

Core/Sheath Structure, Method for Manufacturing Flock Products, And Flock Products**【Technical Field】****【0001】**

The present disclosure relates to core/sheath structure, method for manufacturing flock products, and flock products.

【Background Technology】**【0002】**

Patent Document 1 discloses a consumable filament. The consumable filament is melted and extruded in an additive manufacturing system. The consumable filament includes a core portion and a sheath portion encasing the core portion. The core portion comprises a matrix of a first base polymer and particles dispersed in the matrix. The sheath portion comprises a second base polymer. The particles of the core portion are selected from metallic particles, nonmetallic particles, magnetic particles, and a combination thereof, and may be ferrite particles (paragraph [0005]). The particles of the core portion do not penetrate an outer surface of the sheath portion (paragraph [0074]).

【Prior Art Documents】**【Patent Documents】****【0003】**

【Patent Document 1】 U.S. Patent Application Publication No. 2017/0268133

【Summary of Invention】**【Problem to be solved by the invention】****【0004】**

When a formed product is manufactured by using consumable filaments as disclosed in Patent Document 1, the formed product has a rubbery or a plastic-like tactile feeling, or the like, and does not have a comfortable tactile feeling.

【0005】

The present disclosure was invented in light of this problem. One aspect of the present disclosure is, for example, to provide a formed product or a flock product having a comfortable tactile feeling.

【Means for solving the problem】**【0006】**

A core / sheath structure of one embodiment of the present disclosure is a core / sheath structure composing a forming material or a formed product which is a melted and cured product of the forming material, comprising: a core having a linear shape and an outer peripheral surface and including a first thermoplastic polymer; and a sheath covering the outer peripheral surface and including a second thermoplastic polymer and at least one selected from a group consisting of fibers and particles dispersed in the second thermoplastic polymer.

【0007】

A method for manufacturing a flock product of other embodiment of the present disclosure comprises: a) a step of arranging an adhesive layer on a surface of a material to be treated composed a forming material including a thermoplastic polymer or a formed product which is a melted and cured product of the forming material; b) a step of piercing a flock into the adhesive layer; and c) a step of curing the adhesive layer after the step b).

【0008】

A flock product of one embodiment of the present disclosure comprises: a main body having a surface and composed of a forming material including a thermoplastic polymer or a formed product which is a melted and cured product of the forming material; an adhesive layer arranged on the surface; and a flock pierced into the adhesive layer.

【Brief description of the drawings】

【0009】

FIG. 1 is a perspective view schematically illustrating a forming material of a first embodiment.

FIG. 2 is a cross-sectional view schematically illustrating a forming material of a first embodiment.

FIG. 3 is a photograph of a cross section of a prototype of a forming material of a first embodiment.

FIG. 4 is a cross-sectional view schematically illustrating a forming material of a variant of a first embodiment.

FIG. 5 is a plan view schematically illustrating a formed product of a second embodiment.

FIG. 6 is a cross-sectional view schematically illustrating a linear body provided in a formed product of a second embodiment.

FIG. 7 is an electron microscope (SEM) photograph of an entire cross section of a linear body provided in a prototype of a formed product of a second embodiment.

FIG. 8 is a SEM photograph of a periphery of a cross section of a linear body provided in a prototype of a formed product of a second embodiment.

FIG. 9 is an enlarged cross-sectional view schematically illustrating a vicinity of an interface between a formed product of a second embodiment and a human skin contacting a formed product.

FIG. 10 is a SEM photograph of a cross section of a prototype of a formed product of a second embodiment.

FIG. 11 is a SEM photograph of a cross section of a prototype of a formed product of a second embodiment.

Fig. 12 is a SEM photograph of a cross section of a prototype of a formed product manufactured by using a monofilament.

Fig. 13 is a SEM photograph of a cross section of a prototype of a formed product manufactured by using a monofilament.

Fig. 14 is a SEM photograph of an upper surface of a prototype of a formed product manufactured

by using a monofilament.

Fig. 15 is a SEM photograph of an upper surface of a prototype of a formed product manufactured by using a monofilament.

FIG. 16 is a SEM photograph of a prototype of a formed product manufactured by using a forming material of a variant of a first embodiment.

FIG. 17 is a micrograph of a monofilament made of polyester.

FIG. 18 is a micrograph of a multifilament made of polyester.

FIG. 19 is a side view schematically illustrating a three-dimensional (3D) printer used for manufacturing a formed product of a second embodiment.

FIG. 20 is a plan view schematically illustrating a flock product of a third embodiment.

FIG. 21 is an enlarged cross-sectional view schematically illustrating a vicinity of an interface between a formed product of a third embodiment and a human skin contacting a formed product.

FIG. 22 is a perspective view schematically illustrating an electrostatic deposition apparatus used for manufacturing a flock product of a third embodiment.

FIG. 23 is a flowchart showing a flow of manufacturing of a flock product of a third embodiment.

FIG. 24 is a photograph of a prototype of a main body provided in a flock product of a third embodiment.

FIG. 25 is a photograph of a prototype of a flock product of a third embodiment.

【Mode for carrying out the invention】

【0010】

Hereinafter, explaining about embodiments of the present disclosure by referring to the drawings. In addition, with respect to drawings, same or equivalent elements shall be given same reference numbers, and overlapping explanations shall be omitted.

【0011】

1 First embodiment

1. 1 Outline of formed material

FIG. 1 is a perspective view schematically illustrating a forming material of a first embodiment. FIG. 2 is a cross-sectional view schematically illustrating forming material of a first embodiment. FIG. 3 is a photograph of a cross section of a prototype of a forming material of a first embodiment.

【0012】

A forming material 1 of a first embodiment shown in FIGS. 1, 2 and 3 is used for manufacturing a formed product. When the formed product is manufactured by using the forming material 1, the forming material 1 is melted, a shape is given to the molten forming material, and the forming material given a shape is cured. Thereby, the formed product that is a melted and cured product of the forming material 1 is manufactured. Therefore, the forming material 1 is a consumable good consumed for manufacturing the formed product.

【0013】

The forming material 1 is used, for example, to manufacture the formed product by a three-dimensional (3D) printer, and is used to manufacture the formed product by a fused deposition modeling (FDM) method. However, the forming material 1 may be used to manufacture the formed product by a forming apparatus other than a 3D printer, or may be used to manufacture the formed product by a forming method other than the FDM method. The FDM method is also called a fused filament fabrication (FFF) method.

【0014】

The forming material 1 has a linear shape and has a thermoplastic property. When the forming material 1 is used to manufacture the formed product, the forming material 1 is heated while being sent in the length direction. Thereby, the forming material 1 is melted. The forming material 1 has flexibility and elasticity. The forming material 1 having these characteristics is also called a filament. When the forming material 1 is used to manufacture the formed product by a 3D printer, the forming material 1 has a circular cross-sectional shape and has a diameter suitable for the 3D printer. The diameter of the forming material 1 is, for example, 1.75 mm or 2.85 mm. However, the forming material 1 may have a cross-sectional shape other than a circular cross-sectional shape, and may have a diameter other than 1.75 mm or 2.85 mm.

【0015】

The main part of the forming material 1 has a thermoplastic property. Thereby, the forming material 1 can be melted to be separated into a plurality of components. In addition, new forming materials or other types of products can be manufactured from the forming material 1. For this reason, the forming material 1 is recyclable.

【0016】

The forming material 1 can be sold in the self-made (DIY) market to consumers who make their own formed products. In addition, formed products manufactured by using the forming material 1 can be sold to ordinary consumers in ordinary stores and in ordinary markets.

【0017】

1. 2 Cross-sectional structure and material property of forming materials

As illustrated in FIGS. 1, 2 and 3, the forming material 1 is composed of a core / sheath structure 101 comprising a core 111 and a sheath 112 and having a two-layer structure. The sheath 112 is also called a shell. The core / sheath structure 101 is also called the core / shell structure. The forming material 1 may have a multilayer structure with a three-layer structure or more. The forming material 1 having a multilayer structure with a two-layer structure or more is also called a multifilament. In contrast to the multifilament, a forming material having a single-layer structure is called a monofilament.

【0018】

The core 111 has a linear shape. The core 111 has flexibility. The core 111 has a circular cross-sectional shape. The core 111 may have a cross-sectional shape other than a circular cross-sectional shape. The sheath 112 covers the outer peripheral surface 111S of the core 111. Therefore, the sheath 112 is an outer layer disposed at outside of a radial direction of the core 111 and is an outermost layer disposed at an outermost radial direction of the forming material 1.

【0019】

As illustrated in FIG. 2, the core 111 includes a first thermoplastic polymer 121. The sheath 112 includes a second thermoplastic polymer 122 and at least one selected from a group consisting of fibers and particles (hereinafter, referred to as "fibers / particles") 123.

【0020】

The second thermoplastic polymer 122 is a matrix. The fibers / particles 123 are dispersed in the second thermoplastic polymer 122 that is a matrix. The fibers / particles 123 form a protrusion at a surface of the formed product to be produced, and impart a comfortable tactile feeling to the formed product to be produced.

【0021】

The first thermoplastic polymer 121 and the second thermoplastic polymer 122 are a main component of the core 111 and sheath 112 respectively.

【0022】

The first thermoplastic polymer 121 and the second thermoplastic polymer 122 may be a same type of thermoplastic polymer or different types of thermoplastic polymers. Each thermoplastic polymer of the first thermoplastic polymer 121 and the second thermoplastic polymer 122 may be one thermoplastic polymer or a mixture of two or more thermoplastic polymers.

【0023】

Each thermoplastic polymer includes, for example, at least one selected from a group consisting of a rigid component and a flexible component, and preferably including a flexible component.

【0024】

The rigid component includes, for example, a thermoplastic resin.

【0025】

A thermoplastic resin includes, for example, at least one selected from a group consisting of acrylonitrile butadiene styrene (ABS), polylactic acid (PLA), polyethylene terephthalate (PET) and other derivatives of polyesters, polycarbonate (PC), polyvinyl alcohol (PVA), polyamide (PA), styrene-based polymers, polyvinyl chloride (PVC) and acrylic polymers.

【0026】

The flexible component includes, for example, a thermoplastic elastomer. As the core 111 or the sheath 112 includes a thermoplastic elastomer, a flexibility and an elasticity of the core 111 or sheath 112 are improved respectively, and a flexibility and an elasticity of the forming material 1 are

improved. In addition, a flexibility and an elasticity of the core or the sheath provided in the formed product to be produced are improved respectively, and a flexibility and an elasticity of the formed product to be produced are improved.

【0027】

The thermoplastic elastomer includes at least one selected from a group consisting of, for example, olefin-based thermoplastic elastomer (TPO), styrene-based thermoplastic elastomer (TPS), vinyl chloride-based thermoplastic elastomer (TPVC), amide-based thermoplastic elastomer (TPAE), ester-based thermoplastic elastomer (TPEE), urethane-based thermoplastic elastomer (TPU), and acrylic elastomer, and preferably includes TPU.

【0028】

The fibers / particles 123 include at least one selected from a group consisting of natural materials and compounds. Examples of natural powders and fibers are ramie, cotton, wool, silk, chitosan, and else. Examples for mineral powders are chalk and calcium carbonate.

【0029】

At least one of the core 111 and the sheath 112 may include a reinforcing component. When the core 111 or the sheath 112 includes a reinforcing component, a strength of the core 111 or the sheath 112 is improved, and a strength of the forming material 1 is improved. In addition, a strength of the core or the sheath provided in the formed product to be produced is improved, and a strength of the

formed product to be produced is improved. The reinforcing component includes, for example, filler. The filler includes, for example, at least one selected from a group consisting of fibers, particles, particulate powders, nanoparticles, nanofibers and similar additives. The filler includes, for example, at least one selected from a group consisting of natural materials and compounds.

【0030】

At least one of the core 111 and the sheath 112 may include liquid additives in addition to a plasticizer. At least one of the cores 111 and the sheath 112 may include additives for forming pores. When the core 111 or the sheath 112 includes additives for forming pores, many pores are formed respectively in the core or the sheath provided in the formed product to be produced, improving a flexibility, an elasticity and an air permeability of the core or the sheath provided in the formed product to be produced, and a flexibility, an elasticity, and an air permeability of the formed product to be produced are improved. Additives for forming pores include, for example, at least one selected from a group consisting of a foaming agent and a whipping agent. A filament of a foamed core / sheath structure in which either the core or the sheath is foamed and other layers are not foamed may impart higher strength than a filament of a fully foamed structure due to high consistency with a strength of unfoamed layers.

【0031】

The core 111 may include particles, additives, mixtures, and the like that do not fall under the above-

described components. Particles, additives, mixtures, and the like are dispersed in the first thermoplastic polymer 121, which is a matrix. The sheath 112 may include particles, additives, mixtures, and the like that do not fall under the above-described components. Particles, additives, mixtures, etc. are dispersed in the second thermoplastic polymer 122, which is a matrix.

【0032】

In a first example, the first thermoplastic polymer 121 is a TPU having a hardness of 70 Shore A. The second thermoplastic polymer 122 is also a TPU having a hardness of 60 Shore A.

【0033】

In a second example, the first thermoplastic polymer 121 is a TPU. In addition, the second thermoplastic polymer 122 is PVA. In addition, the fibers / particles 123 are natural fibers.

【0034】

In a third example, the first thermoplastic polymer 121 is a TPU. In addition, the second thermoplastic polymer 122 is a mixture of TPU and PVA. In addition, the sheath 112 includes a whipping agent.

【0035】

In a fourth example, the second thermoplastic polymer 122 is a TPU. In addition, the fibers / particles 123 are natural fibers.

【0036】

In a fifth example, the first thermoplastic polymer 121 and the second thermoplastic polymer 122 are

TPU. In addition, the fibers / particles 123 are ramie fibers.

【0037】

A ratio between an outer diameter of the sheath 112 and a diameter of the core 111 reflects a composition or a mass fraction of materials composing the core 111 and materials composing the sheath 112, and can be controlled within a wide range from 1:1.01 to 1:10.

【0038】

1. 3 Method for manufacturing forming material

The forming material 1 can be manufactured by co-extruding materials composing the core 111 and materials composing the sheath 112 using an appropriate feed-block and a nozzle. Same applies when the forming material 1 comprises layers other than the core 111 and the sheath 112.

【0039】

For example, when the forming material 1 is manufactured, materials composing the core 111 and materials composing the sheath 112 are co-extruded in a co-extrusion line. The co-extrusion line comprises two extruders, a feed-block / multi-manifold die head and a nozzle. The two extruders form two feeds respectively consisting of a feed consisting of materials composing the core 111 and a feed consisting of materials composing the sheath 112. The feed-block / multi-manifold die head converges the two feeds formed. The nozzle co-extrudes the forming material 1 by using a converged feed.

【0040】

1. 4 Variants

FIG. 4 is a cross-sectional view schematically illustrating a forming material of a variant of a first embodiment.

【0041】

In the forming material 1 of the first embodiment shown in FIGS. 1, 2 and 3, the core 111 is a solid body. On the other hand, in a forming material 1M of a variant of a first embodiment shown in FIG. 4, the core 111 is a porous body. Therefore, in the forming material 1M, many pores are formed in the core 111. This allows to improve a flexibility, an elasticity and an air permeability of the core 111, and a flexibility, an elasticity and an air permeability of the forming material 1M can be improved. In addition, a flexibility, an elasticity and an air permeability of the core provided in the formed product to be produced can be improved, and a flexibility, an elasticity and an air permeability of the formed product to be produced can be improved. The core 111, which is a porous body, is resembling a multifilament.

【0042】

2 Second embodiment

2. 1 Outline of formed product

FIG. 5 is a plan view schematically illustrating a formed product of a second embodiment.

【0043】

A formed product 2 of a second embodiment shown in FIG. 5 is manufactured by using the forming material 1 of the first embodiment. For this reason, the formed product 2 is a melted and cured product of the forming material 1.

【0044】

The formed product 2 is a new type of textile (cloth) or fabric (cloth product). The formed product 2 composes, for example, a clothing that can be worn on a body continuously. The clothing is garments, hats, gloves, socks, footwears, accessories, and else. The formed product 2 may compose an article other than the clothing.

【0045】

The clothing may be a self-made product made by a consumer, an order-made product for a specific consumer, or ready-made products made for unspecified consumers. However, the manufacture of the formed product 2 by a 3D printer is suitable for the self-made product and the order-made product.

【0046】

The formed product 2 may be sold to ordinary consumers in ordinary stores and in ordinary markets.

【0047】

A main part of the formed product 2 has a thermoplastic property. Thereby, the formed product 2 can be melted to separate the formed product 2 into a plurality of components. In addition, new formed

product or other types of products can be manufactured from the formed product 2. For this reason, the formed product 2 is recyclable after being used.

【0048】

The properties of the formed product 2 can be adjusted by materials composing the forming material 1 used for manufacturing, a structure of the forming material 1 used for manufacturing, process parameters for manufacturing the formed product 2, and the like. Adjustments are made to improve a flexibility, a softness, a strength and an air permeability of the formed product 2, in addition to an easiness of manufacturing of the formed product 2.

【0049】

2. 2 Planar shape of formed product

As shown in FIG. 5, the formed product 2 comprises first linear bodies 201 and second linear bodies 202.

【0050】

Each of first linear bodies 201 extends to a first direction D1 while meandering. The first linear bodies 201 are arranged in a second direction D2. There is a gap between the adjacent first linear bodies 201. Each of second linear bodies 202 extends to the second direction D2 while meandering. The second linear bodies 202 are arranged in the first direction D1. There is a gap between the adjacent second linear bodies 202. The second direction D2 is perpendicular to the first direction D1.

Thereby, in planar view, the first linear bodies 201 intersect with the second linear bodies 202. Further, the formed product 2 has a lattice-like planar shape. The formed product 2 may have a structure different from the structure shown in FIG. 5.

【0051】

The second linear bodies 202 are arranged on the first linear bodies 201. The second linear bodies 202 contact the first linear bodies 201.

【0052】

2. 3 Cross-sectional structure and material property of linear bodies

FIG. 6 is a cross-sectional view schematically illustrating a linear body provided in a formed product of a second embodiment. In FIG. 6, the forming material is illustrated with a dashed line, so that a size of the forming material of the first embodiment can be compared with a size of the linear body provided in the formed product of the second embodiment.

【0053】

The linear body 210 shown in FIG. 6 is each one of the first linear bodies 201 and each one of the second linear bodies 202.

【0054】

The linear body 210 is formed by extending the forming material 1 in a length direction. For this reason, as shown in FIG. 6, the linear body 210 is also composed of a core / sheath structure 221

comprising a core 231 and a sheath 232. However, a diameter of the linear body 210 is smaller than a diameter of the forming material 1. Also, a diameter of the core 231 is smaller than a diameter of the core 111. Also, a thickness of the sheath 232 is thinner than a thickness of the sheath 112.

【0055】

The core 231 and the sheath 232 provided in the linear body 210 are respectively derived from the core 111 and the sheath 112 provided in the forming material 1. For this reason, the core 231 has a linear shape. The sheath 232 covers an outer peripheral surface 231S of the core 231. The core 231 includes a first thermoplastic polymer 121. The sheath 232 includes a second thermoplastic polymer 122 and fibers / particles 123. The fibers / particles 123 are dispersed in the second thermoplastic polymer 122. The core 231 and the sheath 232 provided in the linear body 210 may respectively include components that can be included in the core 111 and the sheath 112 provided in the forming material 1. The core 231 may be a porous body.

【0056】

FIG. 7 is an electron microscope (SEM) photograph of an entire cross section of a linear body provided in a prototype of a formed product of a second embodiment. FIG. 8 is a SEM photograph of a periphery of a cross section of a linear body provided in a prototype of a formed product of a second embodiment.

【0057】

In the SEM photograph of FIG. 7, a clear interface between the core 231 and the sheath 232 cannot be confirmed, but the fibers / particles 123 can be hardly confirmed in an area of the core 231, and dispersed fibers / particles 123 can be confirmed in an area of the sheath 232 ahead of arrows. Further, also in the SEM photograph of FIG. 8, a clear interface between the core 231 and the sheath 232 cannot be confirmed, but the fibers / particles 123 can be hardly confirmed in an area of the core 231, and dispersed fibers / particles 123 can be confirmed in an area of the sheath 232 inside a circle. Therefore, from the SEM photographs of FIGS. 7 and 8, it can be understood that the sheath 232 includes the fibers / particles 123 and the fibers / particles 123 are dispersed in the second thermoplastic polymer 122. The reason for not being able to confirm a clear interface between the core 231 and the sheath 232 is that the second thermoplastic polymer 122, which is a main component of the sheath 232, is similar to the first thermoplastic polymer 121, which is a main component of the core 231, and may be same as the first thermoplastic polymer 121.

【0058】

FIG. 9 is an enlarged cross-sectional view schematically illustrating a vicinity of an interface between a formed product of a second embodiment and a human skin contacting the formed product.

【0059】

As illustrated in FIG. 9, the linear body 210 includes a linear main body 241 and protrusions 242.

【0060】

The linear main body 241 composes a main part of the linear body 210. The protrusions 242 protrude from an outer peripheral surface 241S of the linear main body 241 to form a characteristic irregular unevenness at the outer peripheral surface of the linear body 210.

【0061】

The fibers / particles 123 include crossing fibers / crossing particles 251 that intersect with the outer peripheral surface 241S of the linear main body 241. One end of the crossing fibers / crossing particles 251 is buried in the second thermoplastic polymer 122 composing the linear main body 241. Thereby, the crossing fibers / crossing particles 251 are fixed to the linear main body 241, and the crossing fibers / crossing particles 251 can be prevented from falling off from the linear main body 241. A rest of the crossing fibers / crossing particles 251 protrudes from the outer peripheral surface 241S of the linear main body 241 and is covered with the second thermoplastic polymer 122 composing the protrusion 242. Thereby, the crossing fibers / crossing particles 251 can be prevented from being exposed, and it is possible to prevent the human skin 261 from directly contacting the crossing fibers / crossing particles 251. The protrusion 242 comprises the second thermoplastic polymer 122 covering the rest of the crossing fibers / crossing particles 251 and the rest of the crossing fibers / crossing particles 251. The second thermoplastic polymer 122 composing the linear main body 241 and the second thermoplastic polymer 122 composing the protrusion 242 are continuing and integrated.

【0062】

The irregular unevenness formed are similar to an unevenness formed when a filling factor of fibers / particles dispersed in a matrix increases. The unevenness can be described as "mountain and valley". In the linear body 210, the protrusion 242 becomes a mountain, and between adjacent protrusions 242, that is, an area which is rich in the second thermoplastic polymer 122 is a valley.

【0063】

A size of the irregular unevenness formed can be controlled by a shape, a size, and the like of the fibers / particles 123. For this reason, a roughness of a surface of the formed product 2 can be controlled by a shape, a size, and the like of the fibers / particles 123.

【0064】

When the human skin 261 contacts the formed product 2, the human skin 261 contacts the protrusion 242, and a gap 262 is formed between the human skin 261 and the outer peripheral surface 241S of the linear main body 241. An air flow can be generated in the gap 262 formed. For this reason, when the human skin 261 contacts the formed product 2, the air flow generated in the gap 262 can quickly dry the human skin 261, and the human skin 261 can be cooled well. For this reason, the formed product 2 does not have a rubbery or a plastic-like tactile feeling, or the like, and has a cloth-like tactile feeling and a comfortable tactile feeling.

【0065】

In addition, when the human skin 261 contacts the formed product 2, the human skin 261 can deflect the protrusion 242 with weak force. In addition, the human skin 261 only contacts a surface of the formed product 2 weakly, and a frictional force generated between the human skin 261 and the formed product 2 is small. Thereby, the formed product 2 has a soft tactile feeling.

【0066】

FIGS. 10 and 11 are SEM photographs of a cross section of a prototype of a formed product of a second embodiment.

【0067】

In the SEM photographs of FIGS. 10 and 11, it can be confirmed that the protrusion 242 protrudes from the sheath 112 and forms an irregular unevenness on the outer periphery surface of the linear body 210.

【0068】

FIGS. 12 and 13 are SEM photographs of a cross-section of a prototype of a formed product manufactured by using a monofilament. FIGS. 14 and 15 are SEM photographs on an upper surface of a prototype of a formed product manufactured by using a monofilament.

【0069】

In the SEM photographs of FIGS. 12, 13, 14, and 15, it can be confirmed that a surface of the linear body provided in a prototype of a formed product manufactured by using a monofilament is smooth

and clean and does not have a distinguished unevenness. In the SEM photographs of FIGS. 14 and 15, white spots are garbage.

【0070】

The formed product 2 having the above-described features has a flexibility, a strength, an air permeability, a wicking, controlled roughness and smoothness, and has a cloth-like tactile feeling and a comfortable tactile feeling. In addition, a color of the formed product 2 can be changed.

【0071】

FIG. 16 is an SEM photograph of a prototype of a formed product manufactured by using a forming material of a variant of a first embodiment. FIG. 17 is a micrograph of a monofilament made of polyester. FIG. 18 is a micrograph of a multifilament made of polyester.

【0072】

The monofilament made of polyester shown in FIG. 17 is strong, hard, and stiff. For this reason, the monofilament made of polyester cannot be used for clothing. Also, when the monofilament is used, an irregular unevenness cannot be formed on a surface of a formed product.

【0073】

On the other hand, the multifilament made of polyester shown in FIG. 18 is soft and not stiff. For this reason, a monofilament made of polyester can be used for clothing. Also, when the multifilament is used, an irregular unevenness can be formed on a surface of a formed product. However, when the

monofilament made of polyester is used, the formed product cannot be printed by a 3D printer.

【0074】

In the SEM photograph of FIG. 16, it can be confirmed that an irregular unevenness is formed on a surface of a formed product manufactured by a 3D printer using a forming material 1M in which the core 111 is a porous body.

【0075】

2. 4 Method for manufacturing formed products

FIG. 19 is a side view schematically illustrating a 3D printer used for manufacturing a formed product of a second embodiment.

【0076】

The 3D printer 271 shown in FIG. 19 prints the formed product 2 by using the forming material 1 by the FDM method. In the following, the forming material 1 is called a filament 1.

【0077】

A filament spool 281 is mounted to the 3D printer 271. The 3D printer 271 comprises a printing head 282, a drive mechanism 283, and a plate 284.

【0078】

The filament spool 281 supplies the filament 1.

【0079】

The print head 282 melts the filament 1 supplied to generate a molten material and discharges the molten material 288 generated. The print head 282 is disposed above an upper surface 284S of the plate 284 in a vertical direction. For this reason, the molten material 288 discharged is dropped and supplied on the upper surface 284S of the plate 284. The molten material 288 may be supplied directly on the upper surface 284S of the plate 284, or may be supplied on the upper surface 284S of the plate 284 by overlapping on the molten material or the hardened molten material already supplied on the upper surface 284S of the plate 284.

【0080】

The drive mechanism 283 moves the print head 282 in a direction parallel to the upper surface 284S of the plate 284. Thereby, a position for supplying the molten material 288 will be moved. The drive mechanism 283 enables a position for supplying the molten material 288 to be arranged at any position within a printing range.

【0081】

The plate 284 supports the molten material 288 supplied. The molten material 288 supported will be hardened into a melted and cured product. The plate 284 supports the melted and cured material.

【0082】

When the 3D printer 271 prints the formed product 2, while the print head 282 discharges the molten material 288, the drive mechanism 283 moves the print head 282 above a linear area where the linear

body 210 provided in the formed product 2 is printed. Thereby, a linear molten material is formed on the linear area. The linear molten material formed will be hardened into the linear body 210.

【0083】

The print head 282 comprises a filament feeder 291, a heater 292, and a nozzle 293.

【0084】

The filament 1 supplied to the print head 282 is inserted into the filament feeder 291. The filament feeder 291 sends the inserted filament 1 in a length direction and inserts the filament 1 into the heater 292.

【0085】

The heater 292 heats the inserted filament 1 to generate the molten material 288 and supplies the molten material 288 generated to the nozzle 293.

【0086】

The nozzle 293 discharges the molten material 288 supplied.

【0087】

When the print head 282 melts the filament 1 to produce the molten material 288, the core / sheath structure is maintained. For this reason, the linear body 210 has a core / sheath structure 221. However, since the filament 1 is stretched, a diameter of the linear body 210 is smaller than a diameter of the filament 1. Further, a thickness of the sheath 232 is thinner than a thickness of the sheath 112. For

example, a diameter of the linear body 210 is about 1/4 of a diameter of the filament 1. Also, a thickness of the sheath 232 is about 1/4 of a thickness of the sheath 112. In this case, the filament 1 with a diameter of 1.75 mm becomes the linear body 210 having a diameter of about 0.40 mm. The sheath 112 with a thickness of 0.2 mm becomes the sheath 232 having a thickness of 0.05 mm.

【0088】

A size of the fibers / particles 123 included in the sheath 112 provided in the filament 1, for example, a length of the fibers or a size of the particles is selected to be sufficiently smaller than a thickness of the sheath 232 provided in the linear body 210 to be printed. For this reason, it is unlikely that the fibers / particles 123 enter the core 231 when the formed product 2 is printed. For this reason, most of the fibers / particles 123 remain in the sheath 232, and a part of the fibers / particles 123 will be crossing fibers / crossing particles 251 that intersect with the outer peripheral surface 111S of the linear main body 241.

【0089】

3 Third embodiment

3. 1 Overview of flock product

FIG. 20 is a plan view schematically illustrating a flock product of a third embodiment. FIG. 21 is an enlarged cross-sectional view schematically illustrating a vicinity of an interface between a flock product of a third embodiment and a human skin contacting the flock product.

【0090】

A flock product 3 of a third embodiment shown in FIGS. 20 and 21 is a product in which a formed product manufactured by using a forming material is flocked.

【0091】

The flock Product 3 is a new type of textile or fabric. The flock product 3 composes, for example, clothing that can be worn on a body continuously. Clothing is garments, hats, gloves, socks, footwears, accessories, etc. The flock product 3 may compose an article other than the clothing.

【0092】

The clothing may be a self-made product made by a consumer, an order-made product made for a specific consumer, or ready-made products made for unspecified consumers. However, the manufacture of the formed products by 3D printers and the manufacture of the flock products 3 by flocking are suitable for the self-made product and the order-made product.

【0093】

A main part of the flock product 3 has thermoplastic property. Thereby, the flock product 3 can be melted to separate the flock product 3 into a plurality of components, and new flock product or other types of products can be manufactured from the flock product 3. For this reason, the flock product 3 is recyclable after being used. From this reason, sustainability and cyclicity for the global environment can be improved. Other types of products manufactured may be co-extruded filaments.

Although, it differs by an existence of fibers in a polymer, a recycling into co-extruded filaments can be performed with minimal degradation of properties.

【0094】

3. 2 Structure of flock products

As illustrated in FIGS. 20 and 21, the flock product 3 includes a main body 301, an adhesive layer 302, and a flock 303.

【0095】

The main body 301 is a formed product manufactured by using a forming material, that is a melted and cured product of the forming material. The forming material may be a forming material having a single layer structure, may be the forming material 1 of the first embodiment having a multilayer structure, or may be another forming material, but includes a thermoplastic polymer. The main body 301 is manufactured by a 3D printer. The main body 301 may be the forming material itself.

【0096】

The adhesive layer 302 is arranged on a surface 301S of the main body 301 and covers the surface 301S of the main body 301. The adhesive layer 302 bonds the flock 303 to the surface 301S of the main body 301 and fixes the flock 303 on the surface 301S of the main body 301.

【0097】

The flock 303 pierces the adhesive layer 302. One end of the flock 303 is buried in the adhesive layer

302. A rest of the flock 303 is arranged at outside the adhesive layer 302. For this reason, the flock 303 protrudes from the adhesive layer 302.

【0098】

As illustrated in FIG. 21, when the human skin 311 contacts the flock product 3, the human skin 311 contacts the flock 303, and a gap 321 is formed between the human skin 311 and a surface of a structure made of the main body 301 and the adhesive layer 302. An air flow can be generated in the gap 321 formed. For this reason, when the human skin 311 contacts the flock product 3, the air flow generated in the gap 321 can quickly dry the human skin 311, and the human skin 311 can be cooled well. For this reason, the flock product 3 does not have a rubbery or a plastic-like tactile feeling, or the like, and has a cloth-like tactile feeling and a comfortable tactile feeling.

【0099】

In addition, if the human skin 311 contacts the flock product 3, the human skin 311 can deflect the flock 303 with weak force. In addition, the human skin 311 only contacts a surface of the flock product 3 weakly, and a frictional force generated between the human skin 311 and the flock product 3 is small. Thereby, the flock product 3 has a soft tactile feeling.

【0100】

The main body 301 includes a thermoplastic polymer. The thermoplastic polymer is preferably a thermoplastic polyurethane. The characteristics of the main body 301 can be adjusted by the forming

material used in a manufacturing.

【0101】

The adhesive layer 302 consists of a cured adhesive agent.

【0102】

The adhesive agent is adjusted to fit the main body 301 and the flock 303.

【0103】

The adhesive agent is a thermoplastic adhesive agent or a thermosetting adhesive agent, and preferably the thermosetting adhesive agent. If the adhesive agent is the thermosetting adhesive agent, a durability of the adhesive layer 302 can be improved. On the other hand, if the adhesive agent is the thermoplastic adhesive agent, an electrostatic deposition of the flock 303 can be easily performed.

【0104】

The adhesive agent is a polymer adhesive agent, preferably a polyurethane adhesive agent or an acrylic adhesive agent, and more preferably the polyurethane adhesive agent. If the adhesive agent is the polyurethane adhesive agent, polyurethane having a flexibility is included in the adhesive layer 302, and the adhesive layer 302 can be prevented from impairing a flexibility of the flock product 3.

【0105】

The polyurethane adhesive agent is, for example, a water-based or a solvent-based polyurethane dispersion or a liquid polyurethane.

【0106】

The flock 303 includes at least one selected from a group consisting of fibers and particles. The flock 303 includes at least one selected from a group consisting of natural materials and compounds. Natural materials include at least one selected from a group consisting of, for example, cotton, wool and viscose. However, natural materials may include substances other than cotton, wool and viscose. The compounds include at least one selected from a group consisting of polyester, polyamide (nylon), polyurethane, polylactic acid (PLA), polyethylene and polypropylene. The compounds may include substances other than polyester, polyamide, polyurethane, polylactic acid, polyethylene and polypropylene.

【0107】

For example, flock fibers have a length of 0.1 mm or more and 5 mm or less, and preferably 0.4 mm or more and 8 mm or less. If a length of the flock fibers is shorter than these ranges, the flock fibers may be embedded in a polymer and do not protrude from a surface, and may not affect a tactile feeling of the surface. Also, a protruding portion of the flock fibers protruding from the surface is too short, the fibers will be in a standing state, and gives an itchy tactile feeling. If a length of the fibers is longer than these ranges, a deposition of the fibers may be insufficient in a flocking process due to a heavier fiber weight. If the flock fibers are too long, the fibers will fall down, so there is a risk of losing a fluffy tactile feeling.

【0108】

The flock fibers, for example, has a diameter of several μm or more and several hundred μm or less. If a diameter of the fibers is thinner than this range, in general terms, a lot of powder dusts may be generated at a manufacturing site, and there is a risk of lung diseases when they reach into a lung. For an end user of the product, the flock fibers are attached to a surface of a printed cloth, so similar problem may occur. If a diameter of the flock fibers is thicker than this range, it may be difficult to flock (embed or disperse) the fibers in a polymer as the fibers do not fit a thickness of the sheath. Also, if a diameter of the fibers is too thick, it may give a stiff tactile feeling and a softness will be lost, and a tactile feeling will be deteriorated.

【0109】

In a first example, the main body 301 is manufactured by using a monofilament made of a TPU. The adhesive agent is a polyurethane adhesive agent. The flock 303 is cotton fibers. As a result, the main body 300 becomes soft, and a tactile feeling of a surface of the flock product 3 becomes a comfortable tactile feeling, so that the flock product 3 can be formed as a comfortable clothing.

【0110】

As illustrated in FIGS. 20 and 21, the flock product 3 includes first linear bodies 331 and second linear bodies 332.

【0111】

Each of the first linear bodies 331 extends in a first direction D1 while meandering. The first linear bodies 331 are arranged in a second direction D2. There is a gap between the adjacent first linear bodies 331. Each of the second linear bodies 332 extends in the second direction D2 while meandering. The second linear bodies 332 are arranged in the first direction D1. There is a gap between the adjacent second linear bodies 332. The second direction D2 is perpendicular to the first direction D1. Thereby, in planar view, the first linear bodies 331 intersect with the second linear bodies 332. The flock product 3 also has a lattice-like planar shape.

【0112】

The second linear bodies 332 are arranged on the first linear bodies 331. The second linear bodies 332 contact the first linear bodies 331.

【0113】

The flock product 3 having the above-described features has a softness, a comfort, an air permeability, a wicking, controlled roughness and smoothness, and has a cloth-like tactile feeling and a comfortable tactile feeling. That is, a flocking can convert the formed product printed by a 3D printer into textiles or fabrics that can be truly worn. In addition, a color of the flock product 3 can be changed.

【0114】

3. 3 Method for manufacturing flock products

FIG. 22 is a perspective view schematically illustrating an electrostatic deposition device used in a manufacturing of a flock product of a third embodiment.

【0115】

An electrostatic deposition device 341 shown in FIG. 22 is an up type electrostatic deposition device that flies the flock 303 from down to up in a vertical direction. The electrostatic deposition device 341 may be an electrostatic deposition device other than the up type electrostatic deposition device. For example, the electrostatic deposition apparatus 341 may be a down type electrostatic deposition device or the like that flies the flock 303 from up to down in a vertical direction.

【0116】

As illustrated in FIG. 22, the electrostatic deposition device 341 comprises a first electrode 351, a second electrode 352, a chamber 353, and a power supply 354.

【0117】

The first electrode 351 has a flat plate shape. The first electrode 351 is installed horizontally.

【0118】

The second electrode 352 has a flat plate lattice shape. The second electrode 352 is arranged above of the first electrode in a vertical direction. The second electrode 352 is installed horizontally. For this reason, the second electrode 352 is parallel to the first electrode 351. The second electrode 352 is grounded.

【0119】

The chamber 353 accommodates the first electrode 351 and the second electrode 352.

【0120】

The power supply 354 generates a DC high voltage. A positive electrode 361 of the power supply 354 is electrically connected to the first electrode 351. A negative electrode 362 of the power supply 354 is electrically connected to and grounded to the second electrode 352. Thereby, the generated DC high voltage is applied between the first electrode 351 and the second electrode 352.

【0121】

When the flock 303 is electrostatically deposited on the workpiece 371, the flock 303 is placed on an upper surface 351S of the first electrode 351. Further, the workpiece 371 is installed above the second electrode 352. Thereafter, the power supply 354 apply a DC high voltage between the first electrode 351 and the second electrode 352. Thereby, the flock 303 is charged, and the charged flock 303 flies from the upper surface 351S of the first electrode 351 to the workpiece 371 via the second electrode 352. At that time, the charged flock 303 passes through a gap formed in the second electrode 352. The flock 303 that reaches the workpiece 371 adheres to the workpiece 371. Thereby, the flock 303 is electrostatic deposited on the workpiece 371.

【0122】

FIG. 23 is a flowchart showing a flow of manufacturing of a flock product of a third embodiment.

【0123】

When the flock product 3 is manufactured, steps S101 to S106 shown in FIG. 23 are performed. Step S101 is a primary process for printing the main body 301 by a 3D printer. Steps S102 to S105 following the step S101 are secondary processes for modifying a tactile feeling and an appearance of a surface of the main body 301 by an electrostatic deposition, that is an electrostatic flocking, performed on a surface of the printed main body 301.

【0124】

In the step S101, the main body 301 to be processed is manufactured. The main body 301 is manufactured by a 3D printer and manufactured by the FDM method. However, the main body 301 may be manufactured by a forming device other than a 3D printer, or may be manufactured by a forming method other than the FDM method.

【0125】

In the subsequent step S102, the adhesive layer 302 is arranged on a surface 301S of the main body 301. Thereby, a workpiece 371 made of the main body 301 and the adhesive layer 302 is produced. At that time, a liquid adhesive agent is applied to the surface 301S of the main body 301 by a spray method, a brushing method, a roller coating method, a doctor blade method, or the like. Thereby, a thin adhesive layer 302 that extends throughout the surface 301S of the main body 301 is formed. The adhesive agent to be applied is selected to fit an electrostatic deposition. The placed adhesive

layer 302 promotes an adhesion between the flock 303 and the main body 301.

【0126】

In the following step S103, the flock 303 and the workpiece 371 are introduced into the chamber 353.

At that time, the flock 303 is placed on an upper surface 351S of the first electrode 351. Further, the workpiece 371 is arranged above the second electrode 352 in a vertical direction.

【0127】

In the following step S104, the flock 303 is pierced into the adhesive layer 302. The flock 303 is pierced into the adhesive layer 302 by an electrostatic deposition. At that time, the power supply 354 apply a DC high voltage between the first electrode 351 and the second electrode 352. Thereby, the flock 303 is charged, and the charged flock 303 flies from the upper surface 351S of the first electrode 351 to the workpiece 371 via the second electrode 352. The flock 303 that reaches the workpiece 371 adheres to the adhesive layer 302. Thereby, the flock 303 is adhered to the surface 301S of the main body 301 via the adhesive layer 302, covering the surface 301S of the main body 301. This brings a new tactile feeling. One end of the attached flock 303 is buried in the adhesive layer 302 and fixed to the adhesive layer 302. A rest of the attached flock 303 is arranged outside the adhesive layer 302. Thereby, the flock 303 protrudes from the adhesive layer 302. For this reason, the flock 303 is pierced into the adhesive layer 302 with the flock 303 protruding from the adhesive layer 302. If the flock 303 is fibers, the flock 303 is pierced into the adhesive layer 302 in a state substantially perpendicular

to the surface 301S of the main body 301.

【0128】

In the following step S105, the adhesive layer 302 can be cured. At that time, the adhesive layer 302 is dried and baked by a heating or the like.

【0129】

In the following step S106, a cleaning is performed. At that time, the adhesive layer 302 removes excessive flocks 303 that are not adhered to the main body 301. This completes the flock product 3.

【0130】

A flocking may be performed manually by a portable electrostatic coating device or the like.

【0131】

FIG. 24 is a photograph of a prototype of a main body provided in a flock product of a third embodiment. FIG. 25 is a photograph of a prototype of a flock product of a third embodiment.

【0132】

When comparing the main body 301 before a flocking shown in FIG. 24 and the flock product 3 after a flocking shown in FIG. 25, it can be understood that a complex unevenness can be formed on a surface of the flock product 3 by a flocking.

【0133】

Step S102 for arranging the adhesive layer 302 on the surface 301S of the main body 301 and step

S104 for piercing the flock 303 into the adhesive layer 302, require only a very short time, for example, 3-10 minutes. Even shorter times are possible, if the steps are automated. However, step S105 for curing the adhesive layer 302 takes a long time, for example, several hours. However, by selecting an adhesive agent, it is possible to reduce the time required for step S105.

【0134】

The coating state of the flock 303 of the surface 301S of the main body 301 can be adjusted by adjusting parameters of an electrostatic deposition in step S104. For example, by adjusting the parameters, the entire surface 301S of the main body 301 can be uniformly coated with the flock 303, or the surface 301S of the main body 301 can be coated with the flock 303 so that a density of the flock 303 has a gradient.

【0135】

A tactile feeling of the flock product 3 can be adjusted by adjusting a type, a decitex (dTex) and a length of the flock 303. A density of the flock 303 can be adjusted by adjusting the main body 301, properties of the adhesive agent, characteristics of the flock 303 and process conditions.

【0136】

The flock 303 is unlikely effected by materials of the main body 301, but can be adjusted by selecting an adhesive agent. Thereby, the flock product 3 suitable for various applications can be manufactured.

【0137】

Characteristics of the flock product 3 are unlikely effected by characteristics of the main body 301, and can be adjusted by selecting an adhesive agent. This is because the adhesive layer 302 functions as an intermediate layer connecting the flock 303 to the main body 301.

【0138】

Two or more types of the flocks 303 may be combined to obtain a structure and characteristics of the flock product 3 that cannot be obtained with one type of the flock 303.

【0139】

In order to implement the method for manufacturing the flock products described above, a factory may be established for performing the primary process and the secondary processes described above according to customer demands or seasonal collections. A factory may be established for performing only the above-described secondary processes according to customer demands. In this case, the main body 300 is provided by the customer.

【0140】

The present disclosure is not limited to the above embodiment, but may be substantially replaced by a configuration substantially identical to the configuration shown in the above embodiment, a configuration having the same effect, or a configuration capable of achieving the same purpose.

【Explanation of reference numbers】

【0141】

1 Forming material (filament), 101 Core/sheath structure, 111 Core, 112 Sheath, 121 First thermoplastic polymer, 122 Second thermoplastic polymer, 123 Fibers/particles, 1M Forming material, 2 Formed product, 201 First linear body, 202 Second linear body, 210 Linear body, 221 Core/sheath structure, 231 Core, 232 Sheath, 241 Linear main body, 242 Protrusions, 251 Crossing fibers/crossing particles, 261 Human skin, 271 3D printer, 281 Filament spool, 282 Print head, 283 Drive mechanism, 284 Plate, 288 Molten material, 3 Flock product, 301 Main body, 302 Adhesive layer, 303 Flock, 311 Human skin, 331 First linear body, 332 Second linear body, 341 Electrostatic deposition device, 351 First electrode, 352 Second electrode, 353 Chamber, 354 Power supply, 361 Positive electrode, 362 Negative electrodes.

Claims

1. A core / sheath structure composing a forming material or a formed product which is a melted and cured product of the forming material, comprising:

a core having a linear shape and an outer peripheral surface and including a first thermoplastic polymer; and

a sheath covering the outer peripheral surface and including a second thermoplastic polymer and at least one selected from a group consisting of fibers and particles dispersed in the second thermoplastic polymer.
2. The core / sheath structure according to claim 1, wherein the core / sheath structure composes the forming material, and

at least one of the core and the sheath include one selected from a group consisting of a foaming agent and a whipping agent.
3. The core / sheath structure according to claim 1 or 2, wherein the core is a porous body.
4. The core / sheath structure according to any of claims 1 to 3, wherein at least one of the first thermoplastic polymer and the second thermoplastic polymer include a thermoplastic elastomer.
5. The core / sheath structure according to any of claims 1 to 4, wherein at least one of the core and the sheath include a reinforcing component.
6. A method for manufacturing a flock product comprising:

a) a step of arranging an adhesive layer on a surface of a material to be treated composed a forming material including a thermoplastic polymer or a formed product which is a melted and cured product of the forming material;

b) a step of piercing a flock into the adhesive layer; and

c) a step of curing the adhesive layer after the step b).

7. The method for manufacturing a flock product according to claim 6, wherein in the step b), the flock is pierced into the adhesive layer by an electrostatic deposition.

8. The method for manufacturing a flock product according to claim 6 or 7, wherein in the step b), the flock is pierced into the adhesive layer in a state that the flock is protruding from the adhesive layer.

9. The method for manufacturing a flock product according to any of claims 6 to 8, wherein the flock includes at least one selected from a group consisting of fibers and particles.

10. The method for manufacturing a flock product according to any of claims 6 to 9, wherein the material to be treated includes a thermoplastic polyurethane, and

the adhesive layer includes a polyurethane.

11. A flock product comprising:

a main body having a surface and composed of a forming material including a thermoplastic polymer or a formed product which is a melted and cured product of the forming material;

an adhesive layer arranged on the surface; and

a flock pierced into the adhesive layer.

12. The flock product according to claim 11, wherein the flock protrudes from the adhesive layer.

13. The flock product according to claim 11 or 12, wherein the flock includes at least one selected from a group consisting of fibers and particles.

14. The flock product according to any of claims 11 to 13, wherein the main body includes a thermoplastic polyurethane, and

the adhesive layer includes a polyurethane.