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(71) Applicant: **Kolon Industries, Inc.**
Seoul 07793 (KR)

(72) Inventors:
- **KIM, Seong-Young**
  Seoul 07793 (KR)
- **LEE, Young Soo**
  Seoul 07793 (KR)
- **PARK, Jung Eun**
  Seoul 07793 (KR)
- **LEE, Sinho**
  Seoul 07793 (KR)

(74) Representative: **Ter Meer Steinmeister & Partner Patentanwälte mbB**
Nymphenburger Straße 4
80335 München (DE)

(54) **DOPE-DYED POLYETHYLENE YARN AND FUNCTIONAL FABRIC INCLUDING SAME**

(57) The present invention relates to a dope dyed polyethylene yarn and a functional fabric including the same, and more particularly, to a dope dyed polyethylene yarn having excellent color uniformity and a functional fabric including the same.

A dope dyed polyethylene yarn according to the present invention contains a pigment, wherein L*, a* and b* measured under the following measurement condition satisfy the following expression:

[Measurement condition]

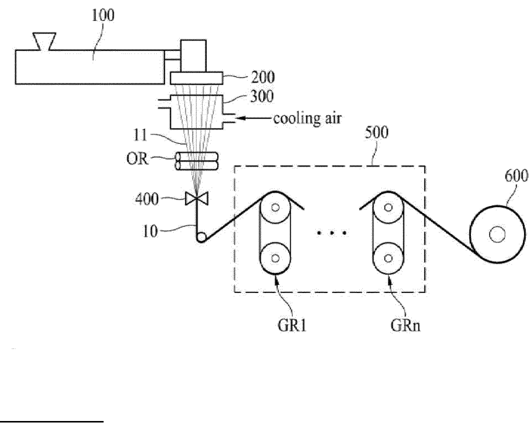
a measurement region is formed by winding the dope dyed polyethylene yarn around a planar substrate, computer color matching (CCM) is measured in the measurement region, and the CCM is measured at least n times (n is a natural number of 50 or more) every time the dope dyed polyethylene yarn is wound around the substrate 70 turns,

[Expression]

$$(C_{max} - C_{min})/C_{aver} \times 100 \leq 15$$

wherein C_{max}, C_{min}, and C_{aver} represent maximum, minimum, and average values of any one selected from L*, a*, and b*, respectively.

【FIG. 1】



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Description

[Technical Field]

[0001] The following disclosure relates to a dope dyed polyethylene yarn and a functional fabric including the same, and more particularly, to a dope dyed polyethylene yarn having excellent color uniformity and a functional fabric including the same.

[Background Art]

[0002] A high-density polyethylene (HDPE) yarn refers to a high-strength polyethylene yarn having a density of 0.94 g/cm^3 or more. The high-density polyethylene yarn has been used in various materials for sports ropes, fishing lines, protective clothes, bulletproof clothes, stab proof clothes, and the like requiring a high strength, and also has been applied to various composite materials requiring an ultrahigh strength.

[0003] In addition, the high-density polyethylene yarn has a high thermal conductivity by lattice vibration called phonon, and has excellent lightness because it has a specific gravity of about 0.93 and is light enough to float on water.

[0004] Therefore, the high-density polyethylene yarn has been widely used for summer clothes, work clothes, sportswear, and the like requiring a cooling sensation, as well as the textile products requiring a high strength, such as sports ropes, fishing lines, protective clothes, bulletproof clothes, and stab proof clothes.

[0005] However, the high-density polyethylene yarn is known as a flame retardant fiber because it is nearly impossible to dye even using any dye in a dyeing system due to its hydrophobicity caused by high crystallinity.

[0006] Two kinds of coloring methods are currently used to dye the high-density polyethylene yarn. One is a dope dyeing method in which spinning is performed by adding a pigment, and the other one is a polymer blend method in which different dyeable polymers are mixed.

[0007] However, a dope dyed polyethylene yarn manufactured by the polymer blend method has a disadvantage in that it is difficult to maintain the specific physical properties of the high-density polyethylene yarn, such as a high thermal conductivity and lightness, because the polymers having different physical properties are mixed in addition to polyethylene.

[0008] Therefore, as disclosed in Korean Patent No. 10-1992444 "Method of Manufacturing Dope Dyed Polyethylene Multi-Filament False-Twist Yarn", a dope dyed polyethylene yarn manufactured by a dope dyeing method of melt spinning a masterbatch chip to which a pigment is added has been used in the related art.

[0009] However, in the dope dyed polyethylene yarn according to the related art, it is difficult for the pigment to be uniformly mixed with polyethylene having a relatively high viscosity, and color unevenness of the yarn due to the non-uniformity of mixing between the pigment and the polyethylene raw material is serious. Therefore, the quality is degraded due to the non-uniformity of the dope dyed yarn itself, and physical properties of the yarn such as a strength are deteriorated as a large amount of pigment is added in order to express a desired color. Furthermore, the quality of the final product manufactured using the yarn is also degraded.

[DETAILED DESCRIPTION OF THE INVENTION]

[Technical Problem]

[0010] An embodiment of the present invention is directed to providing a dope dyed polyethylene yarn having excellent color uniformity and a functional fabric including the same.

[Technical Solution]

[0011] In one general aspect, a dope dyed polyethylene yarn contains a pigment, wherein L*, a* and b* measured under the following measurement condition satisfy the following expression:

[Measurement condition]

[0012] a measurement region is formed by winding the dope dyed polyethylene yarn around a planar substrate, computer color matching (CCM) is measured in the measurement region, and the CCM is measured at least n times (n is a natural number of 50 or more) every time the dope dyed polyethylene yarn is wound around the substrate 70 turns,

[Expression]

$$(C_{max} - C_{min})/C_{aver} \times 100 \leq 15$$

wherein C_{max}, C_{min}, and C_{aver} represent maximum, minimum, and average values of any one selected from L*, a*, and b*, respectively.

[0013] In the dyed polyethylene yarn according to an embodiment of the present invention, when the CCM of the dope dyed polyethylene yarn is measured, a standard deviation of values of L* may be 3 or less.

[0014] In the dope-dyed polyethylene yarn according to an embodiment of the present invention, the pigment may be contained in an amount of 0.00005 to 1 wt% with respect to a total weight of the dope dyed polyethylene yarn.

[0015] In the dyed polyethylene yarn according to an embodiment of the present invention, a degree of crystallinity of the dope dyed polyethylene yarn may be 60 to 80%.

[0016] In the dyed polyethylene yarn according to an embodiment of the present invention, the dope dyed polyethylene yarn may have an initial modulus of 10 to 300 cN/dtex and a strength of 1.5 to 20 g/d when measured according to ASTM D2256.

[0017] In the dope-dyed polyethylene yarn according to an embodiment of the present invention, the dope dyed polyethylene yarn may have a melt index (MI, @190°C) of 0.5 to 22 g/10 min when measured according to ASTM D1238.

[0018] In the dyed polyethylene yarn according to an embodiment of the present invention, the dope dyed polyethylene yarn may have a dry heat shrinkage rate (@100°C) of 2 to 15% when measured according to ASTM D4974-04.

[0019] A functional fabric according to the present invention is manufactured using the dope dyed polyethylene yarn.

[0020] In the functional fabric according to an embodiment of the present invention, the functional fabric may have a contact cooling sensation of 0.1 to 0.3 W/cm^2 when measured by bringing a heat plate (T-box) at 30 ± 2°C into contact with the functional fabric at 20 ± 2°C at 20 ± 2°C and 65 ± 2% R.H.

according to an embodiment of the present invention, the functional fabric may have a thermal conductivity in a thickness direction of 0.05 to 0.25 W/mK when measured by bringing a heat source plate (BT-box) at 30 ± 2°C into contact with the functional fabric at 20 ± 2°C at 20 ± 2°C and 65 ± 2% R.H.

[Advantageous Effects]

[0021] As set forth above, the polyethylene yarn according to the present invention has excellent color uniformity, such that coloring characteristics may be excellent compared to the amount of pigment added.

[0022] Further, the polyethylene yarn according to the present invention may maintain the inherent excellent thermal conductivity of high-density polyethylene in spite of addition of a pigment, such that a fabric having an excellent cooling sensation may be manufactured.

[0023] Further, the functional fabric according to the present invention includes a polyethylene yarn having excellent color uniformity and an excellent thermal conductivity, such that the functional fabric may have excellent coloring characteristics and color uniformity and may have a cooling sensation.

[Brief Description of Drawings]

[0024]

FIG. 1 is a schematic view illustrating a process of manufacturing a yarn according to an exemplary embodiment of the present invention.

FIG. 2 is a photograph of an apparatus for measuring computer color matching (CCM) of a functional fabric according to an exemplary embodiment of the present invention.

FIG. 3 is a schematic view illustrating an apparatus for measuring a contact cooling sensation of the functional fabric according to an exemplary embodiment of the present invention.

FIG. 4 is a schematic view illustrating an apparatus for measuring a thermal conductivity in a thickness direction of the functional fabric according to an exemplary embodiment of the present invention.

FIG. 5 illustrates a result of measuring the CCM of the yarn according to an exemplary embodiment of the present invention.

[DETAILED DESCRIPTION OF EMBODIMENTS]

[0025] Unless otherwise defined, all the technical terms and scientific terms used in the present specification have the same meanings as commonly understood by those skilled in the art to which the present invention pertains. The description for the known function and configuration unnecessarily obscuring the gist of the present invention will be omitted in the following description and the accompanying drawings.

[0026] In addition, unless the context clearly indicates otherwise, the singular forms used in the present specification may be intended to include the plural forms.

[0027] In addition, units used in the present specification without special mention are based on weight, and as an example, a unit of % or a ratio refers to wt% or a weight ratio. Unless otherwise defined, wt% refers to wt% of any one component in a composition with respect to the total weight of the composition.

[0028] In addition, a numerical range used in the present specification includes upper and lower limits and all values within these limits, increments logically derived from a form and span of a defined range, all double limited values, and all possible combinations of the upper and lower limits in the numerical range defined in different forms. Unless otherwise particularly defined in the present specification, all values out of the numerical range that may occur due to the rounding off of the experimental errors or values also fall within the defined numerical ranges.

[0029] In the present specification, the expression "comprise(s)" is intended to be an open-ended transitional phrase having an equivalent meaning to "include(s)," "contain(s)," "have (has)," and "is (are) characterized by," and does not exclude elements, materials, or steps, all of which are not further recited herein.

[0030] In a dope dyed polyethylene yarn according to the related art, it is difficult for a pigment to be uniformly mixed with polyethylene having a relatively high viscosity, and color unevenness of the yarn due to non-uniformity of mixing between the pigment and the polyethylene raw material is serious. Therefore, the quality is degraded due to the non-uniformity of the dope dyed yarn itself, and physical properties of the yarn such as a strength are deteriorated as a large amount of pigment is added in order to express a desired color. Furthermore, the quality of the final product manufactured using the yarn is also degraded.

[0031] Therefore, the present applicant has conducted intensive studies for a long period of time to develop a polyethylene fiber having excellent color uniformity while maintaining physical properties thereof. As a result, the present applicant has developed a novel dope dyed polyethylene yarn having excellent color uniformity by increasing a mixing degree between the pigment and the raw material of the polyethylene yarn.

[0032] Specifically, the dope dyed polyethylene yarn according to the present invention is a dope dyed polyethylene yarn containing a pigment, wherein L*, a* and b* measured under the following measurement condition satisfy the following expression:

[Measurement condition]

[0033] a measurement region is formed by winding the dope dyed polyethylene yarn around a planar substrate, computer color matching (CCM) is measured in the measurement region, and the CCM is measured at least n times (n is a natural number of 50 or more) every time the dope dyed polyethylene yarn is wound around the substrate 70 turns,

[Expression]

$$(C_{max} - C_{min})/C_{aver} \times 100 \leq 15$$

wherein C_{max}, C_{min}, and C_{aver} represent maximum, minimum, and average values of any one selected from L*, a*, and b*, respectively.

[0034] Specifically, in the expression, $(C_{max} - C_{min})/C_{aver} \times 100$ may be 0.1 to 8 and more specifically 3 to 7. The dope dyed polyethylene yarn has excellent color uniformity, such that coloring characteristics may be excellent compared to the amount of pigment added. In addition, although a small amount of pigment is added, the dope dyed polyethylene yarn has excellent coloring characteristics, such that the dope dyed polyethylene yarn may maintain the inherent excellent thermal conductivity of high-density polyethylene, thereby manufacturing a fabric having an excellent cooling sensation.

[0035] Specifically, a region covered with the dope dyed polyethylene yarn, that is, a measurement region, is formed on the substrate, as the dope dyed polyethylene yarn is wound around the planar substrate.

[0036] In this case, the dope dyed polyethylene yarn wound n-1 (n is a natural number of 2 or more) turns and the dope dyed polyethylene yarn wound n turns may be in contact with each other so that they are wound around a perimeter of the substrate in one direction of the substrate.

[0037] Since the measurement region is formed by covering the substrate with the dope dyed polyethylene yarn, the measurement region exhibits a color similar to when the dope dyed polyethylene yarn is made into a fabric. The measurement region is not limited as long as it has an area in which the CCM may be measured. However, the area occupied by the measurement region on the substrate may be appropriately adjusted according to a size of the substrate, and a thickness and the number of turns of winding of the dope dyed polyethylene yarn. As a non-limiting example, a measurement region may be formed by winding a dope dyed polyethylene yarn having a thickness of 410 De around a square planar substrate having a width of 6.5 cm, a length of 6.5 cm, and a height of 0.5 cm, 30 turns or more, specifically, 40 to 100 turns, and more specifically, 50 to 90 turns.

[0038] In the measurement region formed by the method described above, when the n-1th (n is a natural number of 2 or more) CCM is measured and then the nth CCM is measured, a measurement region for measuring the nth CCM may be formed on a measurement region formed for measuring the n-1th CCM.

[0039] Hereinafter, it is assumed that the previously formed measurement region is a first measurement region, and the subsequently formed measurement is a second measurement region.

[0040] CCM is measured in the first measurement region formed by winding the dope dyed polyethylene yarn around the substrate 70 turns in one direction of the substrate, and then, CCM is measured in the second measurement region formed by winding the dope dyed polyethylene yarn around the first measurement region again. That is, the second measurement region is formed by winding the dope dyed polyethylene yarn to cover the first measurement region while a winding direction of the dope dyed polyethylene yarn is changed to a direction opposite to the one direction of the substrate.

[0041] Therefore, the first measurement region in which the n-1th CCM is measured and the second measurement region in which the nth CCM is measured have the same size, and when the second measurement region is formed on the first measurement region, a thickness of the measurement region formed on the substrate is increased by the thickness of the dope dyed polyethylene yarn. In the first measurement region and the second measurement region, the CCMs may be measured at the same position.

[0042] L*, a* and b* of the CCM measured in the measurement region may satisfy the expression described above.

[0043] Specifically, the pigment may be contained in an amount of 0.0001 to 0.5 wt%, specifically, 0.002 to 0.05 wt%, and more specifically, 0.01 to 0.03 wt%, with respect to the total weight of the dope dyed polyethylene yarn, but the present invention is not limited thereto. However, within the above range, the dope dyed polyethylene yarn may have excellent coloring characteristics and color uniformity compared to the amount of pigment added.

[0044] In this case, when the CCM of the yarn is measured, a standard deviation of values of L* is 3 or less, specifically, 2 or less, and more specifically, 1.5 or less. Thus, the dope dyed polyethylene yarn may have significantly excellent color uniformity that is not easily distinguishable with the naked eye.

[0045] In the present invention, the pigment is not limited as long as it is a pigment or a raw material used in dope dyeing of polyethylene according to the related art. As a specific example, in a case of a black polyethylene yarn, the pigment may be carbon black particles.

[0046] An initial modulus of the dope dyed polyethylene yarn may be 10 to 300 cN/dtex and specifically50 to 300 cN/dtex, and more specifically 70 to 150 cN/dtex when measured according to ASTM D2256. In this case, a strength of the dope dyed polyethylene yarn may be, but is not limited to, 1.5 to 20 g/d, specifically 4 to 20 g/d and more specifically 10 to 15 g/d when measured according to ASTM D2256. However, within the above ranges, the dope dyed polyethylene yarn may have a high thermal conductivity and a stiffness suitable for weavability.

[0047] In addition, a polydispersity index of the dope dyed polyethylene yarn may be 5 to 20 and specifically 7 to 15, and in this case, a weight average molecular weight of the dope dyed polyethylene yarn may be 45,000 to 300,000 g/mol and preferably 100,000 to 200,000 g/mol. Within the above ranges, when the yarn is melt-extruded, flowability of a melt is preferable, occurrence of thermal decomposition is prevented, and processability such as no yarn breakage during drawing is secured, such that a fabric having uniform physical properties may be manufactured and a fabric having excellent durability may be provided.

[0048] In addition, a melt index (MI, @190°C) of the dope dyed polyethylene yarn may be 0.5 to 22 g/10 min, specifically, 1 to 10 g/10 min, and more specifically, 2 to 8 g/10 min, when measured at 190°C and 2.16 kg according to ASTM D1238. In addition, a density of the dope dyed polyethylene yarn may be 0.93 to 0.97 g/cm^3. In addition, a degree of crystallinity of the dope dyed polyethylene yarn after spinning may be 60 to 80% and specifically 65 to 75%. The degree of crystallinity of the polyethylene yarn may be derived together with a crystallite size at the time of crystallinity analysis using an X-ray diffractometer. As described above, when the melt index, the density, and the degree of crystallinity are within the above ranges, heat is rapidly diffused and dissipated by lattice vibration called phonon in a direction of molecular chains linked via a covalent bond of high-density polyethylene (HDPE), and a function of discharging moisture generated by sweating or breathing is improved, such that a fabric having an excellent cooling sensation may be provided.

[0049] In addition, the dope dyed polyethylene yarn has a significantly low dry heat shrinkage rate (@100°C) of 2 to 15% and specifically 2.7 to 5% when measured according to ASTM D4974-04, such that the dope dyed polyethylene yarn may have excellent shape stability.

[0050] The dope dyed polyethylene yarn of the present invention may be manufactured by a dope dyeing method.

[0051] Specifically, the dope dyed polyethylene yarn may be formed of a polyethylene resin composition containing a color masterbatch, the color masterbatch being prepared by: mixing a pigment with polyethylene in the form of a chip and performing drying to prepare a first master chip; and repeating a process of melting and re-mixing the first master chip and performing drying n times (n is a natural number of 1 or more) to prepare the nth master chip. In this case, n may be, but is not limited to, 2 to 5 and specifically 2 or 3. The polyethylene resin composition containing the color masterbatch prepared as described above is prepared, such that the dope dyed polyethylene yarn may have more excellent color uniformity.

[0052] A content of the pigment in the color masterbatch may be variously adjusted, and the pigment may be contained in an amount of 0.05 to 10.0 wt% and specifically 0.1 to 5 wt% with respect to the total weight of the color masterbatch. Within the above range, the dope dyed polyethylene yarn may have excellent coloring characteristics in spite of a lower content of the pigment compared to a color masterbatch according to the related art.

[0053] In addition, in the polyethylene resin composition containing the color masterbatch, the color masterbatch may be appropriately mixed according to a content ratio of the pigment in the yarn described above. Specifically, the color masterbatch may be contained in an amount of 0.1 to 10 wt% with respect to the total weight of the polyethylene resin composition.

[0054] The dope dyed polyethylene yarn manufactured by the dope dyeing method may have significantly excellent color uniformity as described above, such that a high-quality fabric may be provided.

[0055] Hereinafter, a method of manufacturing a dope dyed polyethylene yarn according to an exemplary embodiment of the present invention will be described in detail with reference to FIG. 1.

[0056] First, a first master chip is obtained by mixing a pigment with polyethylene in the form of a chip, and then, the dried first master chip is melted again and re-mixed to obtain a second master chip. Thereafter, a dope dyed polyethylene melt is obtained by injecting the prepared second master chip and polyethylene in the form of a chip into an extruder 100 and melting them.

[0057] The molten polyethylene is transported through a die 200 by a screw (not illustrated) in the extruder 100, and the transported polyethylene is extruded through a plurality of holes formed in the die 200. The number of holes of the die 200 may be determined according to a denier per filament (DPF) and a fineness of a yarn to be manufactured. For example, when a yarn having a total fineness of 75 denier is manufactured, the die 200 may have 20 to 75 holes, and when a yarn having a total fineness of 450 denier is manufactured, the die 200 may have 90 to 450 holes and preferably 100 to 400 holes.

[0058] The melting process performed in the extruder 100 and the extrusion process performed in the die 200 may be changed and applied depending on a melt index of the polyethylene chip. Specifically, the melting process and the extrusion process are performed, for example, at 150 to 315°C, preferably 250 to 315°C, and still preferably 265 to 310°C. That is, the extruder 100 and the die 200 are maintained at 150 to 315°C, preferably 250 to 315°C, and more preferably 265 to 310°C.

[0059] When a spinning temperature is lower than 150°C, the polyethylene is not uniformly melted due to a low spinning temperature, resulting in difficulty in spinning. On the other hand, when the spinning temperature is higher than 315°C, a desired strength may not be exhibited due to thermal decomposition of the polyethylene.

[0060] LID that is a ratio of a hole length L to a hole diameter D of the die 200 may be 3 to 40. When LID is less than 3, a die swell phenomenon may occur during melt extrusion, and an elastic behavior of the polyethylene is not easily controlled, resulting in poor spinnability. When LID exceeds 40, a yarn breakage may occur due to a necking phenomenon of the molten polyethylene passing through the die 200, and discharge unevenness may occur due to a decrease in pressure.

[0061] The polyethylene is solidified by a difference between the spinning temperature and room temperature while the molten polyethylene is discharged through the holes of the die 200 to form semi-solidified filaments 11. In the present specification, both the semi-solidified filaments and fully solidified filaments are collectively referred to as "filaments".

[0062] A plurality of filaments 11 are cooled in a cooling zone (or a quenching zone) 300 to be fully solidified. The cooling of the filaments 11 may be performed by an air cooling method.

[0063] In addition, multi-stage cooling is performed at the time of the cooling in the cooling zone, such that more uniform crystallization may be obtained. Therefore, a yarn that further smoothly discharges moisture and sweat and has an excellent cooling sensation may be manufactured.

[0064] Subsequently, the cooled and fully solidified filaments 11 may be interlaced by an interlacer 400 to form a multi-filament 10.

[0065] As illustrated in FIG. 1, the polyethylene yarn of the present invention may be manufactured by a direct spinning drawing (DSD) process. That is, the multi-filament 10 may be directly transferred to a multi-stage drawing unit 500 including a plurality of godet rollers GR1 to GRn, the transferred multi-filament 10 may be subjected to multi-stage drawing at a total draw ratio of 2 to 20 and preferably 3 to 15, and then, the drawn multi-filament 10 may be wound around a winder 600. In addition, shrinkage drawing (relaxation) of 1 to 5% is applied in the final drawing section at the time of the multi-stage drawing, such that a yarn having more excellent durability may be provided.

[0066] Alternatively, the polyethylene yarn of the present invention may be manufactured by winding the multi-filament 10 as an undrawn yarn and then drawing the undrawn yarn. That is, the polyethylene yarn of the present invention may be manufactured through a two-stage process of melt-spinning polyethylene to manufacture an undrawn yarn and then drawing the undrawn yarn.

[0067] A functional fabric according to the present invention includes the dope dyed polyethylene yarn. Since the functional fabric includes the dope dyed polyethylene yarn having excellent color uniformity and an excellent thermal conductivity, such that the functional fabric may have excellent coloring characteristics and color uniformity and may have a cooling sensation.

[0068] The functional fabric according to the present invention may be manufactured using the dope dyed polyethylene yarn described above alone, and may further include a yarn different from the dope dyed polyethylene yarn in order to further impart another functionality. It is preferable that the polyethylene yarn is used alone in terms of having both excellent cooling sensation and color uniformity.

[0069] Specifically, the functional fabric may have a contact cooling sensation of 0.1 to 0.3 W/cm^2 when measured by bringing a heat plate (T-box) heated to 30 $\pm$ 2°C into contact with the functional fabric at 20 $\pm$ 2°C at 20 $\pm$ 2°C and 65 $\pm$ 2% R.H, and may have a thermal conductivity in a thickness direction of 0.05 to 0.25 W/mK when measured by bringing a heat source plate (BT-box) heated to 30 $\pm$ 2°C into contact with the functional fabric at 20 $\pm$ 2°C at 20 $\pm$ 2°C and 65 $\pm$ 2% R.H. More specifically, the contact cooling sensation may be 0.15 to 0.22 W/cm^2, and the thermal conductivity may be 0.08 to 0.2 W/mK. The functional fabric having a cooling sensation may provide an appropriate cooling sensation for a user to feel comfortable in a high temperature environment when it is worn by the user after being manufactured or processed into a product later.

[0070] The fabric may be processed into a product having a cooling sensation requiring an appropriate cooling sensation. The product may be any textile product according to the related art, and may be preferably summer clothes, sportswear, masks, and work clothes to impart a cooling sensation to a human body.

[0071] Hereinafter, the present invention will be described in more detail with reference to Examples. However, the following Examples are only reference examples for describing the present invention in detail, and the present invention is not limited thereto and may be implemented in various forms.

[0072] Unless otherwise defined, all technical terms and scientific terms used herein have the same meanings as commonly understood by those skilled in the art to which the present invention pertains. The terms used for the description herein are only for effectively describing a certain Example rather than limiting the present invention. In addition, unless otherwise stated in the specification, a unit of an additive may be wt%.

[0073] Physical properties were measured as follows.

[Measurement of physical properties of yarn]

<1. Measurement of computer color matching (CCM)>

[0074] As illustrated in FIG. 2, a measurement region was formed by winding a dope dyed polyethylene yarn around a substrate having a width of 6.5 cm, a length of 6.5 cm, and a height of 0.5 cm, computer color matching (CCM) was measured in the measurement region, and the CCM was measured every time the dope dyed polyethylene yarn was wound around the substrate 70 turns ($\pm$ 10). The total number of times of measurement of CCM was 135.

[0075] The CCM was measured by a colorimeter (KAE1-063, GNB TECH), and L*, a*, and b* values and a value of the following expression were calculated.

[Expression]

$$(C_{max} - C_{min})/C_{aver} \times 100$$

wherein C_{max}, C_{min}, and C_{aver} represent maximum, minimum, and average values of any one selected from L*, a*, and b*, respectively.

<2. Weight average molecular weight (Mw) (g/mol) and polydispersity index (PDI)>

[0076] A polyethylene yarn was completely dissolved in the following solvent, and then, a weight average molecular weight (Mw) and a polydispersity index (Mw/Mn: PDI) of the polyethylene yarn were calculated using gel permeation chromatography (GPC).

- Analyzer: HLC-8321 GPC/HT, Tosoh Corporation
- Column: PLgel guard (7.5 $\times$ 50 mm) + 2 $\times$ PLgel mixed-B (7.5 $\times$ 300 mm)
- Column temperature: 160°C
- Solvent: trichlorobenzene (TCB) + 0.04 wt% dibutylhydroxytoluene (BHT) (after drying with 0.1% $CaCl_2$)
- Injector and detector temperature: 160°C
- Detector: RI detector

- Flow rate: 1.0 ml/min
- Injection amount: 300 μL
- Sample concentration: 1.5 mg/mL
- Standard sample: polystyrene

<3. Strength (g/d) and initial modulus (g/d)>

[0077] A stress-strain curve of the polyethylene yarn was obtained using a universal tensile tester (Instron Engineering Corp., Canton, Mass) according to the ASTM D2256 method. A sample length was 250 mm, a tensile speed was 300 mm/min, and an initial load was set to 0.05 g/d. A strength (g/d) was calculated from a stress and an elongation at a breaking point, and an initial modulus (g/d) was calculated from a tangent line providing a maximum gradient on the curve in the vicinity of the origin point. The measurement was performed 5 times for each yarn, and an average of the values was calculated.

<4. Degree of crystallinity>

[0078] A degree of crystallinity of the polyethylene yarn was measured using an X-ray diffractometer (XRD) [manufacturer: Malvern Panalytical, model name: EMPYREAN]. Specifically, the polyethylene yarn was cut to prepare a sample having a length of 2.5 cm, the sample was fixed to a sample holder, and the measurement was performed under the following conditions.

- Light source (X-ray source): Cu-Kα radiation
- Power: 45 kV × 25 mA
- Mode: continuous scan mode
- Scan angle range: 10 to 40°
- Scan speed: 0.1°/sec

<5. Strength at break (kgf) and elongation at break (%)>

[0079] A strength at break of the yarn sample was measured by applying a tensile speed of 300 mm/min to a sample having a size of 250 mm using an Instron tester (Instron Engineering Corp., Canton, Mass) according to the ASTM D-885 test method.

<6. Dry heat shrinkage rate>

[0080] According to the ASTM D4974-04 method, each of an initial length (L1) of the sample in a state in which a load of 0.2 gld was applied and a length (L2) of the sample after 2 minutes in a state in which a load of 0.2 g/d was applied at 100°C was measured using a dry heat shrinkage rate measuring apparatus (manufacturer: TESTRITE, model name: MK-V), and a dry heat shrinkage rate (%) of the yarn was calculated by the following Expression 2:

[Expression 2]

$$\text{Dry heat shrinkage rate (\%)} = [(L1 - L2)/L1] \times 100.$$

<7. Melt index>

[0081] A melt index (MI, @190°C) was measured at 190°C and 2.16 kg according to ASTM D1238.

[Measurement of physical properties of fabric]

<1. Contact cooling sensation>

[0082] Upon request, Korea Apparel Testing & Research Institute (KATRI) measured a contact cooling sensation in a test environment of 20 ± 2°C and 65 ± 2% R.H using KES-F7 (Thermo Labo II) apparatus.

[0083] Specifically, a fabric sample having a size of 20 cm × 20 cm was prepared, and the fabric sample was left under conditions of a temperature of 20 ± 2°C and RH of 65 ± 2% for 24 hours. Subsequently, a contact cooling sensation (Q max) of the fabric was measured in a test environment of a temperature of 20 ± 2°C and RH of 65 ± 2%

using KES-F7 THERMO LABO II (Kato Tech Co., Ltd.) apparatus. Specifically, as illustrated in FIG. 3, a fabric sample 23 was placed onto a base plate (also referred to as "Water-Box") 21 maintained at 20°C ± 2°C, and a heat plate (T-Box) 22a (contact area: 3 cm × 3 cm) heated to 30°C ± 2°C was placed onto the fabric sample 23 for only 1 second. That is, one surface of the fabric sample 23 having the other surface in contact with the base plate 21 was instantaneously brought into contact with the T-Box 22a. The contact pressure applied to the fabric sample 23 by the T-box 22a was 6 gf/cm^2. Subsequently, a Q max value displayed on a monitor (not illustrated) connected to the apparatus was recorded. Such a test was repeated 10 times, and an arithmetic mean of the Q max values was calculated.

<2. Thermal conductivity>

[0084] A fabric sample having a size of 20 cm × 20 cm was prepared, and the fabric sample was left under conditions of a temperature of 20 ± 2°C and RH of 65 ± 2% for 24 hours. Subsequently, a thermal conductivity and a heat transfer coefficient of the fabric were measured in a test environment of a temperature of 20 ± 2°C and RH of 65 ± 2% using KES-F7 THERMO LABO II (Kato Tech Co., Ltd.) apparatus. Specifically, as illustrated in FIG. 4, the fabric sample 23 was placed onto the base plate 21 maintained at 20°C ± 2°C, and a heat source plate (BT-Box) 22b (contact area: 5 cm × 5 cm) at 30°C ± 2°C was placed onto the fabric sample 23 for 1 minute. Heat was continuously supplied to the BT-Box 22b so that the temperature of the BT-Box 22b was maintained at 30°C ± 2°C even while the BT-Box 22b was in contact with the fabric sample 23. The quantity of heat (that is, a heat flow loss) supplied to maintain the temperature of the BT-Box 22b was displayed on a monitor (not illustrated) connected to the apparatus. Such a test was repeated 5 times, and an arithmetic mean of the heat flow loss values was calculated. Subsequently, a thermal conductivity and a heat transfer coefficient of the fabric were calculated using the following Expressions 3 and 4:

[Expression 3]

$$K = (W \cdot D)/(A \cdot \Delta T)$$

[Expression 4]

$$k = K/D$$

wherein K is the thermal conductivity (W/cm·°C), D is a thickness (cm) of the fabric sample 23, A is the contact area (= 25 cm^2) of the BT-Box 22b, ΔT is a temperature difference (= 10°C) between the both surfaces of the fabric sample 23, W is the heat flow loss (Watt), and k is the heat transfer coefficient (W/cm^2·°C).

[Example 1]

<Preparation of color masterbatch>

[0085] A first master chip was obtained by mixing a pigment with polyethylene in the form of a chip, and then, the dried first master chip was melted and mixed again to obtain a second master chip, that is, a color masterbatch. In this case, the pigment was mixed in an amount of 0.83 wt% with respect to the total weight of the color masterbatch.

<Manufacturing of polyethylene yarn>

[0086] A dope dyed polyethylene yarn having a total fineness of 410 denier was manufactured.

[0087] Specifically, a polyethylene chip having a weight average molecular weight (Mw) of 154,604 g/mol and the second master chip were injected into an extruder to melt them, thereby forming a melt. In this case, the second master chip was mixed in an amount of 3 wt% with respect to the total weight of the melt. The melt was extruded through a die having 200 holes. LID that was a ratio of a length L to a hole diameter D of the die was 6. The die temperature was 270°C.

[0088] Filaments formed while being discharged through nozzle holes of the die were cooled, interlaced, and then drawn. Subsequently, the drawn multi-filament was wound around a winder. The winding tension was 0.8 g/d.

[0089] The physical properties of the manufactured yarn were measured. The calculated value of $(C_{max} - C_{min})/C_{aver} \times 100$ is shown in Table 1 as a ΔC value.

<Manufacturing of functional fabric>

[0090] The manufactured dope dyed polyethylene yarn was weaved to manufacture a functional fabric having an area density of 500 g/m^2. The physical properties of the manufactured functional fabric were measured. The results are shown in Table 2.

[Example 2]

[0091] A yarn and a fabric were manufactured in the same manner as that of Example 1, except that the content of the pigment in the color masterbatch was changed from 0.83 wt% to 0.40 wt% and the content of the color masterbatch in the melt was changed from 3 wt% to 3.3 wt% in Example 1. In addition, the measured physical properties of the yarn and the fabric manufactured in the same manner as that of Example 1 are shown in Tables 1 and 2, respectively.

[Example 3]

[0092] A yarn and a fabric were manufactured in the same manner as that of Example 1, except that the content of the pigment in the color masterbatch was changed from 0.83 wt% to 0.40 wt% and the content of the color masterbatch in the melt was changed from 3 wt% to 3.8 wt% in Example 1. In addition, the measured physical properties of the yarn and the fabric manufactured in the same manner as that of Example 1 are shown in Tables 1 and 2, respectively.

[Comparative Example 1]

[0093] A yarn and a fabric were manufactured in the same manner as that of Example 1, except that a pigment was mixed with polyethylene in the form of a chip having a weight average molecular weight (Mw) of 134,277 glmol to obtain a first master chip, the dried first master chip was used as a color masterbatch, the content in the pigment in the color masterbatch was changed to 10.0 wt%, and the content of the color masterbatch in the melt was changed from 3 wt% to 0.25 wt% in Example 1. In addition, the measured physical properties of the yarn and the fabric manufactured in the same manner as that of Example 1 are shown in Tables 1 and 2, respectively.

Table 1

Classification			Example 1	Example 2	Example 3	Comparativ e Example 1
Physical properties of polyethylene yarn	CCM	L* average (C_{aver})	67.91	66.82	68.95	63.18
		L* minimum (C_{min})	65.30	65.90	67.18	58.17
		L* maximum (C_{max})	71.63	39.33	70.63	69.67
		ΔC	9.32	5.13	5.00	18.20
		L* standard deviation	1.26	0.83	0.66	3.23
	PDI		7.7	8.1	7.2	7.5
	Mw (g/mol)		137,267	139,768	146,822	134,277
	Degree of crystallinity (%)		75.1	75.6	74.2	65.2
	Strength (g/d)		12.5	13.1	13.4	7.64
	Initial modulus (g/d)		140.2	147.7	153.5	111
	Strength at break (kgf)		5.13	5.37	5.49	3.1
	Elongation at break (%)		8.2	7.8	7.0	13.8
	Melt index (g/10 min)		5.4	7.3	7.4	11.9

[Table 2]

Classification		Example 1	Example 2	Example 3	Comparative Example 1
Physical properties of functional	Contact cooling sensation (W/cm^2)	0.208	0.207	0.212	0.151
fabric	Thermal conductivity (W/mK)	0.105	0.107	0.112	0.123

[0094] Referring to Tables 1 and 2, in the case of the fabric according to each of Examples, it was confirmed that the mechanical properties such as the strength and the elongation were excellent, the cooling sensation was excellent, and the color uniformity of the yarn was significantly excellent.

[0095] FIG. 5 illustrates the result obtained by measuring the value of the CCM over time in the measurement region of the dope dyed polyethylene yarn illustrated in FIG. 2 while spinning the dope dyed polyethylene yarn according to each of Examples. Specifically, the values of the CCMs of the dope dyed polyethylene yarns according to Examples 1 to 3 and Comparative Example 1 are illustrated.

[0096] Referring to FIG. 5, in the dope dyed polyethylene yarn according to the present invention, it was confirmed that the color was hardly changed even during spinning for a long period of time, and thus, the yarn having excellent color uniformity was manufactured.

[0097] Hereinabove, although the present invention has been described by specific matters, exemplary embodiments, and drawings, they have been provided only for assisting in the entire understanding of the present invention. Therefore, the present invention is not limited to the exemplary embodiments. Various modifications and changes may be made by those skilled in the art to which the present invention pertains from this description.

[0098] Therefore, the spirit of the present invention should not be limited to the described exemplary embodiments, but the claims and all modifications equal or equivalent to the claims are intended to fall within the scope and spirit of the present invention.

[Detailed Description of Elements]

[0099]

10: Multi-filament 11: Filament
21: Base plate 23: Fabric
22a: T-box 22b: BT-box
100: Extruder 200: Die
300: Cooling zone 400: Interlacer
500: Drawing unit 600: Winder

Claims

1. A dope dyed polyethylene yarn comprising a pigment,

wherein L*, a* and b* measured under the following measurement condition satisfy the following expression:
[Measurement condition]
a measurement region is formed by winding the dope dyed polyethylene yarn around a planar substrate, computer color matching (CCM) is measured in the measurement region, and the CCM is measured at least n times (n is a natural number of 50 or more) every time the dope dyed polyethylene yarn is wound around the substrate 70 turns,

[Expression]

$$(C_{max} - C_{min})/C_{aver} \times 100 \leq 15$$

wherein C_{max}, C_{min}, and C_{aver} represent maximum, minimum, and average values of any one selected from L*, a*, and b*, respectively.

2. The dope dyed polyethylene yarn of claim 1, wherein when the CCM of the dope dyed polyethylene yarn is measured, a standard deviation of values of L* is 3 or less.

3. The dope dyed polyethylene yarn of claim 1, wherein the pigment is contained in an amount of 0.00005 to 1 wt% with respect to a total weight of the dope dyed polyethylene yarn.

4. The dope dyed polyethylene yarn of claim 1, wherein a degree of crystallinity of the dope dyed polyethylene yarn is 60 to 80%.

5. The dope dyed polyethylene yarn of claim 1, wherein the dope dyed polyethylene yarn has an initial modulus of 10 to 300 cN/dtex and a strength of 1.5 to 20 g/d when measured according to ASTM D2256.

6. The dope dyed polyethylene yarn of claim 1, wherein the dope dyed polyethylene yarn has a melt index (MI, @190°C) of 0.5 to 22 g/10 min when measured according to ASTM D1238.

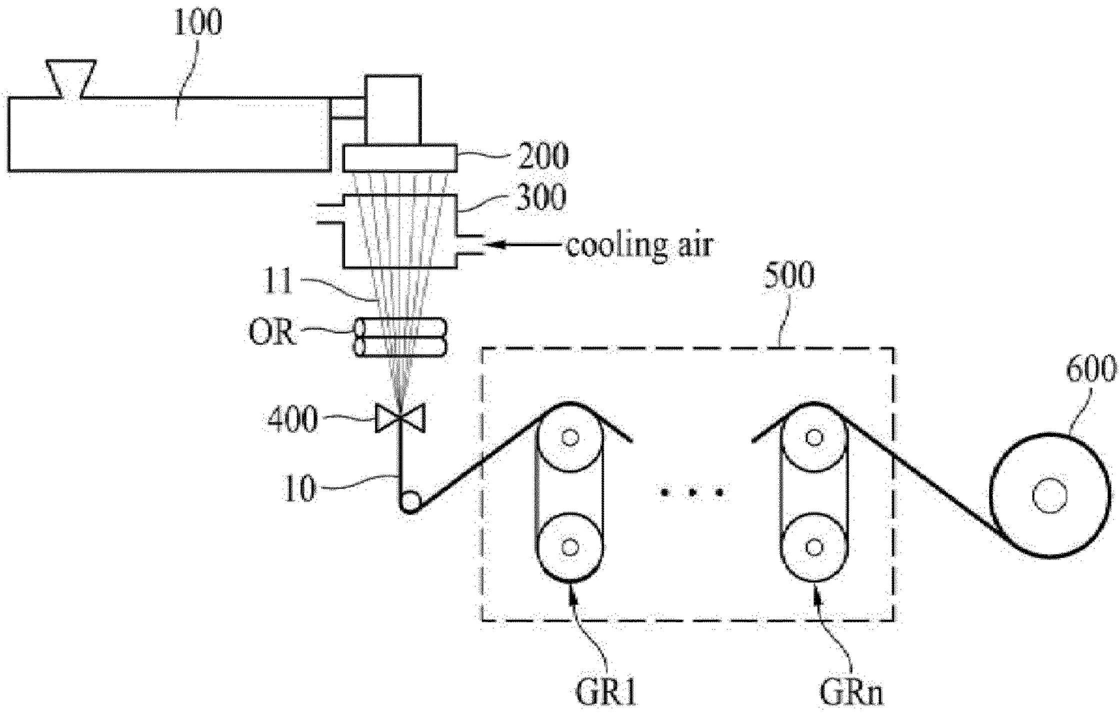
7. The dope dyed polyethylene yarn of claim 1, wherein the dope dyed polyethylene yarn has a dry heat shrinkage rate (@100°C) of 2 to 15% when measured according to ASTM D4974-04.

8. A functional fabric manufactured using the dope dyed polyethylene yarn of any one of claims 1 to 7.

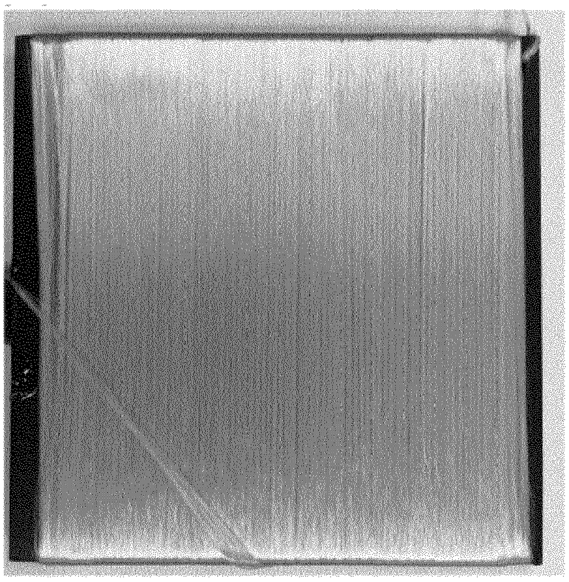
9. The functional fabric of claim 8, wherein the functional fabric has a contact cooling sensation of 0.1 to 0.3 W/cm^2 when measured by bringing a heat plate (T-box) at 30 ± 2°C into contact with the functional fabric at 20 ± 2°C at 20 ± 2°C and 65 ± 2% R.H.

10. The functional fabric of claim 8, wherein the functional fabric has a thermal conductivity in a thickness direction of 0.05 to 0.25 W/mK when measured by bringing a heat source plate (BT-box) at 30 ± 2°C into contact with the functional fabric at 20 ± 2°C at 20 ± 2°C and 65 ± 2% R.H.

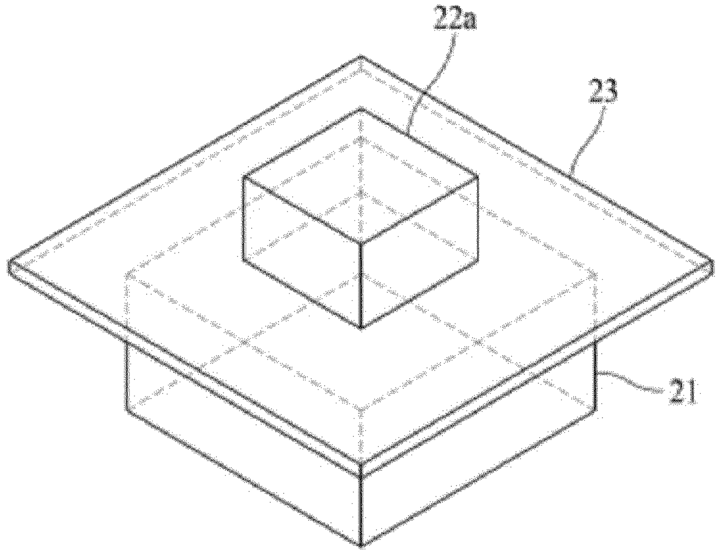
【FIG. 1】



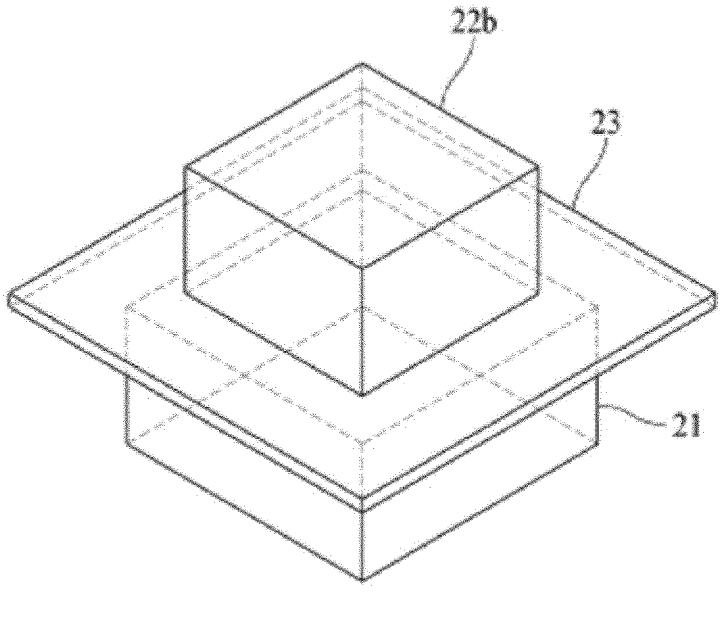
【FIG. 2】



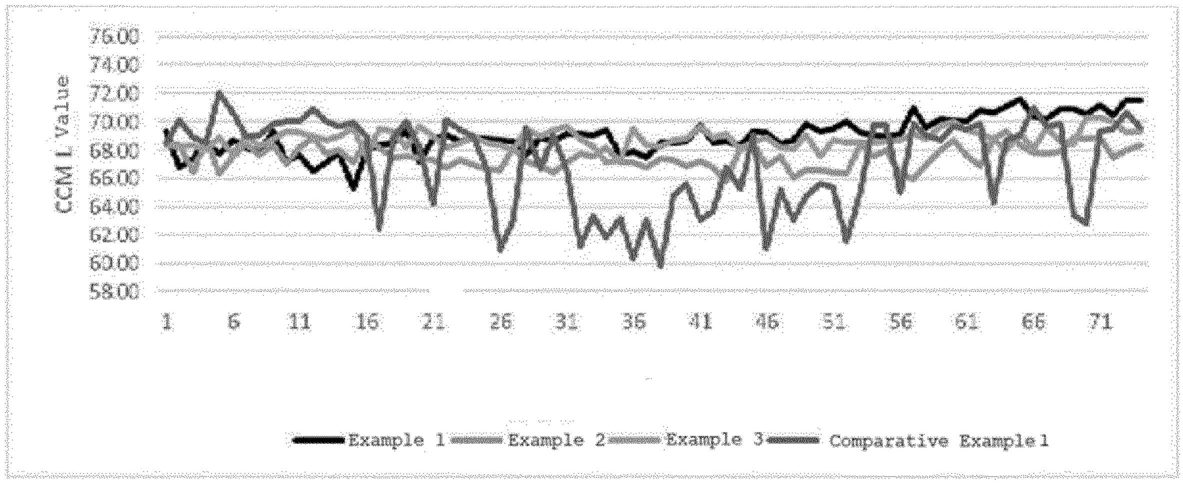
【FIG. 3】



【FIG. 4】



【FIG. 5】


CCM L Value
76.00
74.00
72.00
70.00
68.00
66.00
64.00
62.00
60.00
58.00
1
6
11
16
21
26
31
36
41
46
51
56
61
66
71
Example 1
Example 2
Example 3
Comparative Example 1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2022/019716

A. CLASSIFICATION OF SUBJECT MATTER

D01F 6/04(2006.01)i; **D01F 1/04**(2006.01)i; **D01D 5/088**(2006.01)i; **D01D 5/098**(2006.01)i; **D03D 15/54**(2021.01)i; **D03D 15/283**(2021.01)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)

D01F 6/04(2006.01); A01M 29/08(2011.01); D01D 10/02(2006.01); D01D 5/088(2006.01); D01D 5/253(2006.01); D01F 8/06(2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models: IPC as above
Japanese utility models and applications for utility models: IPC as above

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

eKOMPASS (KIPO internal) & keywords: 폴리에틸렌 (polyethylene), 용융 (melt), 컬러 (color), 열전도도 (thermal conductivity), 온도 (temperature)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR 10-2019-0000540 A (HUVIS CORPORATION) 03 January 2019 (2019-01-03) See paragraphs [0024]-[0027] and [0056]; page 7; and claims 1-3.	1-3,6-7
Y		5,8-10
A		4
Y	KR 10-2020-0036171 A (KOLON INDUSTRIES, INC.) 07 April 2020 (2020-04-07) See paragraphs [0120] and [0137]-[0139]; page 13; and claim 6.	5,8-10
A	KR 10-2012-0095733 A (JEONG, Mal Boon) 29 August 2012 (2012-08-29) See entire document.	1-10
A	KR 10-2016-0059653 A (SAMYANG CORPORATION) 27 May 2016 (2016-05-27) See entire document.	1-10

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

* Special categories of cited documents:
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"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
15 March 2023	**17 March 2023**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office **Government Complex-Daejeon Building 4, 189 Cheongsa-ro, Seo-gu, Daejeon 35208**	
Facsimile No. **+82-42-481-8578**	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2022/019716

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2013-168543 A1 (TEIJIN LIMITED) 14 November 2013 (2013-11-14) See entire document.	1-10

Form PCT/ISA/210 (second sheet) (July 2022)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2022/019716

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
KR 10-2019-0000540 A	03 January 2019	KR 10-1954356 B1	05 March 2019
KR 10-2020-0036171 A	07 April 2020	KR 10-2167737 B1	19 October 2020
KR 10-2012-0095733 A	29 August 2012	None	
KR 10-2016-0059653 A	27 May 2016	KR 10-1775142 B1	05 September 2017
WO 2013-168543 A1	14 November 2013	CN 104271819 A	07 January 2015
		JP 2016-168543 A1	07 January 2016

Form PCT/ISA/210 (patent family annex) (July 2022)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- KR 101992444 **[0008]**