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# (54) POLYAMIDE SEA-ISLAND FIBER, PREPARATION METHOD THEREFOR, AND USE THEREOF

(57) The present invention relates to the technical field of polyamide materials, and specifically relates to a polyamide sea-island fiber and a process for producing the same and the use thereof. In the polyamide sea-island fiber, the island component is a polyamide resin selected from one of polyamide 56, polyamide 510, polyamide 511, polyamide 512, polyamide 513, polyamide 514, polyamide 515 and polyamide 516, preferably polyamide 56 or polyamide 510; the sea component is one of polyethylene, low-density polyethylene, polystyrene, water-soluble polyesters, polyesters and polyurethanes, preferably polyethylene, low-density polyethylene or water-soluble polyester. The polyamide sea-island fiber of the present invention has better mechanical properties, better softness, good dyeing properties, high grade of dyeing grey scale, high dye uptake, high dyeing depth and high color fastness.

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## Description

### Technical Field

**[0001]** The present invention belongs to the technical field of polyamide materials, and relates to a polyamide sea-island fiber, a process for producing the same and use thereof.

### Background Art

**[0002]** Sea-island composite fibers, also known as hyper-conjugated fibers, are formed by embedding a polymer in an extremely fine form (fibril) in another polymer (matrix). They are also called sea-island fiber because the dispersed phase (fibril) is in the form of island in the fiber cross section. Ultra-fine fibers are obtained by dissolving the sea component from the sea-island fiber. Sea-island fibers can be divided into two types, namely, figured sea-island fiber and unfigured sea-island fiber according to distribution rule. The figured sea-island fibers are uniform and immobile with regard to the island distribution, and are generally spun by a composite spinning process. That is, two polymers are spun through a melt composite spinning machine and a special spin pack, wherein one component is uniformly distributed as islands in another polymer (sea component). The islands of the unfigured fiber are neither mobile nor sufficiently uniform. The fineness of unfigured fibers varies greatly. The thinnest unfigured fiber is thinner than that of a figured fiber, but the thicker unfigured fibers can have a fineness of 0.1 dtex or more. The unfigured fibers are mainly manufactured by blending spinning. The sea component in the sea-island composite fiber is a water-soluble polymer. The sea component is removed by dissolving with water via hydrolysis to obtain isolated island components. Ultrafine fibers with a linear density of 0.03-0.3 dtex are thus formed, which are mainly used for imitation suede materials. Alternatively, the island component is dissolved off, resulting in hollow fibers, which are mainly used for adsorption materials.

**[0003]** The ultra-fine characteristics of sea-island fibers impart them excellent properties that conventional fibers cannot achieve: 1. soft and delicate hand feel, and significantly reduced bending rigidity; 2. good softness, and improved bending rigidity; 3. soft gloss and increased diffused light; 4. high cleaning capability; and increased contact area; 5. high water and oil absorption; 6. high density in structure; 7. strong thermal insulation, and more air retained.

**[0004]** The products have both the properties of natural leather (such as hygroscopicity, softness and comfort) and the advantages such as good chemical resistance, good physical properties, waterproofness and light weight. They are mainly used in the fields of clothing, home textiles, industrial applications, etc.. The clothing includes imitation wools, imitation silks, imitation leathers, imitation peach skins, imitation suedes, high-density waterproof fabrics, thermal insulation materials, safety shoes and the like. The field of home textiles includes high-performance cleaning clothes, sofa cloth, curtain cloth, cases and the like. The field of industrial applications includes electronic product protective equipment, automotive trims, high-performance adsorbing and filtering materials, highly oil absorptive materials, and highly water absorptive materials.

**[0005]** Sea-island composite fibers have low linear density, large specific surface area; absorb more dyes quickly, and have small fiber radius. Therefore, the distance for the dye to diffuse into such fibers is short, the diffusion time is short and it is easy for the dye to penetrate deeply. In addition, the fibers have a high content of amorphous region and the dyeing dyes fast, which gives the sea-island fibers a poor levelness. Ultrafine fibers have large surface area, the surface is not smooth enough, the dyes are used in a large amount, and the stained dye that is in a large amount is difficult to be removed by washing. Therefore, the wet fastness of dyes on ultrafine fiber fabrics is lower than that on conventional fibers.

**[0006]** CN106987923A discloses a stock solution dyed black sea-island fiber. The stock solution dyed black sea-island fiber is used for solving the problem that sea-island fibers are difficult to be deeply stained and have poor color fastness. The fiber comprises a sea component and an island component. The island component comprises 1 to 60% by weight of a black master batch, and 10 to 90% by weight of polyamide 6 or polyester; the sea component is an alkali soluble polyester; after splitting, the fineness is less than 0.08 dtex, blackness L value is less than 15, and the color fastness is 4 grade or higher. The sea-island fiber is black, and the color is too single, which limits its application.

**[0007]** CN106435821A discloses blended and melted sea-island fibers, ultrafine fibers as well as a preparation process thereof, wherein the island component is polyamide and the sea component is a water soluble polyester compound, the process comprising: blending, melting and spinning the polyamide and the water soluble polyester, placing the sea-island fibers into hot water, and conducting weight reduction treatment by water to remove the sea component polyester, and thus obtain the polyamide ultrafine fibers. In the Examples, the island component is selected from polyamide 6 and polyamide 66, and the sea component is selected from water-soluble polyester. A sea-island fiber is prepared by a blend spinning process, wherein the island component is used as the dispersed phase and the sea component is used as the matrix. The blending during the processing is non-uniform, which results in non-uniform distribution of the island component. The components are greatly different in the thickness upon splitting, which affects the subsequent dyeing and causes a chromatic difference.

## SUMMARY OF THE INVENTION

**[0008]** A first object of the present invention is to provide a polyamide sea-island fiber simultaneously having better mechanical properties, better softness and good dyeing properties.

**[0009]** A second object of the present invention is to provide a process for producing the polyamide sea-island fiber, wherein the island component polyamide uses materials from non-petroleum-based sources (i.e., bio-based sources), which will not cause serious pollution and is beneficial to environmental protection.

**[0010]** A third object of the present invention is to provide a use of the polyamide sea-island fiber.

**[0011]** In order to achieve the above objects, the present invention provides the following solutions.

[Polyamide Sea-island Fiber]

**[0012]** The present invention provides a polyamide sea-island fiber, wherein the island component is a polyamide resin selected from one of polyamide 56, polyamide 510, polyamide 511, polyamide 512, polyamide 513, polyamide 514, polyamide 515 and polyamide 516, preferably polyamide 56 or polyamide 510; the sea component is one of polyethylene, low-density polyethylene, polystyrene, water-soluble polyesters, polyesters and polyurethanes, preferably polyethylene, low-density polyethylene or water-soluble polyester.

**[0013]** The island component may be super bright (SB) polyamide resins, semi dull (SD) polyamide resins, full dull (FD) polyamide resins and mixtures thereof.

**[0014]** In some preferred embodiments of the present invention, the island component polyamide resin has a relative viscosity of 2.4-3.0, preferably 2.5-2.9, and more preferably 2.6-2.8; and/or
the mass ratio of the island component to the sea component of the sea-island fiber is 20-80:80-20, and more preferably 30-70:70-30.

**[0015]** In some preferred embodiments of the present invention, the sea-island fiber includes

a figured sea-island fiber and an unfigured sea-island fiber; and/or

the number of the islands in the figured sea-island fiber is 16-500;

in some preferred embodiments of the present invention, the polyamide sea-island fiber has a fineness of 10-300 dtex, preferably 20-200 dtex, and more preferably 30-100 dtex; and/or

the polyamide sea-island fiber has a break strength of 2.0-5.0 cN/dtex, preferably 2.5-4.5 cN/dtex, and more preferably 3.0-4.0 cN/dtex; and/or

the polyamide sea-island fiber has an elongation at break of 30-80%, preferably 40-70%, and more preferably 45-60%; and/or

the polyamide sea-island fiber has an initial modulus of 20-50 cN/dtex, preferably 23-45 cN/dtex, and more preferably 28-38 cN/dtex; and/or

after the polyamide sea-island fiber is split, the island component has a monofilament fineness of 0.001-0.2 dtex, preferably 0.005-0.1 dtex, and more preferably 0.01-0.05 dtex; and/or

the polyamide sea-island fiber has a K/S value of 15 or more, preferably 20 or more, and more preferably 25 or more; and/or

the polyamide sea-island fiber has a dye uptake of 90% or more, preferably 93% or more, and more preferably 96% or more; and/or

the polyamide sea-island fiber has a dyeing uniformity (grey scale) of grade 3.5 or more, preferably grade 4.0 or more, and more preferably grade 4.5 or more; and/or

the polyamide sea-island fiber has a soap fastness for fading of grade 3.0 or more, preferably grade 3.5 or more, more preferably grade 4.0 or more; and still more preferably 4.5 or more; and/or

the polyamide sea-island fiber has a soap fastness for staining of grade 3.0 or more, preferably grade 3.5 or more, more preferably grade 4.0, and still more preferably grade 4.5 or more.

**[0016]** The present invention provides a process for producing the above figured sea-island fiber, the process comprising the steps of:

1) heating and melting the island component resin and the sea component resin respectively to obtain two melts; conveying the two melts into a spinning beam through a pipe; precisely metering each melt by a metering pump respectively, and injecting them into a sea-island type of composite spin pack in the spinning beam; distributing the two melts via a distribution pipe in the spin pack, and converging and extruding them at the entrance of a spinneret orifice; wherein the island component has a moisture content of less than 1500 ppm, and the sea component has a moisture content of less than 300 ppm; and

2) cooling, spinning finishing, drawing, heat setting and winding the as-formed fiber that is extruded in Step 1), so as to obtain the figured sea-island fiber.

**[0017]** The heating in Step 1) is performed in a screw extruder, wherein the screw extruder preferably includes five zones for heating;

for a screw for the island component, the temperature of a first zone is 200-260°C; the temperature of a second zone is 230-280°C; the temperature of a third zone is 240-290°C; the temperature of a fourth zone is 260-300°C; and the temperature of a fifth zone is 270-310°C; and/or

for a screw for the sea component, the temperature of a first zone is 120-220°C; the temperature of a second zone is 140-240°C; the temperature of a third zone is 160-260°C; the temperature of a fourth zone is 180-280°C; and the temperature of a fifth zone is 160-290°C. For sea-island fibers, reasonable adjustment of the temperatures of the two melts is the key for controlling the cross-sectional shape of the two components after they are conjugated. When the temperature is too high or too low, the cross-sectional shape of the as-formed yarn will change and the uniformity of the cross-sectional shape will also decrease. Generally, the difference in the melt viscosities of the two polymers will affect the cross-sectional shape. If the viscosities of the two melts are greatly different, the uniformity of the cross-sectional shape will be affected, and the island component will even adhere, or will even constitute a "solid" body. This will render the island component not capable of being separated during the post treatment of splitting. Therefore, a suitable spinning temperature should be selected during spinning. The process is adjusted to ensure that the spinning temperature falls within the above-mentioned temperature ranges and the melt viscosities of the sea component and island component match with each other.

**[0018]** In Step 1), the temperature of the spinning beam is 200-300°C; the spin pack pressure of the island component is 10.0-15.0 MPa; the spin pack pressure of the sea component is 8.0-15.0 MPa; and the spin pack pressure difference between the sea component and the island component is controlled to be less than 4.0 MPa.

**[0019]** In Step 2), the cooling is conducted by quench air or cross air blow; an air speed is 0.2-1.2 m/s, preferably 0.2-1.0 m/s, and more preferably 0.3-0.8 m/s; the air temperature of the quench air is 15-30°C, preferably 20-27°C, and more preferably 22-25°C; and/or

an oil pick up is 0.2-1.0 wt%, preferably 0.3-0.8 wt%, and more preferably 0.4-0.6 wt%, wherein the oil pick up is calculated based on the weight of the fiber; and/or

the drawing process is that the as-formed yarn that has been spinning finished is directed to a hot drawing roller through a feeding roller for drawing, and the drawing ratio is preferably 2.0-5.0, and more preferably 2.5-3.0; and/or

the heat setting temperature is 150-220°C, preferably 160-200°C, and more preferably 170-180°C; and/or

the winding speed is 1000-6000 m/min, preferably 2000-5000 m/min, and more preferably 2500-4000 m/min.

**[0020]** In some preferred embodiments of the present invention, the process further comprises: splitting the sea-island fiber obtained in Step 2) in a solvent to remove the sea component;

the solvent is toluene, xylene and 1-10 wt% aqueous solution of sodium hydroxide; the splitting temperature is 60-100°C, preferably 65-95°C, and more preferably 75-85°C; the splitting time is 10-70 mins, preferably 20-60 mins, and more preferably 30-50 mins; and the bath ratio is 1:10-1:80, preferably 1:20-1:60, and more preferably 1:30-1:40; and/or

the weight loss percent of the sea-island fiber is 20-50 wt%, preferably 25-45 wt%, and more preferably 30-40 wt%.

**[0021]** The present invention provides a process for producing the above-mentioned unfigured sea-island fiber, the process comprising the steps of:

a) uniformly mixing the island component and the sea component in a certain proportion and then heating and melting the mixture; conveying the resultant blended melt into a spinning beam through a pipe; precisely metering the blended melt by a metering pump, and injecting it into a one-component spin pack in the spinning beam; and extruding the blended melt through a spinneret orifice; wherein the island component has a moisture content of less than 1500 ppm; and the sea component has a moisture content of less than 300 ppm;
2) cooling, spinning finishing, drawing, heat setting and winding the as-formed fiber which is extruded to obtain the unfigured sea-island fiber.

**[0022]** In Step a), the heating is performed in a screw extruder, wherein the screw extruder preferably includes five zones for heating; the temperature of a first zone is 180-240°C; the temperature of a second zone is 200-260°C; the temperature of a third zone is 220-270°C; the temperature of a fourth zone is 240-280°C; and the temperature of a fifth zone is 200-300°C.

**[0023]** In Step a), the temperature of the spinning beam is 200-300°C; and the spin pack pressure is 10.0-25.0 MPa.

**[0024]** In Step b), the cooling is conducted by quench air or cross air blow; the air speed is 0.2-1.2 m/s, preferably 0.4-1.0 m/s, and more preferably 0.6-0.8 m/s; the air temperature of the quench air is 15-30°C, preferably 23-27°C, and more preferably 24-25°C; and/or

the oil pick up is 0.2-1.0 wt%, preferably 0.3-0.8 wt%, and more preferably 0.4-0.6 wt%; and/or

the drawing process is that the as-formed yarn that has been spinning finished is directed to a hot drawing roller through a feeding roller for drawing, and the drawing ratio is preferably 2.0-5.0, and more preferably 2.5-3.0; and/or

the heat setting temperature is 150-220°C, preferably 160-200°C, and more preferably 170-180°C; and/or

the winding speed is 1000-6000 m/min, preferably 2000-5000 m/min, and more preferably 2500-4000 m/min.

**[0025]** In some preferred embodiments of the present invention, the process further comprises: splitting the sea-island fiber obtained in Step b) in a solvent to remove the sea component;

the solvent is toluene, xylene and 1-10 wt% aqueous solution of sodium hydroxide; the splitting temperature is 60-100°C, preferably 65-95°C, and more preferably 75-85°C; the splitting time is 10-70 mins, preferably 20-60 mins, and more preferably 30-50 mins; and the bath ratio is 1:10-1:80, preferably 1:20-1:60, and more preferably 1:30-1:40; and/or

the weight loss percent of the sea-island fiber is 20-50 wt%, preferably 25-45 wt%, and more preferably 30-40 wt%.

[Use of Polyamide Sea-island Fiber]

**[0026]** Polyamide sea-island fibers include filaments and staple fibers, and are mainly used in the field of the manufacture of imitation wools, imitation silks, imitation leathers, imitation peach skins, imitation suedes, high-density waterproof fabrics, high-performance cleaning clothes, high-performance adsorbing and filtering materials, highly oil absorptive materials, highly water absorptive materials, thermal insulation materials, medical materials, automotive trim materials, safety shoes, cases, handbags, sofas and the like.

**[0027]** As compared with conventional sea-island fabrics, the fabric made from the polyamide sea-island fiber of the present invention has softer hand feel, good penetration resistance and good dyeing properties. Such fabric is more suitable for wiping cloth. It produces good effect and is not apt to damage the surface of the object to be wiped. The superior fully dull effect possessed by such fabrics is sufficiently reflected in the fabrics for down jackets and nurse uniforms. Moreover, upon splitting, such fibers can produce an extremely fine yarn which has a smaller fineness, softer hand feel and less penetration resistance as compared with conventional sea-island extremely fine yarn. The production process is simple and easy to operate.

**[0028]** By adopting the above technical solutions, the present invention possesses the following benefits as compared with the prior art:
Firstly, the raw materials of the island component of the polyamide sea-island fiber according to the present invention are prepared by a biological process, and thus are green materials which do not depend on petroleum resources and do not cause serious pollution to the environment. Moreover, carbon dioxide emission and greenhouse effect can be

reduced.

**[0029]** Secondly, the polyamide sea-island fiber of the present invention has better mechanical properties and better softness.

**[0030]** Thirdly, the polyamide sea-island fiber of the present invention has good dyeing properties, high grade of dyeing grey scale, high dye uptake, high dyeing depth and high color fastness.

**[0031]** Finally, the polyamide sea-island fiber of the present invention has a monofilament fineness of 0.01-0.2 dtex after splitting. The monofilament is finer, and the fiber has a soft and delicate hand feel. The bending rigidity is significantly reduced, and the gloss is soft. The fiber has a larger specific surface area, and the structure is of high-density. It is more suitable for use in the field of imitation wools, imitation silks, imitation leathers, imitation peach skins, imitation suedes, high-density waterproof fabrics, high-performance cleaning clothes, high-performance adsorbing and filtering materials, highly oil absorptive materials, highly water absorptive materials, thermal insulation materials, medical materials, automotive trim materials, safety shoes, protection devices for electronic products, cases, handbags, sofas and the like.

## Mode of Carrying Out the Invention

**[0032]** In order to render the objects, technical solutions and advantages of the present disclosure clearer, the technical solutions of the present disclosure will be clearly and completely described hereinafter with reference to the Examples. Obviously, the Examples described are only part of but not all of the Examples of the present disclosure. All other Examples obtained by those of ordinary skill in the art based on the Examples in the present disclosure without spending inventive labor shall fall within the protection scope of the present disclosure.

(1) Fineness:
The fineness is measured according to GB/T 14343.
(2) Break Strength:
The break strength is measured according to GB/T 14344-2008.
(3) Elongation at Break:
The elongation at break is measured according to GB/T 14344-2008.
(4) Initial Modulus:
The initial Modulus is measured according to GB/T 14344. The initial modulus is defined as the break strength corresponding to 1% elongation at break.
(5) Weight Loss

Weight Loss (wt%) = (the fiber weight before splitting - the fiber weight after splitting)/the fiber weight before splitting × 100%;

(6) Dyeing Uniformity (grey card)/grade:
The dyeing uniformity is measured according to FZ/T 50008 Test Method for Dyeing Uniformity of Polyamide Filament.
(7) K/S value:
The K/S value of a dyed fabric is measured with a computer color measuring and color matching instrument. The K/S value represents the apparent color depth value.

$$K/S = \frac{(1-R)^2}{2R}$$

wherein S represents a dispersion coefficient, K represents an absorption coefficient, and R represents reflectance.
(8) Dye-uptake: The difference in concentrations of the dye liquors before and after dyeing is measured by using a spectrophotometer.

$$\text{Dye-uptake (\%)} = (A_0 - A_t)/A_0 \times 100\%;$$

wherein: Ao represents the absorbance value of the characteristic absorption peak of the dye before treatment, and $A_t$ represents the absorbance value of the dye at the treatment time t.
(9) Soap Fastness:
The soap fastness is measured according to the national standard GB/T 3921.1-1997.
(10) Relative Viscosity:

The relative viscosity of polyamide 5X resin is measured by a concentrated sulfuric acid method using an Ubbelohde viscometer. The steps are as follows: precisely weighing 0.25±0.0002 g of the dried polyamide 5X resin sample, adding 50 mL of concentrated sulfuric acid (96%) for dissolution. The flow time to of the concentrated sulfuric acid and the flow time t of the sample solution of the polyamide 5X continuous bulked filament are measured and recorded in a water bath at a constant temperature of 25°C.

**[0033]** Relative viscosity is calculated according to the following equation:

$$\text{Relative Viscosity } VN = t/t_0;$$

t represents the flow time of the solution;

to represents the flow time of the solvent.

(11) Moisture Content:

**[0034]** The moisture content is measured by a Karl Fischer moisture titrator.

**[0035]** The water soluble polyester COPET is commercially available from Puyuan Chemical Fiber Co., Ltd. (Shanghai). The polyester COPET is in fiber grade, and has an intrinsic viscosity of 0.6-0.8. Polyamide 56 chips having a relative viscosity of 2.4-3.0 are commercially available from Kaisai (Jinxiang) Biomaterials Co., Ltd. Polyamide 6 chips having a relative viscosity of 2.5-2.7 are commercially available from Ruimeifu Industrial Co., Ltd. (Jiangsu). Polyamide 66 chips having a relative viscosity of 2.4-2.7 are commercially available from Shenma Plastic Technology Co., Ltd (Pingdingshan). Polyethylene resins having a melt index of 10-80 g/10min are commercially available from Yanshan Petrochemical Co., Ltd. (Beijing).

**Example 1**

**[0036]** The present Example provided a process for producing a polyamide 56/polyethylene figured sea-island fiber, comprising the following steps:

1) drying the island component polyamide 56 resin and the sea component polyethylene resin respectively; after drying, controlling the moisture content of the island component at 800 ppm, and controlling the moisture content of the sea component at 60 ppm;

2) heating and melting the island component resin and the sea component resin in a certain proportion respectively, wherein the mass ratio of the island component to the sea component in the island-sea fiber was 70:30; conveying the two melts to a spinning beam through a pipe; precisely metering each melt by a metering pump respectively, and injecting them into a sea-island type of composite spin pack in the spinning beam; converging and extruding the two melts at the entrance of the spinneret orifice after being distributed via a distribution pipe in the spin pack; and

3) cooling, spinning finishing, drawing, heat setting and winding the as-formed fiber that is extruded, so as to obtain the figured sea-island fiber.

**[0037]** The number of islands in a monofilament of the figured sea-island fiber was 51, and the fiber has a circular cross section.

**[0038]** In Step 1), the relative viscosity of the island component polyamide 56 resin was 2.5.

**[0039]** In Step 2), the heating was performed in a screw extruder, wherein the screw extruder included five zones for heating;

for the screw for the island component: the temperature of the first zone was 230°C; the temperature of the second zone was 250°C; the temperature of the third zone was 270°C; the temperature of the fourth zone was 290°C; and the temperature of the fifth zone was 285°C;

for the screw for the sea component: the temperature of the first zone was 120°C; the temperature of the second zone was 140°C; the temperature of the third zone was 160°C; the temperature of the fourth zone was 180°C; and the temperature of the fifth zone was 220°C;

in Step 2), the temperature of the spinning beam was 280°C; the spin pack pressure of the island component was 13.0 MPa; the spin pack pressure of the sea component was 11.0 MPa; and the spin pack pressure difference between the sea component and the island component was controlled to be less than 4.0 MPa.

**[0040]** In step 3), the cooling was conducted by quench air; the air speed was 0.5 m/s; the air temperature was 23°C; the oil pick up was 0.3 wt%, which was calculated based on the weight of the fiber;
the as-formed yarn that has been spinning finished was directed to a hot drawing roller through a feeding roller for drawing, and the drawing ratio was 3.0, the heat setting temperature was 180°C; and the winding speed was 3500 m/min.
**[0041]** The splitting process of the sea-island fiber was as follows: the solvent was xylene; the splitting temperature was 70°C; the splitting time was 30 mins; the bath ratio was 1:30; and the weight loss of the fiber was 29 wt%.
**[0042]** The test data of the sea-island fibers obtained were shown in Table 1.

**Example 2**

**[0043]** The present Example provided a process for producing a polyamide 56/low-density polyethylene figured sea-island fiber, comprising the following steps:

1) drying the island component polyamide 56 resin and the sea component low-density polyethylene resin respectively; after drying, controlling the moisture content of the island component at 1000 ppm, and controlling the moisture content of the sea component at 90 ppm;

2) heating and melting the island component resin and the sea component resin in a certain proportion respectively, wherein the mass ratio of the island component to the sea component in the island-sea fiber was 60:40; conveying the two melts to a spinning beam through a pipe; precisely metering each melt by a metering pump respectively, and injecting them into a sea-island type of composite spin pack in the spinning beam; converging and extruding the two melts at the entrance of the spinneret orifice after being distributed via a distribution pipe in the spin pack; and

3) cooling, spinning finishing, drawing, heat setting and winding the as-formed fiber that is extruded, so as to obtain the figured sea-island fiber.

**[0044]** The number of islands in a monofilament of the figured sea-island fiber was 37, and the fiber has a circular cross section.
**[0045]** In Step 1), the relative viscosity of the island component polyamide 56 resin was 2.8.
**[0046]** In Step 2), the heating was performed in a screw extruder, wherein the screw extruder included five zones for heating;

for the screw for the island component: the temperature of the first zone was 240°C; the temperature of the second zone was 260°C; the temperature of the third zone was 280°C; the temperature of the fourth zone was 290°C; and the temperature of the fifth zone was 280°C;

for the screw for the sea component: the temperature of the first zone was 120°C; the temperature of the second zone was 150°C; the temperature of the third zone was 180°C; the temperature of the fourth zone was 190°C; and the temperature of the fifth zone was 210°C;

in Step 2), the temperature of the spinning beam was 270°C; the spin pack pressure of the island component was 14.0 MPa; the spin pack pressure of the sea component was 13.0 MPa; and the spin pack pressure difference between the sea component and the island component was controlled to be less than 4.0 MPa.

**[0047]** In step 3), the cooling was conducted by quench air; the air speed was 0.3 m/s; the air temperature was 22°C; the oil pick up was 0.6 wt%, which was calculated based on the weight of the fiber;
the as-formed yarn that has been spinning finished was directed to a hot drawing roller through a feeding roller for drawing, and the drawing ratio was 3.2, the heat setting temperature was 120°C; and the winding speed was 4000 m/min.
**[0048]** The splitting process of the sea-island fiber was as follows: the solvent was toluene; the splitting temperature was 80°C; the splitting time was 40 mins; the bath ratio was 1:40; and the weight loss of the fiber was 38 wt%.
**[0049]** The test data of the sea-island fibers obtained were shown in Table 1.

**Example 3**

**[0050]** The present Example provided a process for producing a polyamide 56/water soluble polyester figured sea-island fiber, comprising the following steps:

1) drying the island component polyamide 56 resin and the sea component water soluble polyester resin respectively; after drying, controlling the moisture content of the island component at 500 ppm, and controlling the moisture content of the sea component at 30 ppm;

2) heating and melting the island component resin and the sea component resin in a certain proportion respectively, wherein the mass ratio of the island component to the sea component in the island-sea fiber was 80:20; conveying the two melts to a spinning beam through a pipe; precisely metering each melt by a metering pump respectively, and injecting them into a sea-island type of composite spin pack in the spinning beam; converging and extruding the two melts at the entrance of the spinneret orifice after being distributed via a distribution pipe in the spin pack; and

3) cooling, spinning finishing, drawing, heat setting and winding the as-formed fiber that is extruded, so as to obtain the figured sea-island fiber.

**[0051]** The number of islands in a monofilament of the figured sea-island fiber was 37, and the fiber has a circular cross section.

**[0052]** In Step 1), the relative viscosity of the island component polyamide 56 resin was 2.8.

**[0053]** In Step 2), the heating was performed in a screw extruder, wherein the screw extruder included five zones for heating;

for the screw for the island component: the temperature of the first zone was 240°C; the temperature of the second zone was 260°C; the temperature of the third zone was 280°C; the temperature of the fourth zone was 290°C; and the temperature of the fifth zone was 290°C;

for the screw for the sea component: the temperature of the first zone was 180°C; the temperature of the second zone was 220°C; the temperature of the third zone was 240°C; the temperature of the fourth zone was 260°C; and the temperature of the fifth zone was 240°C;

in Step 2), the temperature of the spinning beam was 285°C; the spin pack pressure of the island component was 14.0 MPa; the spin pack pressure of the sea component was 13.0 MPa; and the spin pack pressure difference between the sea component and the island component was controlled to be less than 4.0 MPa.

**[0054]** In step 3), the cooling was conducted by quench air; the air speed was 0.6 m/s; the air temperature was 25°C; the oil pick up was 0.5 wt%, which was calculated based on the weight of the fiber;
the as-formed yarn that has been spinning finished was directed to a hot drawing roller through a feeding roller for drawing, and the drawing ratio was 2.5, the heat setting temperature was 160°C; and the winding speed was 2500 m/min.

**[0055]** The splitting process of the sea-island fiber was as follows: the solvent was 20 wt% aqueous solution of sodium hydroxide; the splitting temperature was 90°C; the splitting time was 40 mins; the bath ratio was 1:20; and the weight loss of the fiber was 19 wt%.

**[0056]** The test data of the sea-island fibers obtained were shown in Table 1.

**Example 4**

**[0057]** The present Example provided a process for producing a polyamide 510/polyethylene figured sea-island fiber, comprising the following steps:

1) drying the island component polyamide 510 resin and the sea component polyethylene resin respectively; after drying, controlling the moisture content of the island component at 900 ppm, and controlling the moisture content of the sea component at 80 ppm;

2) heating and melting the island component resin and the sea component resin in a certain proportion respectively, wherein the mass ratio of the island component to the sea component in the island-sea fiber was 65:35; conveying the two melts to a spinning beam through a pipe; precisely metering each melt by a metering pump respectively, and injecting them into a sea-island type of composite spin pack in the spinning beam; converging and extruding

the two melts at the entrance of the spinneret orifice after being distributed via a distribution pipe in the spin pack; and

3) cooling, spinning finishing, drawing, heat setting and winding the as-formed fiber that is extruded, so as to obtain the figured sea-island fiber.

**[0058]** The number of islands in a monofilament of the figured sea-island fiber was 51, and the fiber has a circular cross section.

**[0059]** In Step 1), the relative viscosity of the island component polyamide 510 resin was 2.6.

**[0060]** In Step 2), the heating was performed in a screw extruder, wherein the screw extruder included five zones for heating;

for the screw for the island component: the temperature of the first zone was 220°C; the temperature of the second zone was 230°C; the temperature of the third zone was 240°C; the temperature of the fourth zone was 260°C; and the temperature of the fifth zone was 260°C;

for the screw for the sea component: the temperature of the first zone was 130°C; the temperature of the second zone was 150°C; the temperature of the third zone was 170°C; the temperature of the fourth zone was 180°C; and the temperature of the fifth zone was 230°C;

in Step 2), the temperature of the spinning beam was 255°C; the spin pack pressure of the island component was 12.0 MPa; the spin pack pressure of the sea component was 10.0 MPa; and the spin pack pressure difference between the sea component and the island component was controlled to be less than 4.0 MPa.

**[0061]** In step 3), the cooling was conducted by quench air; the air speed was 0.8 m/s; the air temperature was 22°C; the oil pick up was 0.4 wt%, which was calculated based on the weight of the fiber;
the as-formed yarn that has been spinning finished was directed to a hot drawing roller through a feeding roller for drawing, and the drawing ratio was 2.5, the heat setting temperature was 130°C; and the winding speed was 3000 m/min.

**[0062]** The splitting process of the sea-island fiber was as follows: the solvent was xylene; the splitting temperature was 70°C; the splitting time was 30 mins; the bath ratio was 1:30; and the weight loss of the fiber was 34 wt%.

**[0063]** The test data of the sea-island fibers obtained were shown in Table 1.

**Example 5**

**[0064]** The present Example provided a process for producing a polyamide 56/water soluble polyester unfigured sea-island fiber, comprising the following steps:

1) drying the island component resin and the sea component resin respectively; after drying, controlling the moisture content of the island component at 800 ppm, and controlling the moisture content of the sea component at 90 ppm;

2) uniformly mixing the aforementioned island component and the sea component in a certain proportion and then heating and melting the mixture, wherein the mass ratio of the island component to the sea component in the island-sea fiber was 70:30; conveying the blended melt to a spinning beam through a pipe; precisely metering the blended melt by a metering pump, and injecting it into a one-component spin pack in the spinning beam; and extruding the blended melt through a spinneret orifice; and

3) cooling, spinning finishing, drawing, heat setting and winding the as-formed fiber that is extruded to obtain the unfigured sea-island fiber.

**[0065]** In Step 1), the relative viscosity of the island component polyamide 56 resin was 2.7.

**[0066]** In Step 2), the heating was performed in a screw extruder, wherein the screw extruder included five zones for heating: the temperature of the first zone was 220°C; the temperature of the second zone was 240°C; the temperature of the third zone was 260°C; the temperature of the fourth zone was 280°C; and the temperature of the fifth zone was 280°C;
in Step 2), the temperature of the spinning beam was 280°C; the pressure of the spin pack was 16.0 MPa.

**[0067]** In step 3), the cooling was conducted by quench air; the air speed was 0.4 m/s; the air temperature was 24°C; the oil pick up was 0.3 wt%, which was calculated based on the weight of the fiber;
the as-formed yarn that has been spinning finished was directed to a hot drawing roller through a feeding roller for drawing, and the drawing ratio was 3.0, the heat setting temperature was 170°C; and the winding speed was 4200 m/min.

**[0068]** The splitting process of the sea-island fiber was as follows: the solvent was 3.0 wt% aqueous solution of sodium hydroxide; the splitting temperature was 90°C; the splitting time was 40 mins; the bath ratio was 1:30; and the weight loss of the fiber was 28 wt%.

**[0069]** The test data of the sea-island fibers obtained were shown in Table 1.

**Example 6**

**[0070]** The present Example provided a process for producing a polyamide 510/water soluble polyester unfigured sea-island fiber, comprising the following steps:

1) drying the island component resin and the sea component resin respectively; after drying, controlling the moisture content of the island component at 700 ppm, and controlling the moisture content of the sea component at 60 ppm;

2) uniformly mixing the aforementioned island component and the sea component in a certain proportion and then heating and melting the mixture, wherein the mass ratio of the island component to the sea component in the island-sea fiber was 60:40; conveying the blended melt to a spinning beam through a pipe; precisely metering the blended melt by a metering pump, and injecting it into a one-component spin pack in the spinning beam; and extruding the blended melt through a spinneret orifice;

3) cooling, spinning finishing, drawing, heat setting and winding the as-formed fiber extruded to obtain the unfigured sea-island fiber.

**[0071]** In Step 1), the relative viscosity of the island component polyamide 510 resin was 2.7.

**[0072]** In Step 2), the heating was performed in a screw extruder, wherein the screw extruder included five zones for heating: the temperature of the first zone was 220°C; the temperature of the second zone was 230°C; the temperature of the third zone was 260°C; the temperature of the fourth zone was 270°C; and the temperature of the fifth zone was 280°C;
in Step 2), the temperature of the spinning beam was 270°C; the pressure of the spin pack was 14.0 MPa.

**[0073]** In step 3), the cooling was conducted by quench air; the air speed was 0.6 m/s; the air temperature was 25°C; the oil pick up was 0.5 wt%, which was calculated based on the weight of the fiber;
the as-formed yarn that has been spinning finished was directed to a hot drawing roller through a feeding roller for drawing, and the drawing ratio was 1.5, the heat setting temperature was 180°C; and the winding speed was 4000 m/min.

**[0074]** The splitting process of the sea-island fiber was as follows: the solvent was 5.0 wt% aqueous solution of sodium hydroxide; the splitting temperature was 85°C; the splitting time was 50 mins; the bath ratio was 1:20; and the weight loss of the fiber was 38 wt%.

**[0075]** The test data of the sea-island fibers obtained were shown in Table 1.

**Comparative Example 1**

**[0076]** The present Comparative Example provided a process for producing a polyamide 6/polyethylene figured sea-island fiber, comprising the following steps:

1) drying the island component polyamide 6 resin and the sea component polyethylene resin respectively; after drying, controlling the moisture content of the island component at 800 ppm, and controlling the moisture content of the sea component at 60 ppm;

2) heating and melting the island component resin and the sea component resin in a certain proportion respectively, wherein the mass ratio of the island component to the sea component in the island-sea fiber was 70:30; conveying the two melts to a spinning beam through a pipe; precisely metering each melt by a metering pump respectively, and injecting them into a sea-island type of composite spin pack in the spinning beam; converging and extruding the two melts at the entrance of the spinneret orifice after being distributed via a distribution pipe in the spin pack; and

3) cooling, spinning finishing, drawing, heat setting and winding the as-formed fiber extruded, so as to obtain the figured sea-island fiber.

**[0077]** The number of islands in a monofilament of the figured sea-island fiber was 51, and the fiber has a circular cross section.

**[0078]** In Step 1), the relative viscosity of the island component polyamide 6 resin was 2.5.

**[0079]** In Step 2), the heating was performed in a screw extruder, wherein the screw extruder included five zones for heating;

for the screw for the island component: the temperature of the first zone was 220°C; the temperature of the second zone was 230°C; the temperature of the third zone was 240°C; the temperature of the fourth zone was 260°C; and the temperature of the fifth zone was 275°C;

for the screw for the sea component: the temperature of the first zone was 120°C; the temperature of the second zone was 140°C; the temperature of the third zone was 160°C; the temperature of the fourth zone was 180°C; and the temperature of the fifth zone was 220°C;

in Step 2), the temperature of the spinning beam was 250°C; the spin pack pressure of the island component was 12.0 MPa; the spin pack pressure of the sea component was 11.0 MPa; and the spin pack pressure difference between the sea component and the island component was controlled to be less than 4.0 MPa.

**[0080]** In step 3), the cooling was conducted by quench air; the air speed was 0.5 m/s; the air temperature was 23°C; the oil pick up was 0.3 wt%, which was calculated based on the weight of the fiber;
the as-formed yarn that has been spinning finished was directed to a hot drawing roller through a feeding roller for drawing, and the drawing ratio was 3.0, the heat setting temperature was 180°C; and the winding speed was 3500 m/min.

**[0081]** The splitting process of the sea-island fiber was as follows: the solvent was xylene; the splitting temperature was 70°C; the splitting time was 30 mins; the bath ratio was 1:30; and the weight loss of the fiber was 28 wt%.

**[0082]** The test data of the sea-island fibers obtained were shown in Table 1.

**Comparative Example 2**

**[0083]** The present Comparative Example provided a process for producing a polyamide 6/water soluble polyester unfigured sea-island fiber, comprising the following steps:

1) drying the island component resin and the sea component resin respectively; after drying, controlling the moisture content of the island component at 800 ppm, and controlling the moisture content of the sea component at 90 ppm;

2) uniformly mixing the aforementioned island component and the sea component in a certain proportion and then heating and melting the mixture, wherein the mass ratio of the island component to the sea component in the island-sea fiber was 70:30; conveying the blended melt to a spinning beam through a pipe; precisely metering the blended melt by a metering pump, and injecting it into a one-component spin pack in the spinning beam; and extruding the blended melt through a spinneret orifice; and

3) cooling, spinning finishing, drawing, heat setting and winding the as-formed fiber extruded, so as to obtain the unfigured sea-island fiber.

**[0084]** In Step 1), the relative viscosity of the island component polyamide 6 resin was 2.7.

**[0085]** In Step 2), the heating was performed in a screw extruder, wherein the screw extruder included five zones for heating: the temperature of the first zone was 220°C; the temperature of the second zone was 240°C; the temperature of the third zone was 250°C; the temperature of the fourth zone was 260°C; and the temperature of the fifth zone was 260°C;
in Step 2), the temperature of the spinning beam was 260°C; the pressure of the spin pack was 12.0 MPa.

**[0086]** In step 3), the cooling was conducted by quench air; the air speed was 0.4 m/s; the air temperature was 24°C; the oil pick up was 0.3 wt%, which was calculated based on the weight of the fiber;
the as-formed yarn that has been spinning finished was directed to a hot drawing roller through a feeding roller for drawing, and the drawing ratio was 3.0, the heat setting temperature was 170°C; and the winding speed was 4200 m/min.

**[0087]** The splitting process of the sea-island fiber was as follows: the solvent was 3.0 wt% aqueous solution of sodium hydroxide; the splitting temperature was 90°C; the splitting time was 40 mins; the bath ratio was 1:30; and the weight loss of the fiber was 28 wt%.

**[0088]** The test data of the sea-island fibers obtained were shown in Table 1.

**Comparative Example 3**

**[0089]** The present Comparative Example provided a process for producing a polyamide 66/water soluble polyester

unfigured sea-island fiber, comprising the following steps:

1) drying the island component resin and the sea component resin respectively; after drying, controlling the moisture content of the island component at 800 ppm, and controlling the moisture content of the sea component at 90 ppm;

2) uniformly mixing the aforementioned island component and the sea component in a certain proportion and then heating and melting the mixture, wherein the mass ratio of the island component to the sea component in the island-sea fiber was 70:30; conveying the blended melt to a spinning beam through a pipe; precisely metering the blended melt by a metering pump, and injecting it into a one-component spin pack in the spinning beam; and extruding the blended melt through a spinneret orifice; and

3) cooling, spinning finishing, drawing, heat setting and winding the as-formed fiber extruded to obtain the unfigured sea-island fiber.

**[0090]** In Step 1), the relative viscosity of the island component polyamide 66 resin was 2.7.

**[0091]** In Step 2), the heating was performed in a screw extruder, wherein the screw extruder included five zones for heating: the temperature of the first zone was 230°C; the temperature of the second zone was 250°C; the temperature of the third zone was 270°C; the temperature of the fourth zone was 280°C; and the temperature of the fifth zone was 290°C;
in Step 2), the temperature of the spinning beam was 290°C; the pressure of the spin pack was 13.0 MPa.

**[0092]** In step 3), the cooling was conducted by quench air; the air speed was 0.4 m/s; the air temperature was 24°C; the oil pick up was 0.3 wt%, which was calculated based on the weight of the fiber;
the as-formed yarn that has been spinning finished was directed to a hot drawing roller through a feeding roller for drawing, and the drawing ratio was 3.0, the heat setting temperature was 170°C; and the winding speed was 4200 m/min.

**[0093]** The splitting process of the sea-island fiber was as follows: the solvent was 3.0 wt% aqueous solution of sodium hydroxide; the splitting temperature was 90°C; the splitting time was 40 mins; the bath ratio was 1:30; and the weight loss of the fiber was 28 wt%.

**[0094]** The test data of the sea-island fibers obtained were shown in Table 1.

**Comparative Example 4**

**[0095]** The present Comparative Example provided a process for producing a polyamide 56/water soluble polyester figured sea-island fiber, comprising the following steps:

using polyamide 56 as the island component polymer and the water-soluble polyester as the sea component polymer; upon melting and metering with metering pumps respectively, passing them into a spinning die at a spinning temperature of 298°C;
wherein the overall ratio of the sea component to the island component was set at 20/80; introducing the melts of the sea component and the island component into a sea-island composite spinning spin pack and then extruding from the spinneret;
cooling the yarns spinning from the spinneret by an air cooling device; after spinning finishing the yarns, winding them into an undrawn 175dtex-112 filament by a winder at a speed of 1500 m/min;
subsequently, drawing the filament in a drawing device at a speed of 300 m/min and controlling the elongation at 20-40% to obtain a drawn yard of 66dtex-112 filament; immersing the obtained sea-island composite fiber in a 1 wt % aqueous solution of sodium hydroxide at 80°C so as to remove the sea component by dissolution.

**[0096]** The test data of the sea-island fibers obtained were shown in Table 1.

Table 1 Comparison of properties of the products in the Examples of the present invention and the Comparative Examples

| | Example 1 | Example 2 | Example 3 | Example 4 | Example 5 |
|---|---|---|---|---|---|
| Monofilament (dtex) | 0.05 | 0.08 | 0.06 | 0.02 | 0.03 |
| Break Strength (CN/dtex) | 4.2 | 4.5 | 3.9 | 5.0 | 3.9 |
| Elongation at Break (%) | 45.2 | 48.1 | 38.9 | 35.2 | 33.4 |

(continued)

| | | Example 1 | Example 2 | Example 3 | Example 4 | Example 5 |
|---|---|---|---|---|---|---|
| Initial Modulus (CN/dtex) | | 38.4 | 35.7 | 38.3 | 33.8 | 40.2 |
| K/S | | 18.5 | 19.2 | 22.4 | 20.5 | 18.9 |
| Dye Uptake (%) | | 96.5 | 97.4 | 98.2 | 97.2 | 98.6 |
| Dyeing Uniformity (grey scale)/grade | | 4.5 | 4.5 | 4.5 | 4.0 | 4.0 |
| Soap Fastness (grade) | fading | 4.0 | 4.0 | 4.0 | 3.5 | 4.0 |
| | staining | 4.0 | 3.5 | 3.5 | 4.0 | 4.0 |
| | | Example 6 | Comparative Example 1 | Comparative Example 2 | Comparative Example 3 | Comparative Example 4 |
| Monofilament(dtex) | | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Break Strength (CN/dtex) | | 4.0 | 3.9 | 3.8 | 4.1 | 3.2 |
| Elongation at Break (%) | | 40.3 | 39.6 | 43.5 | 45.2 | 28.5 |
| Initial Modulus (CN/dtex) | | 33.6 | 45.2 | 46.3 | 48.5 | 30.5 |
| K/S | | 21.6 | 15.5 | 15.2 | 14.7 | 14.2 |
| Dye Uptake (%) | | 97.5 | 88.5 | 87.6 | 85.4 | 85.5 |
| Dyeing Uniformity (grey scale)/grade | | 4.0 | 3.5 | 3.0 | 3.0 | 3.0 |
| Soap Fastness (grade) | fading | 3.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| | staining | 3.5 | 2.5 | 2.5 | 2.5 | 2.5 |

**[0097]** The polyamide sea-island fibers prepared in Examples 1 to 6 of the present invention had lower initial modulus as compared with those prepared in Comparative Examples 1 to 3. Therefore, the polyamide sea-island fibers prepared in Examples 1 to 6 had better softness. In addition, the polyamide sea-island fibers of the present invention had good dyeing properties. The polyamide sea-island fibers prepared in Examples 1 to 6 are also significantly better than those prepared in Comparative Examples 1 to 3 in terms of dye uptake, dyeing grey scale, dyeing depth and color fastness.

**[0098]** Therefore, the polyamide sea-island fiber monofilament prepared by the present invention is finer, and has soft and delicate hand feel. The bending rigidity is significantly reduced, the gloss is soft, the fiber specific surface area is larger, and the structure is of high-density. The polyamide sea-island fiber monofilament prepared by the present invention is more suitable for use in the field of imitation wools, imitation silks, imitation leathers, imitation peach skins, imitation suedes, high-density waterproof fabrics, high-performance cleaning clothes, high-performance adsorbing and filtering materials, highly oil absorptive materials, highly water absorptive materials, thermal insulation materials, medical materials, automotive trim materials, safety shoes, cases, handbags, sofas and the like.

**[0099]** Finally, it should be noted that the above embodiments are only used to illustrate the technical solutions of the present invention, but not to limit them. Although the present invention has been described in detail with reference to the foregoing embodiments, those ordinary skilled in the art should understand that the technical solutions described in the foregoing embodiments can be further modified, or can be equivalently replaced in terms of some or all of the technical features thereof. These modifications or replacements do not make the spirits of the corresponding technical solutions depart from the scope of technical solutions of the embodiments of the present invention.

## Claims

1. A polyamide sea-island fiber, **characterized in that** an island component is a polyamide resin selected from one of polyamide 56, polyamide 510, polyamide 511, polyamide 512, polyamide 513, polyamide 514, polyamide 515 and polyamide 516, preferably polyamide 56 or polyamide 510; a sea component is one of polyethylene, low-density polyethylene, polystyrene, water-soluble polyesters, polyesters and polyurethanes, preferably polyethylene, low-density polyethylene or water-soluble polyesters.

2. The polyamide sea-island fiber according to claim 1, **characterized in that** the island component is selected from the group consisting of super bright polyamide resins, semi dull polyamide resins, full dull polyamide resins and mixtures thereof; and/or

   the island component polyamide resin has a relative viscosity of 2.4-3.0, preferably 2.5-2.9, and more preferably 2.6-2.8; and/or
   the mass ratio of the island component to the sea component of the sea-island fiber is 20-80:80-20, and more preferably 30-70:70-30.

3. The polyamide sea-island fiber according to claim 1, **characterized in that** the sea-island fiber includes a figured sea-island fiber and an unfigured sea-island fiber; and/or
   the number of the islands in the figured sea-island fiber is 16-500.

4. The polyamide sea-island fiber according to claim 1, **characterized in that** the polyamide sea-island fiber has a fineness of 10-300 dtex, preferably 20-200 dtex, and more preferably 30-100 dtex; and/or

   the polyamide sea-island fiber has a break strength of 2.0-5.0 cN/dtex, preferably 2.5-4.5 cN/dtex, and more preferably 3.0-4.0 cN/dtex; and/or
   the polyamide sea-island fiber has an elongation at break of 30-80%, preferably 40-70%, and more preferably 45-60%; and/or
   the polyamide sea-island fiber has an initial modulus of 20-50 cN/dtex, preferably 23-45 cN/dtex, and more preferably 28-38 cN/dtex; and/or
   after the polyamide sea-island fiber is split, the island component has a monofilament fineness of 0.001-0.2 dtex, preferably 0.005-0.1 dtex, and more preferably 0.01-0.05 dtex; and/or
   the polyamide sea-island fiber has a K/S value of 15 or more, preferably 20 or more,
   and more preferably 25 or more; and/or
   the polyamide sea-island fiber has a dye uptake of 90% or more, preferably 93% or more, and more preferably 96% or more; and/or
   the polyamide sea-island fiber has a dyeing uniformity (grey scale) of grade 3.5 or more, preferably grade 4.0 or more, and more preferably grade 4.5 or more; and/or
   the polyamide sea-island fiber has a soap fastness for fading of grade 3.0 or more, preferably grade 3.5 or more, more preferably grade 4.0 or more; and still more preferably 4.5 or more; and/or
   the polyamide sea-island fiber has a soap fastness for staining of grade 3.0 or more, preferably grade 3.5 or more, more preferably grade 4.0 or more, and still more preferably grade 4.5 or more.

5. A process for producing the figured sea-island fiber according to claim 3, **characterized in that** the process comprises the steps of:

   1) heating and melting the island component resin and the sea component resin respectively to obtain two melts; conveying the two melts into a spinning beam through a pipe; precisely metering each melt by a metering pump respectively, and injecting them into a sea-island type of composite spin pack in the spinning beam; distributing the two melts via a distribution pipe in the spin pack, and converging and extruding them at the entrance of a spinneret orifice; wherein the island component has a moisture content of less than 1500 ppm, and the sea component has a moisture content of less than 300 ppm; and
   2) cooling, spinning finishing, drawing, heat setting and winding the as-formed fiber that is extruded in Step 1), so as to obtain the figured sea-island fiber.

6. The process according to claim 5, **characterized in that**, in Step 1),

   the heating is performed in a screw extruder, wherein the screw extruder preferably includes five zones for

heating;
for a screw for the island component, the temperature of a first zone is 200-260°C; the temperature of a second zone is 230-280°C; the temperature of a third zone is 240-290°C; the temperature of a fourth zone is 260-300°C; and the temperature of a fifth zone is 270-310°C;
for a screw for the sea component, the temperature of a first zone is 120-220°C; the temperature of a second zone is 140-240°C; the temperature of a third zone is 160-260°C; the temperature of a fourth zone is 180-280°C; and the temperature of a fifth zone is 160-290°C; and/or
the temperature of the spinning beam is 200-300°C; and/or
the spin pack pressure of the island component is 10.0-15.0 MPa; the spin pack pressure of the sea component is 8.0-15.0 MPa; and the spin pack pressure difference between the sea component and the island component is controlled to be less than 4.0 MPa.

**7.** The process according to claim 5, **characterized in that**, in Step 2),

the cooling is conducted by quench air or cross air blow; an air speed is 0.2-1.2 m/s, preferably 0.2-1.0 m/s, and more preferably 0.3-0.8 m/s; the air temperature of the quench air is 15-30°C, preferably 20-27°C, and more preferably 22-25°C; and/or
an oil pick up is 0.2-1.0 wt%, preferably 0.3-0.8 wt%, and more preferably 0.4-0.6 wt%; and/or
the drawing process is that the as-formed yarn that has been spinning finished is directed to a hot drawing roller through a feeding roller for drawing, and the drawing ratio is preferably 2.0-5.0, and more preferably 2.5-3.0; and/or
the heat setting temperature is 150-220°C, preferably 160-200°C, and more preferably 170-180°C; and/or
the winding speed is 1000-6000 m/min, preferably 2000-5000 m/min, and more preferably 2500-4000 m/min.

**8.** A process for producing the unfigured sea-island fiber according to claim 3, **characterized in that** the process comprises the steps of:

a) uniformly mixing the island component and the sea component in a certain proportion and then heating and melting the mixture; conveying the resultant blended melt into a spinning beam through a pipe; precisely metering the blended melt by a metering pump, and injecting it into a one-component spin pack in the spinning beam; and extruding the blended melt through a spinneret orifice; wherein the island component has a moisture content of less than 1500 ppm; and the sea component has a moisture content of less than 300 ppm;
2) cooling, spinning finishing, drawing, heat setting and winding the as-formed fiber that is extruded to obtain the unfigured sea-island fiber.

**9.** The process according to claim 8, wherein in Step a),

the heating is performed in a screw extruder, wherein the screw extruder preferably includes five zones for heating; the temperature of a first zone is 180-240°C; the temperature of a second zone is 200-260°C; the temperature of a third zone is 220-270°C; the temperature of a fourth zone is 240-280°C; and the temperature of a fifth zone is 200-300°C; and/or
the temperature of the spinning beam is 200-300°C; and the spin pack pressure is 10.0-25.0 MPa.

**10.** The process according to claim 8, wherein in Step b),

the cooling is conducted by quench air or cross air blow; the air speed is 0.2-1.2 m/s, preferably 0.4-1.0 m/s, and more preferably 0.6-0.8 m/s; the air temperature of the quench air is 15-30°C, preferably 23-27°C, and more preferably 24-25°C; and/or
the oil pick up is 0.2-1.0 wt%, preferably 0.3-0.8 wt%, and more preferably 0.4-0.6 wt%; and/or
the drawing process is that the as-formed yarn that has been spinning finished is directed to a hot drawing roller through a feeding roller for drawing, and the drawing ratio is preferably 2.0-5.0, and more preferably 2.5-3.0; and/or
the heat setting temperature is 150-220°C, preferably 160-200°C, and more preferably 170-180°C; and/or
the winding speed is 1000-6000 m/min, preferably 2000-5000 m/min, and more preferably 2500-4000 m/min.

**11.** Use of the polyamide sea-island fiber according to claim 1 in the manufacture of imitation wools, imitation silks, imitation leathers, imitation peach skins, imitation suedes, high-density waterproof fabrics, high-performance cleaning clothes, high-performance adsorbing and filtering materials, highly oil absorptive materials, highly water absorp-

tive materials, thermal insulation materials, medical materials, automotive trim materials, safety shoes, cases, handbags or sofas.

## INTERNATIONAL SEARCH REPORT

International application No.
**PCT/CN2020/072229**

**A. CLASSIFICATION OF SUBJECT MATTER**

D01F 8/12(2006.01)i; D01F 8/14(2006.01)i; D01F 8/06(2006.01)i; D01D 5/00(2006.01)i

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

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

D01F, D01D

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

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

CNPAT, DWPI, SIPOABS, CNKI, WEB OF SCIENCE: 生物基, 聚酰胺, 尼龙, 锦纶, PA, 聚酰胺5, 尼龙5, 戊二胺, 海岛, 聚烯烃, 聚酯, 聚氨酯, 聚乙烯, 柔软, 染色, NYLON5 , polyamide5, spun, spin+, island, pentanediamine , diaminepentan+

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | CN 1399014 A (CHINA PETROCHEMICAL CORPORATION et al.) 26 February 2003 (2003-02-26)<br>description page 2 line 5 from the bottom to page 5 line 4 | 1-4, 8-11 |
| Y | CN 1399014 A (CHINA PETROCHEMICAL CORPORATION et al.) 26 February 2003 (2003-02-26)<br>description page 2 line 5 from the bottom to page 5 line 4 | 5-7 |
| Y | CN 103820872 A (JINJIANG MINGAO TEXTILE TECHNOLOGY CO., LTD.) 28 May 2014 (2014-05-28)<br>claims 1-4 | 5-7 |
| A | CN 106868623 A (SHANGHAI CATHAY BIOTECHNOLOGY R & D CENTER CO., LTD. et al.) 20 June 2017 (2017-06-20)<br>entire document | 1-11 |
| A | CN 101798714 A (XIAMEN HONGXIN SUPERFINE FIBRE MATERIALS CO., LTD.) 11 August 2010 (2010-08-11)<br>entire document | 1-11 |
| A | CN 105803571 A (DONGHUA UNIVERSITY et al.) 27 July 2016 (2016-07-27)<br>entire document | 1-11 |

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"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 |
|---|---|
| **09 July 2020** | **24 July 2020** |
| Name and mailing address of the ISA/CN<br>**China National Intellectual Property Administration (ISA/CN)**<br>**No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088**<br>**China** | Authorized officer |
| Facsimile No. **(86-10)62019451** | Telephone No. |

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2020/072229

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | CN 106555249 A (SHANGHAI CATHAY BIOTECHNOLOGY R & D CENTER CO., LTD. et al.) 05 April 2017 (2017-04-05)<br>entire document | 1-11 |
| A | CN 105040156 A (SHANGHAI CATHAY BIOTECHNOLOGY R & D CENTER CO., LTD. et al.) 11 November 2015 (2015-11-11)<br>entire document | 1-11 |
| A | CN 107750286 A (RHODIA POLIAMIDA E ESPECIALIDA) 02 March 2018 (2018-03-02)<br>entire document | 1-11 |

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**INTERNATIONAL SEARCH REPORT**
**Information on patent family members**

International application No.
**PCT/CN2020/072229**

| Patent document cited in search report | Publication date (day/month/year) | Patent family member(s) | Publication date (day/month/year) |
|---|---|---|---|
| CN 1399014 A | 26 February 2003 | CN 1164810 C | 01 September 2004 |
| CN 103820872 A | 28 May 2014 | None | |
| CN 106868623 A | 20 June 2017 | None | |
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| CN 105803571 A | 27 July 2016 | None | |
| CN 106555249 A | 05 April 2017 | None | |
| CN 105040156 A | 11 November 2015 | CN 107177903 B | 17 March 2020 |
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## REFERENCES CITED IN THE DESCRIPTION

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- CN 106435821 A **[0007]**