.0	4.5	2.1	2.1	1.9	2.5	1.9
	Spinnability		a	e	e	a	a	e	a
Properties of finished yarn	Fineness	dtex	78.1	78.2	78.1	78	77.9	78	78.5
	Strength	cN/dtex	3.6	1.7	3	3.4	5	1.5	5.8
	Elongation	%	40	32	31.2	38	40.5	34.3	35.6
	Single filament fineness	dtex	1.1	1.2	0.2	3.9	1.1	1.1	1.2
	Degree of shrinkage in boiling water	%	6.5	6.8	6	6.5	7	6	7.5
	Crimp property	%	6.3	5.5	4.1	5.8	7.5	5.6	21.6

(continued)

		Unit	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5	Comparative Example 6	Comparative Example 7
Properties of tights	Softness		a	a	a	c	a	a	a
	Color tone		a	a	c	a	e	a	c
	Anit-pilling property		H	L	H	N	N	M	N
	Notes								Dye finishing

[0100] The results in Table 1 (Examples 1 to 10) show that, from the spun-dyed black polyamide yarn of the present invention, it is possible to obtain Zokki tights having a soft texture (softness), developing a dark black color (color tone) and having good durability (anti-pilling property) by optimizing the carbon black content, average particle diameter and single fiber fineness. The results show that, in Example 10, since Nylon 66 was used, the number of yarn breakages during spinning somewhat decreased as compared to Nylon 6. Because of this, when the yarn is formed into hosiery, there existed fluff of original yarn in the hosiery and the product quality somewhat decreased.

[0101] As for Comparative Example 1, the coefficient of dynamic friction on the surface of the tights was large because of the presence of carbon black having a small average particle diameter, and the tights had a poor anti-pilling property.

[0102] As for Comparative Example 2, because of the presence of carbon black having a large average particle diameter, the filtration pressure in the spin pack greatly increased, and not only the life of the pack decreased but also many yarn breakages occurred and the spinnability was poor. Furthermore, the obtained nylon spun-dyed black yarn had a strength as low as 1.5 cN/dtex, and the anti-pilling property was somewhat poor.

[0103] As for Comparative Example 3, the single fiber fineness was small, and not only many yarn breakages occurred and spinnability was poor, but also the anti-pilling property was poor.

[0104] As for Comparative Example 4, the single fiber fineness was large and the texture was hard, and the soft texture (softness) was poor.

[0105] Comparative Example 5 had a low carbon black content, and thus easily transmitted light and looked whitish and was poor in color tone (dark black color).

[0106] Comparative Example 6 had a high carbon black content, and thus the filtration pressure in the spin pack greatly increased, and not only the life of the pack decreased but also many yarn breakages occurred and spinnability was poor. Furthermore, the obtained nylon spun-dyed black yarn had a strength as low as 0.9 cN/dtex, and the anti-pilling property was somewhat poor.

[0107] Those obtained in Comparative Example 7 are conventional Zokki tights which are dyed in black. The Zokki thighs had a soft texture, but looked whitish because of irregular reflections of light and were poor in color tone (dark black color).

[0108] Zokki tights obtained from the spun-dyed black polyamide yarn of the present invention are not dyed in black. Therefore, not only the cost for the dyeing step can be eliminated and costs can be reduced, but also the load on the environment is reduced.

INDUSTRIAL APPLICABILITY

[0109] A spun-dyed black polyamide yarn of the present invention has a soft texture and is capable of developing a dark black color. A finished yarn obtained by false-twisting the spun-dyed black polyamide yarn, and a covered elastic yarn obtained by covering an elastic yarn with the spun-dyed black polyamide yarn, are suitably applicable to stockings and tights.

Claims

1. A spun-dyed black polyamide yarn comprising 1% to 5% by mass of carbon black, wherein the average particle diameter of the carbon black in a polyamide is 1 μm to 20 μm and the single fiber fineness of the spun-dyed black polyamide yarn is 0. 8 dtex to 2 dtex.

2. The spun-dyed black polyamide yarn according to claim 1, wherein the polyamide is Nylon 6.

3. The spun-dyed black polyamide yarn according to claim 1 or 2, wherein the CV of the dry heat shrinkage stress of the spun-dyed black polyamide yarn is 4.0% or less.

4. A false-twisted yarn obtained by false-twisting the spun-dyed black polyamide yarn recited in claims 1 to 3.

5. A covered elastic yarn comprising, as a covering yarn, the spun-dyed black polyamide yarn recited in claims 1 to 3 or the false-twisted yarn recited in claim 4.

6. Hosiery comprising, in at least part of a leg portion, at least one of the spun-dyed black polyamide yarn recited in claims 1 to 3, the false-twisted yarn recited in claim 4, and the covered elastic yarn recited in claim 5.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/056923

A. CLASSIFICATION OF SUBJECT MATTER
D01F6/90(2006.01)i, *D02G1/02*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D01F1/00-8/18, D02G1/00-1/20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2013
Kokai Jitsuyo Shinan Koho 1971-2013 Toroku Jitsuyo Shinan Koho 1994-2013

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	JP 2005-232609 A (Teijin Techno Products Ltd.), 02 September 2005 (02.09.2005), paragraphs [0012], [0013], [0020] (Family: none)	1,3-5
A	JP 2000-226730 A (Unitika Ltd.), 15 August 2000 (15.08.2000), entire text (Family: none)	1-6
A	JP 6-341016 A (Toray Industries, Inc.), 13 December 1994 (13.12.1994), entire text (Family: none)	1-6

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
26 April, 2013 (26.04.13)	14 May, 2013 (14.05.13)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/056923

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2005-9048 A (Toyobo Co., Ltd.), 13 January 2005 (13.01.2005), entire text & KR 10-2004-0041520 A & CN 1521291 A & IT TO20030890 A1	1-6
A	WO 2006/095621 A1 (Kuraray Co., Ltd.), 14 September 2006 (14.09.2006), entire text & JP 4659821 B & US 2009/0075018 A1 & EP 1857577 A1	1-6
A	JP 3-220313 A (Teijin Ltd.), 27 September 1991 (27.09.1991), entire text (Family: none)	1-6
A	JP 7-243127 A (Hoechst AG.), 19 September 1995 (19.09.1995), entire text & US 5662852 A & EP 662534 A1	1-6
A	JP 64-6119 A (Aderans Co., Ltd.), 10 January 1989 (10.01.1989), entire text (Family: none)	1-6

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- JP 2002146624 A **[0004]**