

DESCRIPTION

Textile Using a Flat Multilobar Cross-Section Fiber

Technical Field

[0001]

5 The present invention relates to a fabric that is lightweight and thin and has high strength, low air permeability, and excellent glossiness. More particularly, the present invention relates to a fabric that is lightweight and thin and has high strength, low air permeability, and excellent glossiness, comprising a polyamide fiber with a fine size and a flat multifoliar cross section.

10 Background Art

[0002]

 As represented by the outdoor activity boom in recent years, the interest of consumers in recreation has been increasing year by year. Particularly in sportswear applications, demands are increasing year by year with the proliferation
15 of outdoor sports, and there has been an increasing demand for reduction in weight and thickness of, for example, tents, sleeping bags, materials of canvas and the like, and clothing. A fabric used for sportswear requires high strength, in particular, improved tear strength and improved wear resistance. The fabric, particularly when subjected to a coating process such as laminating, is less likely to cause yarn slippage
20 and thus tends to have reduced tear strength, and accordingly, improvement in tear strength of a base fabric has been increasingly desired.

[0003]

 Conventionally, aiming at reduction in weight and thickness, fabrics made of a polyester multifilament, nylon multifilament, or conjugate fiber thereof have often
25 been used for down wear, material for sports, and the like due to their excellent mechanical properties. Such fabrics are soft, lightweight, and excellent in properties such as windbreak, water-repellency, and fastness, and thus have often

been used for, for example, coats, blousons, golf wear, and outdoor wear for sports.

[0004]

Patent Document 1 discloses, as a means for solving the problem of high strength and reduction in weight and thickness, a fabric comprising a synthetic multifilament, wherein by
5 subjecting the fabric to calender processing on at least one surface, monofilaments are pressed overlapped each other in at least a part of the synthetic multifilament, the synthetic multifilament having a fineness of 7 dtex to 44 dtex, wherein the monofilaments have a Y-shaped or cruciform cross section, the fabric having a cover factor of 1300 to 2200.

Prior Art Documents

10 Patent Documents

[0005]

Patent Document 1: JP 2010-196213 A

Summary

Problems to be Solved

15 [0006]

The fabric obtained by the method disclosed in Patent Document 1, however, has a gloss with glitter and streaks because of uniformly reflected light, and is unsatisfactory in appearance, such as glossiness of products, as well as functionality. As described above, there are fabrics satisfying the required properties such as high strength, reduced weight, and
20 reduced thickness in the prior art, but glossiness has not been considered sufficiently, and there has been no fabric having a delicate and elegant gloss. Furthermore, in the prior art, a sufficiently lasting function has not been provided: e.g., a fabric shows a significant decrease in air permeability after repeated washing, and suffers from slipping-out of downs, for example, when used as a shell of a down jacket.

25 [0007]

The present disclosure aims to solve such problems of the prior art and provide a fabric that is lightweight and thin, has high strength, low air permeability, and excellent glossiness, and can be suitably used for a ticking of sportswear, casual wear, and women's and men's wear represented, for example, by down jackets, windbreakers, golf wear, and rainwear; a sewn product obtained by using the fabric at least in part; and a down shell and a down jacket obtained by using the fabric at least in part.

Means for Solving the Problems

[0008]

To achieve the above object, the fabric of the present disclosure mainly has the following constitution.

(1) In a first aspect, there is provided a fabric subjected to calender processing on one or both surfaces, comprising a polyamide fiber used as warp or/and woof having, after calender processing of the fabric, a single filament fineness of 0.5 to 2.5 dtex and a total fiber fineness of 5 to 50 dtex, the single filament having a cross-sectional shape that is flat multifoliar with 6 to 10 lobe parts and has a flat ratio (W) (α/β) of 1.5 to 3.0, wherein α is a length of a line segment A, which is a longest line segment connecting any two apexes of convex portions of the flat multifoliar shape, and β is a length of a line segment B of a circumscribed quadrangle formed by lines that are parallel to the line segment A and are tangent lines containing outermost apexes (the angle between adjacent sides is 90°), the line segment B being other than the lines that are parallel to the line segment A, the fabric having a cover factor of 1200 to 2500.

[0009]

(2) The fabric according to (1) above, wherein the polyamide fiber has, before calender processing of the fabric, a single filament fineness of 0.4 to 2.2 dtex and a total fiber fineness of 4 to 44 dtex, the single filament having a cross-sectional shape that is flat multifoliar with 6 to 10 leaves and satisfies both equations below:

Flat ratio (F) $(a/b) = 1.5$ to 3.0

Modified shape ratio (F) $(c/d) = 1.0$ to 8.0

wherein a is a length of a longest line segment A connecting any two apexes of convex portions of the flat multifoliar shape; b is a length of a line segment B of a circumscribed quadrangle formed by lines that are parallel to the line segment A and are tangent lines containing outermost apexes (the angle between adjacent sides is 90°), the line segment B being other than the lines that are parallel to the line segment A; c is a length of a line segment C connecting the apexes of adjacent convex portions of the largest concavity and convexity among concavities and convexities formed by the flat multifoliar shape; and d is a length of a perpendicular D drawn from the bottom of a concave portion between the convex portions to the line segment C connecting the apexes of the convex portions.

(3) The fabric according to (1) or (2) above, having a tear strength of 5.0 N or more and an initial air permeability of $1.0\text{ cc/cm}^2/\text{s}$ or lower.

[0010]

(4) The fabric according to any one of (1) to (3) above, having an air permeability after fifty washing of $1.0\text{ cc/cm}^2/\text{s}$ or lower.

[0011]

(5) The fabric according to any one of (1) to (4) above, wherein the difference between the initial air permeability and the air permeability after fifty washing is $0.4\text{ cc/cm}^2/\text{s}$ or less.

[0012]

(6) In a second aspect, there is provided a sewn product obtained by using the fabric according to any one of (1) to (5) as defined above at least in part.

[0013]

(7) In a third aspect, there is provided a down shell or a down jacket obtained by using the fabric according to any one of (1) to (5) as defined above at least in part.

Effects

[0014]

The present disclosure provides a fabric that is lightweight and thin and has high strength, low air permeability, and excellent glossiness with no glitter or streaks. The disclosure further provides a fabric that can be suitably used for a ticking of, for example, sportswear, casual wear, and women's and men's wear represented, for example, by down jackets, windbreakers, golf wear, and rainwear. The present disclosure also provides a sewn product obtained by using the fabric as defined above in part. The disclosure further provides a down shell and a down jacket obtained by using the fabric as defined above in part.

Brief Description of the Drawings

[0015]

FIG. 1 is a SEM photograph of a fabric transverse cross section illustrating the fabric of the present invention;

FIG. 2 is a cross-sectional view illustrating the outline of the cross-sectional shape of a single filament constituting the fabric of the present invention;

FIG. 3 is a schematic cross-sectional view illustrating the shape of the spinneret outlet port used in Examples of the present invention;

FIG. 4 is a schematic cross-sectional view illustrating the shape of the spinneret outlet port used in Comparative Examples; and

FIG. 5 is a schematic cross-sectional view of the fabric including fibers having a Y-shaped cross section obtained in Comparative Example.

Mode for Carrying Out the Invention

[0016]

The polyamide constituting the fabric of the present invention is what is called a polymer in which hydrocarbon groups are linked by amide bonds to the main

chain, and examples include polycaprolactam (nylon 6), polyhexamethylene adipamide (nylon 66), polyhexamethylene sebacamide (nylon 6,10), polytetramethylene adipamide (nylon 4,6), polypentamethylene adipamide (nylon 5,6), polyamides formed by condensation polymerization of 1,4-cyclohexanebis(methylamine) and a linear aliphatic dicarboxylic acid, copolymers thereof, and mixtures thereof. In terms of stainability and color development, nylon 6 and nylon 66 are preferred, and nylon 6 is more preferred.

[0017]

The degree of polymerization of the above polyamide, which may be set as appropriate depending on the properties required for fabrics, is preferably 2 or more in terms of relative viscosity in 98% sulfuric acid, more preferably 3 or more. A relative viscosity in 98% sulfuric acid of 3 or more allows spinning to form a single filament whose cross-sectional shape is flat multifoliar with 6 to 10 leaves, and achieves stable spinning with a flat ratio and a modified shape ratio controlled in a specific range. In particular, the relative viscosity in 98% sulfuric acid is more preferably 3.3 or more. The upper limit of the relative viscosity in 98% sulfuric acid is preferably not more than 7 from the standpoint of spinnability.

[0018]

Additionally, additives for improving productivity, for example, improving heat resistance (e.g., light stabilizers, heat stabilizers, oxidation stabilizers, antistatic agents, terminal regulators, and dyeability-improving agents) and additives for providing functionality (e.g., ultraviolet ray absorbing agents, ultraviolet ray shielding agents, contact cold-sensation agents, and antibacterial agents) may be added, provided that the additives are in an amount and of type that do not impair the object of the present invention. However, not to reduce spinnability or durability, the average particle diameter of the additives is preferably 1 μm or less. Inorganic particles including white pigments are added preferably in an amount of not more

than 2.0% by mass relative to the fiber, more preferably in an amount of not more than 1.0% by mass, although these values are not limitative.

[0019]

The polyamide fiber after calender processing constituting the fabric of the present invention will now be described in more detail.

[0020]

For the polyamide fiber after calender processing constituting the fabric of the present invention, the cross-sectional shape of a single filament is required to be flat multifoliar with 6 to 10 lobe parts and have a flat ratio (W) of 1.5 to 3.0.

[0021]

FIG. 1 is a SEM photograph (x600) of a fabric transverse cross section illustrating the fabric of the present invention. As shown in FIG. 1, polyamide single filaments located at the fabric surface after calender processing (e.g., 1 to 3) are smooth. Thus, in determining the flat ratio (W), polyamide single filaments not located at the fabric surface (e.g., 4 to 6) were used as single filaments of the polyamide fiber after calender processing. For the flat ratio, the average of measurements of five randomly-selected polyamide single filaments not located at the fabric surface was used.

[0022]

"Flat ratio (W)" as used herein, as illustrated by the outline of the cross-sectional shape of a single filament shown in FIG. 2, is defined as a flat ratio of α/β , wherein α is a length of a longest line segment A connecting any two apexes of convex portions of the flat multifoliar shape, and β is a length of a line segment B of a circumscribed quadrangle formed by lines that are parallel to the line segment A and are tangent lines containing outermost apexes (the angle between adjacent sides is 90°), the line segment B being other than the lines that are parallel to the line segment A. A flat ratio (W) (α/β) of 1.5 to 3.0 allows single filaments in the fabric

produced to be overlapped with a small gap therebetween, leading to reduced air permeability. Furthermore, a flat ratio in this range can achieve excellent glossiness and sufficient strength for practical use simultaneously. A flat ratio of less than 1.5 reduces the surface area, failing to achieve sufficient glossiness. A flat ratio of more than 3.0 leads to high polymer anisotropy, resulting in a glittering gloss, and further, failing to provide sufficient strength for practical use. The flat ratio is preferably 1.5 to 2.8.

[0023]

The number of lobe parts as used herein is a value obtained by dividing the number of inflexion points in a fiber cross section by 2. Namely, in a multifoliar cross section, convex portions forming lobe parts and concave portions between the lobe parts are typically alternated, each having an inflexion point, thus the number of lobe parts can be counted by dividing the number of inflexion points by 2. As shown in FIG. 1, polyamide single filaments located at the fabric surface after calender processing (e.g., 1 to 3) are smooth. Thus, in determining the number of lobe parts, polyamide single filaments not located at the fabric surface (e.g., 4 to 6) were used as single filaments of the polyamide fiber after calender processing.

[0024]

For the number of lobe parts, the average of measurements of five randomly-selected polyamide single filaments not located at the fabric surface was used. Six to ten lobe parts provide favorable glossiness. In particular, 6 to 8 lobe parts provide delicate gloss, which is preferred, and 8 lobe parts provide high-quality gloss, which is a more preferred aspect. When the number of lobe parts is less than 6, an artificial gloss with glitter is provided, giving an appearance like streaks. When the number of lobe parts is more than 10, light scatters to cause a dim gloss, failing to provide a satisfactory gloss.

[0025]

When the flat ratio (W) and the number of lobe parts are in such ranges, movement of single filaments tends to be restricted, and upon being pressed and fixed by calender processing, concavities and convexities of the single filaments overlap each other with a small gap therebetween to enhance the air permeability-reducing effect, leading to reduced air permeability. For example, in a Y-shaped cross section or a cruciform cross section, although a portion unlikely to cause yarn slippage where a concave portion and a convex portion overlap each other (area O) is formed depending on the direction in which single filaments overlap, a portion prone to yarn slippage where a concave portion and a concave portion overlap each other (area X) is also formed in decent numbers depending on the direction in which single filaments overlap, resulting in increased air permeability or causing yarn slippage (FIG. 5). In the fabric of the present invention, the cross section of a single filament has appropriate concavities and convexities, due to which the fabric surface tends to become uniformly smooth by calender processing, and favorable glossiness is provided.

[0026]

The polyamide fiber after calender processing constituting the fabric of the present invention is required to have a single filament fineness of 0.5 to 2.5 dtex. A single filament fineness in this range provides a fabric having sufficient strength for practical use and low air permeability. A single filament fineness of less than 0.5 dtex fails to provide sufficient strength for practical use, and a single filament fineness of more than 2.5 dtex fails to provide low air permeability. The single filament fineness is preferably 0.5 to 2.0 dtex.

[0027]

Further, the polyamide fiber after calender processing constituting the fabric of the present invention is required to have a total fiber fineness of 5 to 50 dtex from the standpoint of lightness of the fabric in use for down wear or material for sports.

A total fiber fineness in this range provides a fabric that is lightweight and thin and has sufficient strength for practical use. A total fiber fineness of less than 5 dtex fails to provide a fabric that has sufficient strength for practical use, and a total fiber fineness of more than 50 dtex fails to provide a fabric that is lightweight and thin.

5 The total fiber fineness is preferably 5 to 45 dtex, more preferably 5 to 35 dtex.

[0028]

The total fiber fineness as used herein was measured as described below: two lines were drawn on a fabric in the warp or woof direction at an interval of 100 cm; the fabric was disentangled into warp or woof; a load of 1/10 g/dtex was applied to the disentangled yarn; and a length (Lcm) between two points was measured. The
10 yarn was cut at the two points (L), and its weight (Wg) was measured to calculate the fineness by the following equation.

[0029]

Total fiber fineness (disentangled yarn of fabric) = $W/L \times 1000000$ (dtex)

15 The single filament fineness is a value obtained by dividing the total fiber fineness by the number of filaments.

[0030]

The polyamide fiber used for the fabric before calender processing constituting the fabric of the present invention will now be described in more detail.

20 [0031]

For the polyamide fiber used for the fabric before calender processing constituting the fabric of the present invention, the cross-sectional shape of a single filament preferably is flat multifoliar with 6 to 10 leaves and has a flat ratio (F) (a/b) of 1.5 to 3.0 and a modified shape ratio (F) (c/d) of 1.0 to 8.0. Furthermore, when
25 the cross-sectional shape of a single filament is 6 to 10 leaves, it is easy to provide favorable glossiness. In particular, a cross section of 6 to 8 leaves is more preferred because it provides a delicate gloss, and a flat multifoliar shape with 8 leaves is a

most preferred aspect because it provides a high-quality gloss.

[0032]

"Flat ratio (F)" and "modified shape ratio (F)" as used herein, as illustrated by the outline of the cross-sectional shape of a single filament shown in FIG. 2, are defined as a flat ratio of a/b and a modified shape ratio of c/d , respectively, wherein a is a length of a longest line segment A connecting any two apexes of convex portions of the flat multifoliar shape; b is a length of a line segment B of a circumscribed quadrangle formed by lines that are parallel to the line segment A and are tangent lines containing outermost apexes (the angle between adjacent sides is 90°), the line segment B being other than the lines that are parallel to the line segment A; c is a length of a line segment C connecting the apexes of adjacent convex portions of the largest concavity and convexity formed by the flat multifoliar shape; and d is a length of a perpendicular D drawn from the bottom of a concave portion between the convex portions to the line segment C connecting the apexes of the convex portions. For the cross section of single filaments constituting yarn, five single filaments are randomly selected from a cross-sectional photograph (x400) taken by using a light microscope, and a/b and c/d are calculated. Their average values are used as the flat ratio (F) and the modified shape ratio (F).

[0033]

A flat ratio (F) (a/b) of 1.5 to 3.0 allows single filaments in the fabric produced to be overlapped with a small gap therebetween, leading to reduced air permeability. Furthermore, a flat ratio in this range can achieve excellent glossiness and sufficient strength for practical use simultaneously. The flat ratio is preferably 1.5 to 2.8.

[0034]

The modified shape ratio (F) (c/d) represents the size of a concave portion between leaves in the flat multifoliar shape. A higher modified shape ratio (F)

means a shallower concave portion, and a lower modified shape ratio (F) means a deeper concave portion. To keep gaps between single filaments during fabric formation small and facilitate overlapping to increase the effect of low air permeability, the modified shape ratio (F) is preferably 8.0 or less.

5 [0035]

On the other hand, the modified shape ratio (F) is preferably 1.0 or more to maintain the strength of a polyamide that forms a single filament. In terms of glossiness and texture, the modified shape ratio (F) is more preferably 2 to 7.

[0036]

10 By using filaments of flat multifoliar cross-sectional shape having a flat ratio (F) and a modified shape ratio (F) in such ranges in advance, movement of single filaments tends to be restricted, and upon being pressed and fixed by calender processing, concavities and convexities of the single filaments overlap each other with a small gap therebetween to enhance the air permeability-reducing effect,
15 leading to reduced air permeability. Furthermore, since the cross section of the single filaments is multifoliar, the concavities and convexities of the single filaments certainly engage each other regardless of the direction in which the single filaments overlap to prevent yarn slippage of the fabric, exerting an outstanding air permeability-reducing effect even after washing. Furthermore, the cross section of
20 the single filaments has appropriate concavities and convexities, due to which the fabric surface tends to become uniformly smooth by calender processing, and favorable glossiness is easily provided.

[0037]

The polyamide fiber used for the fabric before calender processing
25 constituting the fabric of the present invention preferably has a single filament fineness of 0.4 to 2.2 dtex. A single filament fineness of less than 0.4 dtex is too thin and makes it difficult to provide sufficient strength for practical use. A single

filament fineness of more than 2.2 dtex makes it difficult to provide low air permeability. The single filament fineness is more preferably 0.4 to 1.8 dtex.

[0038]

Further, the polyamide fiber used for the fabric before calender processing constituting the fabric of the present invention preferably has a total fiber fineness of 4 to 44 dtex from the standpoint of lightness of the fabric in use for down wear or material for sports. A total fiber fineness of less than 4 dtex makes it difficult to provide a fabric that has sufficient strength for practical use. A total fiber fineness of more than 44 dtex makes it difficult to provide a fabric that is lightweight and thin. The total fiber fineness is more preferably 4 to 40 dtex, still more preferably 4 to 31 dtex.

[0039]

In the fabric of the present invention, the polyamide fiber having a flat multifoliar cross section described above is used as warp or/and woof. The fiber can be of any form produced by a known method used also for common synthetic fibers such as finished yarn and twisted yarn.

[0040]

The fabric is produced by a known method (weaving and dyeing) used also for common synthetic fibers. A preferred production method will now be given below.

[0041]

In a weaving process, a loom beam for warp is first prepared. Specifically, a warp beam is prepared with a beam warper and then sized, if necessary, via a sizing machine, and a beamer is used to prepare a loom beam with a desired number of yarns. When sizing is unnecessary, a loom beam may be prepared directly from a warp beam using a beamer. Alternatively, a loom beam may be prepared after a sizing beam is directly prepared using a warper sizer. Subsequently, the loom beam is subjected to leasing and drawing and set on a loom, and woof is picked to weave a

fabric.

[0042]

The loom may be any type of loom such as a water-jet loom, an air-jet loom, a rapier loom, and a gripper loom. The weave of the fabric may be a plain weave, a
5 twill weave, a warp rib weave, a derivative weave thereof, or a combined weave thereof depending on the intended use of the fabric, and the plain weave with many crossover points is preferred to promote low air permeability. For textures for down proof wear, textures for outdoor wear, textures for windbreakers, and the like, which require enhanced tear strength, a weave forming a grid pattern is preferred,
10 and a rip-stop weave having rip-stop portions is more preferred.

[0043]

The fabric of the present invention is required to have a cover factor (hereinafter also referred to as CF for short) of 1200 to 2500. A CF in this range provides a fabric that is lightweight and thin and has low air permeability. A CF of
15 less than 1200 provides a fabric that is lightweight and thin, but this fabric is unlikely to be satisfactory in low air permeability. A CF of more than 2500 provides low air permeability but makes it difficult to provide a fabric that is lightweight and thin.

"Cover factor (CF)" as used herein is calculated by the equation below:

$$CF = T \times (DT)^{1/2} + W \times (DW)^{1/2}$$

20 wherein T and W represent ends and picks per inch of the fabric, and DT and DW represent a total fiber fineness (dtex) of warp and woof constituting the fabric.

[0044]

In a dying process, refinement, presetting, dying, and finish setting are performed. For dying, acid dyes and metal complex dyes used for polyamide fibers
25 can preferably be used. After the dying, processing for functionalization may be performed. In processing for providing a functionalizing agent, the functionalizing agent is provided, for example, by dipping (padding), dried, and then cured. For

example, for down proof wear, outdoor wear, and windbreakers, calender processing and water-repellent finishing are performed for functionalization, and examples of water-repellent agents that can be used include water-repellent agents such as organic fluorine compounds, silicones, and paraffin.

5 [0045]

The fabric of the present invention is required to be subjected to calender processing on one or both surfaces. In calender processing, a conventional calender processing machine is used, and in recent years, thermal calender processing has been commonly practiced. A fabric having an air permeability at a desired value
10 can be obtained by appropriately selecting the heat shrinkage percentage of fibers, gray fabric density, and processing conditions such as heating temperature, pressure, and treating time in heating and pressing. These conditions, which are related to one another, are appropriately set within the ranges, typically, of 130°C to 210°C (heating roll temperature), 98 kN to 149 kN (heating roll load), and 10 to 30 m/min
15 (fabric travel speed), while taking the heat shrinkage percentage of fibers into consideration.

[0046]

The fabric of the present invention preferably has a tear strength of 5.0 N or more, more preferably 6.0 N or more. "Tear strength" as used herein refers, in the
20 case where the polyamide fiber having a flat multifoliar cross section is used as warp, to a tear strength in the longitudinal direction, and, in the case where the polyamide fiber having a flat multifoliar cross section is used as woof, to a tear strength in the transverse direction. In the case where the polyamide fiber of flat multifoliar shape is used as warp and woof, the tear strength refers to tear strengths in the longitudinal
25 direction and the transverse direction. A tear strength of 5.0 N or more provides a fabric that has sufficient strength for practical use. To provide a fabric that is lightweight and thin and has high strength, the tear strength is preferably 40 N or less,

more preferably 30 N or less.

[0047]

The fabric of the present invention preferably has an air permeability (also referred to as initial air permeability) of $1.0 \text{ cc/cm}^2/\text{s}$ or lower, more preferably $0.8 \text{ cc/cm}^2/\text{s}$ or lower. An air permeability of $1.0 \text{ cc/cm}^2/\text{s}$ or lower provides a fabric having excellent low air permeability. When the fabric of the present invention is used for a ticking of, for example, down wear, down jackets, and sportswear, the air permeability is desirably $0.3 \text{ cc/cm}^2/\text{s}$ or higher in order to provide a moderately low air permeability that facilitates deformation including inflation and deflation due to the entrance and exit of air.

[0048]

The fabric of the present invention preferably has an air permeability after fifty washing of $1.0 \text{ cc/cm}^2/\text{s}$ or lower, more preferably $0.9 \text{ cc/cm}^2/\text{s}$ or lower. An air permeability after fifty washing of $1.0 \text{ cc/cm}^2/\text{s}$ or lower cannot cause slipping-out of downs from the fabric during washing or slipping-out of downs due to yarn slippage of the fabric after washing, providing a fabric with excellent down proofness. An air permeability after fifty washing of higher than $1.0 \text{ cc/cm}^2/\text{s}$ is likely to cause slipping-out of downs, and exhibits irregularities on the fabric surface due to yarn slippage of the fabric, which can cause significant degradation of the quality, for example, of down jackets.

[0049]

For the fabric of the present invention, by using filaments of flat multifoliar cross-sectional shape having a flat ratio (F) and a modified shape ratio (F) in the above-described ranges in advance, movement of single filaments tends to be further restricted, and upon being pressed and fixed by calender processing, concavities and convexities of the single filaments overlap each other with a small gap therebetween to enhance the air permeability-reducing effect, leading to reduced air permeability.

Furthermore, since the cross section of the single filaments is multifoliar, the concavities and convexities of the single filaments certainly engage each other regardless of the direction in which the single filaments overlap to prevent yarn slippage of the fabric, exerting an outstanding air permeability-reducing effect even after washing. For example, in a Y-shaped cross section fiber or a cruciform cross section fiber, a portion prone to yarn slippage where a concave portion and a concave portion overlap each other is formed depending on the direction in which single filaments overlap, leading to increased air permeability or causing yarn slippage (FIG. 5).

[0050]

Furthermore, the difference between the initial air permeability and the air permeability after fifty washing of the fabric of the present invention is preferably $0.4 \text{ cc/cm}^2/\text{s}$ or less. The fabric of the present invention, by including filaments of flat multifoliar cross-sectional shape that has a flat ratio (F) and a modified shape ratio (F) in the ranges mentioned above and having a CF in the range mentioned above, is able to maintain low air permeability after washing and keep a high-gloss and uniform surface because of the yarn slippage-preventing effect of concavities and convexities of single filaments, thereby maintaining the quality, for example, of down jackets.

[0051]

The present invention provides a fabric that is lightweight and thin and has high strength, low air permeability, and excellent glossiness with no glitter or streaks. Furthermore, the invention provides a fabric that can be suitably used for a ticking of, for example, sportswear, casual wear, and women's and men's wear represented, for example, by down jackets, windbreakers, golf wear, and rainwear.

[0052]

The sewn product of the present invention is characterized by being obtained

by using the fabric according to the present invention in part. Its applications include, but are not limited to, sportswear, casual wear, and women's and men's wear represented, for example, by down jackets, windbreakers, golf wear, and rainwear.

[0053]

5 Further, the down shell and the down jacket of the present invention is characterized by being obtained by using the fabric according to the present invention at least in part.

Examples

[0054]

10 The fabric of the present invention will now be described in detail with reference to examples. The measured values in the examples were determined according to the following methods.

[0055]

A. Relative Viscosity

15 A weighed sample is dissolved in 98 mass% concentrated sulfuric acid to a sample concentration (C) of 1 g/100 ml, and the time-of-fall seconds (T1) of the resulting solution is measured at a temperature of 25°C using an Ostwald viscometer. Similarly, the time-of-fall seconds (T2) of 98 mass% concentrated sulfuric acid containing no sample is measured at a temperature of 25°C, and a relative viscosity
20 in 98% sulfuric acid (η_r) of the sample is calculated by the following equation.

$$(\eta_r) = (T1/T2) + \{1.891 \times (1.000 - C)\}$$

[0056]

B. Total Fiber Fineness and Single Filament Fineness

(a) Nylon 6 Fiber

25 A fiber sample is wound around a counter reel with a circumference of 1.125 m 400 times at a tension of $1/30 \text{ cN} \times \text{displayed decitex}$ to prepare a skein. The skein is dried at a temperature of 105°C for 60 minutes, transferred to a desiccator,

and allowed to cool in an environment of 20°C and 55 RH for 30 minutes. The mass of the skein is measured, and a mass per 10000 m is calculated from the value obtained. The total fiber fineness is calculated using the standard moisture regain (4.5%) of nylon 6. Total fiber fineness is defined as the average of four measurements. Single filament fineness is defined as a value obtained by dividing the total fiber fineness by the number of filaments.

[0057]

(b) Disentangled Yarn of Fabric

Two lines are drawn on a fabric in the warp or woof direction at an interval of 100 cm, and the warp or woof of the fabric between the lines is disentangled. Next, a provisional total fiber fineness is calculated in order to determine a measuring load. A load of 2 g is applied to the disentangled yarn obtained, and a length (Lcm) between two points is measured, after which the yarn is cut at the two points (Lcm) to measure its weight (Wg), and a provisional total fiber fineness is calculated by the following equation. Next, in contrast to the provisional total fiber fineness, a load of 1/10 g/dtex is applied, and a length and weight between two points are measured similarly to the above, after which a total fiber fineness is calculated by the following equation.

$$\text{Total fiber fineness (disentangled yarn of fabric)} = W/L \times 1000000$$

(dtex)

Single filament fineness (dtex) is defined as a value obtained by dividing the total fiber fineness by the number of filaments. The same measurement was repeated five times, and its average are shown in the results.

[0058]

C. Cross-Sectional Shape of Nylon 6 Fiber

A cross-sectional shape was observed using a light microscope at a magnification of 400. For a longest line segment A connecting any two apexes of

convex portions of the flat multifoliar shape, a line segment B of a circumscribed quadrangle formed by lines that are parallel to the line segment A and are tangent lines containing outermost apexes (the angle between adjacent sides is 90°), the line segment B being other than the lines that are parallel to the line segment A, a line segment C connecting the apexes of adjacent convex portions in the largest concavity and convexity formed by the flat multifoliar shape, and a perpendicular D drawn from the bottom of a concave portion between the convex portions to the line segment C connecting the apexes of the convex portions, their lengths were measured, and calculation was performed by the following equations.

$$\text{Flat ratio (F)} = (a/b)$$

a : length of line segment A, b : length of line segment B

$$\text{Modified shape ratio (F)} = (c/d)$$

c : length of line segment C, d : length of line segment D

According to the method described above, a flat ratio (F) and a modified shape ratio (F) were calculated, and the averages of randomly-selected five filaments were used as the flat ratio (F) and the modified shape ratio (F) of yarn.

[0059]

D. Cross-Sectional Shape of Fabric

Using a cross-sectional photograph of the fabric obtained by SEM at a magnification of 600, the cross-sectional shape of the fiber was observed to determine a flat ratio (W) and the number of concavities and convexities according to the method described above. From single filaments constituting the fabric, five filaments not exposed at the surface subjected to calender processing were randomly selected and evaluated, and its average value was used as the flat ratio (W) and the number of inflexion points of the polyamide fiber.

[0060]

(a) Flat Ratio (W)

Flat ratio (W) is defined as α/β , wherein α is a length of a longest line segment A connecting any two apexes of convex portions of the flat multifoliar shape), and β is a length of a line segment B of a circumscribed quadrangle formed by lines that are parallel to the line segment A and are tangent lines containing
 5 outermost apexes (the angle between adjacent sides is 90°), the line segment B being other than the lines that are parallel to the line segment A (see FIG. 2).

[0061]

(b) The Number of Lobe Parts

The number of lobe parts is defined as a value obtained by dividing the
 10 number of inflexion points in a fiber cross section by 2.

[0062]

E. Tear Strength

The tear strength of the fabric was measured in both the warp direction and the woof direction in accordance with the tear strength JIS D method (wet grab
 15 method) stipulated in JIS L 1096 (2010) 8.14.1.

[0063]

F. Density of Fabric

The density of the fabric was measured in accordance with JIS L 1096 (2010) 8.3.1 based on corrected weight.

20 [0064]

G. Air Permeability

The air permeability of the fabric was measured in accordance with the air permeability A method (Frajour type method) stipulated in JIS L 1096 (2010) 8.26.1.

(a) Initial Air Permeability

25 For the fabric before washing, air permeability was measured three times, and initial air permeability was evaluated by its average value.

(b) Air Permeability After Fifty Washing

The fabric was washed in accordance with F-2 method described in dimensional change of fabric in JIS L 1096 (2010) 8.64.4. Fifty washing means that washing-spinning-drying is repeated 50 times. Air permeability after fifty washing of the fabric was evaluated by the average of three measurements of air permeability after fifty washing.

[0065]

H. Glossiness

The glossiness of the fabric was visually evaluated by five experts relatively to Comparative Example 1, and rated on a 5-point scale. For a fabric subjected to calender processing on only one surface, the surface subjected to calender processing was evaluated. Rating 4 or higher was considered as acceptable.

5: Having a high-quality delicate gloss

4: Having a mild gloss

3: Having a normal gloss (Comparative Example 1)

2: Having slight glitter or streaks

1: Having glitter or streaks

[0066]

I. Down Proof Test

The down proof test was carried out using a fabric after fifty washing as follows: a sample of 35 cm × 35 cm filled inside with 40 g of feathers was prepared (seams being sealed with resin); this sample was placed in a tumble dryer together with five rubber tubes stipulated in JIS L 1076 (2010) A method, and the tumble dryer was operated for 60 minutes without heating; and after the operation completed, the sample was taken out, and the degree of slipping-out of feathers was visually rated on a 5-point scale below. Rating 4 or higher was considered as acceptable.

5: 3 feathers or less

4: 4 to 10 feathers

3: 11 to 30 feathers

2: 31 to 50 feathers

1: 51 feathers or more

J. Overall Evaluation

5 The glossiness and the down proofness were summed, and 8 or higher was considered as acceptable.

[0067]

Example 1

Preparation of Nylon 6 Fiber Having Flat Cross Section with Eight Leaves

10 Nylon 6 with a relative viscosity of 3.5 was melt-extruded through a spinneret having an outlet port with a shape as shown in FIG. 3(a) (slit width: 0.07 mm, slit length ratio: $e/f = 5/2$) at a spinning temperature of 285°C, cooled, oiled, entangled, and taken up with a godet roller of 2800 m/min. Subsequently, the resultant was stretched to 1.4 times, heat-set at a temperature of 155°C, and wound up at a rate of
15 3500 m/min to obtain a nylon 6 fiber of 33 dtex and 26 filaments having a flat cross section with eight leaves.

[0068]

A flat ratio (F) and a modified shape ratio (F) was calculated from a cross-sectional photograph of the nylon 6 fiber obtained. The results are shown in Table

20 1.

Preparation of Nylon 6 Fiber of 22 Dtex and 20 Filaments Having Round Cross Section

[0069]

25 Nylon 6 with a relative viscosity of 3.0 was melt-extruded through a round-hole spinneret at a spinning temperature of 280°C, cooled, oiled, entangled, and taken up with a godet roller of 2480 m/min. Subsequently, the resultant was stretched to 1.7 times, heat-set at a temperature of 155°C, and wound up at a rate of

4000 m/min to obtain a nylon 6 fiber of 22 dtex and 20 filaments having a round cross section.

[0070]

Production of Fabric

5 Using the nylon 6 fiber having a flat cross section with eight leaves as woof, and the nylon 6 fiber of 22 dtex and 20 filaments having a round cross section as warp, a fabric was woven in a plain weave at 188 ends per inch and 135 picks per inch.

[0071]

10 According to a conventional method, the gray fabric obtained was refined with a solution containing caustic soda (NaOH) in an amount of 2 g per liter using an open soaper, dried at a temperature of 120°C using a cylinder dryer, preset at 170°C, stained with a jigger dyeing machine, impregnated (padded) with a fluorine resin compound, dried (temperature: 120°C), and subjected to finish setting (temperature:
15 175°C). Thereafter, the resultant was subjected to calender processing (processing conditions: cylinder processing, heating roll surface temperature: 180°C, heating roll load: 147 kN, fabric travel speed: 20 m/min) once on both surfaces to obtain a fabric. The physical properties and evaluation results of the fabric obtained are shown in Tables 2 and 3. The fabric was satisfactory. A SEM photograph of a transverse
20 cross section of the fabric is shown in FIG. 1.

[0072]

Example 2

 A fabric was obtained using the nylon 6 fiber of 22 dtex and 20 filaments having a round cross section as warp and a nylon 6 fiber of 33 dtex and 26 filaments
25 having a flat cross section with eight leaves prepared in the same manner as in Example 1 except that the spinning temperature of the nylon 6 fiber having a flat cross section with eight leaves was changed to 280°C. The physical properties and

evaluation results of the fabric obtained are shown in Tables 2 and 3. The fabric was satisfactory.

[0073]

Example 3

5 A fabric was obtained using the nylon 6 fiber of 22 dtex and 20 filaments having a round cross section as warp and a nylon 6 fiber of 33 dtex and 26 filaments having a flat cross section with eight leaves prepared in the same manner as in Example 1 except that the spinning temperature of the nylon 6 fiber having a flat cross section with eight leaves was changed to 275°C. The physical properties and
10 evaluation results of the fabric obtained are shown in Tables 2 and 3. The fabric was satisfactory.

[0074]

Example 4

A fabric was obtained using the nylon 6 fiber of 22 dtex and 20 filaments
15 having a round cross section as warp and a nylon 6 fiber of 33 dtex and 26 filaments having a flat cross section with six leaves prepared in the same manner as in Example 1 except that the shape of the outlet port of the spinneret was changed (FIG. 3(b), slit width: 0.07 mm, slit length ratio: $g/h = 5/2$). The physical properties and evaluation results of the fabric obtained are shown in Tables 2 and 3. The fabric
20 was satisfactory.

[0075]

Example 5

A fabric was obtained using the nylon 6 fiber of 22 dtex and 20 filaments having a round cross section as warp and a nylon 6 fiber of 33 dtex and 26 filaments
25 having a flat cross section with ten leaves prepared in the same manner as in Example 1 except that the shape of the outlet port of the spinneret was changed (FIG. 3(c), slit width: 0.07 mm, slit length ratio: $i/j = 5/2$). The physical properties and

evaluation results of the fabric obtained are shown in Tables 2 and 3. The fabric was satisfactory.

[0076]

Example 6

5 A fabric was obtained using the nylon 6 fiber of 22 dtex and 20 filaments having a round cross section as warp and a nylon 6 fiber of 22 dtex and 20 filaments having a flat cross section with eight leaves prepared in the same manner as in Example 1 except that the number of filaments of the nylon 6 fiber having a flat cross section with eight leaves was changed to 20 and the total fiber fineness was 22
10 dtex. The physical properties and evaluation results of the fabric obtained are shown in Tables 2 and 3. The fabric was satisfactory.

[0077]

Example 7

A fabric was obtained using the nylon 6 fiber of 22 dtex and 20 filaments
15 having a round cross section as warp and a nylon 6 fiber of 44 dtex and 40 filaments having a flat cross section with eight leaves prepared in the same manner as in Example 1 except that the number of filaments of the nylon 6 fiber having a flat cross section with eight leaves was changed to 40 and the total fiber fineness was 44 dtex. The physical properties and evaluation results of the fabric obtained are
20 shown in Tables 2 and 3. The fabric was satisfactory.

[0078]

Example 8

A fabric was obtained using the nylon 6 fiber of 22 dtex and 20 filaments having a round cross section as warp and a nylon 6 fiber of 22 dtex and 12 filaments
25 having a flat cross section with eight leaves prepared in the same manner as in Example 1 except that the number of filaments of the nylon 6 fiber having a flat cross section with eight leaves was changed to 12 and the total fiber fineness was 22

dtex. The physical properties and evaluation results of the fabric obtained are shown in Tables 2 and 3. The fabric was satisfactory.

[0079]

Example 9

5 A fabric was obtained using the nylon 6 fiber of 22 dtex and 20 filaments having a round cross section as warp and a nylon 6 fiber of 44 dtex and 58 filaments having a flat cross section with eight leaves prepared in the same manner as in Example 1 except that the number of filaments of the nylon 6 fiber having a flat cross section with eight leaves was changed to 58 and the total fiber fineness was 44
10 dtex. The physical properties and evaluation results of the fabric obtained are shown in Tables 2 and 3. The fabric was satisfactory.

[0080]

Example 10

A fabric was obtained using the nylon 6 fiber of 22 dtex and 20 filaments
15 having a round cross section as warp and a nylon 6 fiber of 11 dtex and 8 filaments having a flat cross section with eight leaves prepared in the same manner as in Example 1 except that the number of filaments of the nylon 6 fiber having a flat cross section with eight leaves was changed to 8 and the total fiber fineness was 11
20 dtex. The physical properties and evaluation results of the fabric obtained are shown in Tables 2 and 3. The fabric was satisfactory.

[0081]

Example 11

A fabric was obtained in the same manner as in Example 1 except that the fabric was subjected to calender processing (processing conditions: cylinder
25 processing, heating roll surface temperature: 180°C, heating roll load: 147 kN, fabric travel speed: 20 m/min) once on one surface. The physical properties and evaluation results of the fabric obtained are shown in Tables 2 and 3. The fabric

was satisfactory.

[0082]

Example 12

A fabric was obtained in the same manner as in Example 1 except that the
5 nylon 6 fiber of 22 dtex and 20 filaments having a round cross section was used as
warp; a nylon 6 fiber of 33 dtex and 26 filaments having a flat cross section with
eight leaves prepared in the same manner as in Example 1 was used as woof; and the
fabric was woven in a plain weave at 220 ends per inch and 160 picks per inch. The
physical properties and evaluation results of the fabric obtained are shown in Tables
10 2 and 3. The fabric was satisfactory.

[0083]

Example 13

A fabric was obtained in the same manner as in Example 1 except that the
fabric was woven in a rip-stop taffeta weave. The physical properties and
15 evaluation results of the fabric obtained are shown in Table 2. The fabric was
satisfactory.

Example 14

A fabric was obtained in the same manner as in Example 1 except that the
heating roll load in calender processing was 74 kN. The physical properties and
20 evaluation results of the fabric obtained are shown in Tables 2 and 3. The fabric
was satisfactory although it was inferior to Example 1 in glossiness and down proof
test because of weak calendering.

[0084]

Example 15

25 A fabric was obtained in the same manner as in Example 1 except that a
nylon 6 fiber of 33 dtex and 26 filaments having a flat cross section with eight leaves
prepared in the same manner as in Example 1 was used as warp; the nylon 6 fiber of

22 dtex and 20 filaments having a round cross section was used as woof; and the fabric was woven in a plain weave at 190 ends per inch and 160 picks per inch. The physical properties and evaluation results of the fabric obtained are shown in Tables 2 and 3. The fabric was satisfactory.

5 [0085]

Example 16

A fabric was obtained in the same manner as in Example 1 except that a nylon 6 fiber of 33 dtex and 26 filaments having a flat cross section with eight leaves prepared in the same manner as in Example 1 was used as warp and woof, and the
10 fabric was woven in a plain weave at 190 ends per inch and 135 picks per inch. The physical properties and evaluation results of the fabric obtained are shown in Tables 2 and 3. The fabric was satisfactory.

[0086]

Comparative Example 1

15 A fabric was obtained in the same manner as in Example 1 except for using the nylon 6 fiber of 22 dtex and 20 filaments having a round cross section as warp and a polyamide fiber of 22 dtex and 20 filaments having a round cross section as woof. The physical properties and evaluation results of the fabric obtained are shown in Tables 2 and 3. In particular, the fabric obtained, in which the overlap of
20 filaments was reduced and the pressed state was insufficient even after calender processing because of the use of the polyamide fiber having a round cross section, had poor air permeability and was poor in the down proof test.

[0087]

Comparative Example 2

25 A fabric was obtained using the nylon 6 fiber of 22 dtex and 20 filaments having a round cross section as warp and a nylon 6 fiber of 33 dtex and 24 filaments having a Y-shaped cross section prepared in the same manner as in Example 1 except

that a spinneret having a Y-shaped outlet port (FIG. 4 (a), slit width: 0.07 mm, slit length k: 0.5 mm) was used. The physical properties and evaluation results of the fabric obtained are shown in Tables 2 and 3. The fabric obtained was significantly poor in air permeability after fifty washing and poor in the down proof test.

5 Furthermore, for glossiness, the fabric obtained had a glittering gloss and also streaks, and a fabric with a delicate and elegant gloss could not be obtained.

[0088]

Comparative Example 3

A fabric was obtained using the nylon 6 fiber of 22 dtex and 20 filaments
10 having a round cross section as warp and a nylon 6 fiber of 33 dtex and 24 filaments having a cruciform cross section prepared in the same manner as in Example 1 except that a spinneret having a cross-shaped outlet port (FIG. 4 (b), slit width: 0.07 mm, slit length l: 0.5 mm) was used. The physical properties and evaluation results of the fabric obtained are shown in Tables 2 and 3. The fabric obtained, similarly to
15 Comparative Example 2, was significantly poor in air permeability after fifty washing and poor in the down proof test. For glossiness, the fabric obtained had a glittering gloss and also streaks, and a fabric with a delicate and elegant gloss could not be obtained.

[0089]

20 Comparative Example 4

A fabric was obtained using the nylon 6 fiber of 22 dtex and 20 filaments having a round cross section as warp and a nylon 6 fiber of 33 dtex, 26 filaments, and a flat ratio (F) of 1.3 having a flat cross section with eight leaves prepared in the same manner as in Example 1 except that nylon 6 with a relative viscosity of 2.5 was
25 used. The physical properties and evaluation results of the fabric obtained are shown in Tables 2 and 3. The fabric obtained had a low flat ratio (W) and insufficient glossiness, and also was poor in air permeability after fifty washing and

somewhat poor in the down proof test.

[0090]

Comparative Example 5

A fabric was obtained using the nylon 6 fiber of 22 dtex and 20 filaments
5 having a round cross section as warp and a nylon 6 fiber of 33 dtex, 26 filaments, and
a flat ratio (F) of 3.5 having a flat cross section with eight leaves prepared in the
same manner as in Example 1 except that nylon 6 with a relative viscosity of 4.0 was
used and the spinning temperature was changed to 275°C. The physical properties
and evaluation results of the fabric obtained are shown in Tables 2 and 3. The
10 fabric was very glittering because of the high flat ratio (W).

[0091]

Comparative Example 6

A fabric was obtained using the nylon 6 fiber of 22 dtex and 20 filaments
having a round cross section as warp and a nylon 6 fiber of 33 dtex and 26 filaments
15 having a flat cross section with twelve leaves prepared in the same manner as in
Example 1 except that the shape of the outlet port of the spinneret was changed (FIG.
4 (c), slit width: 0.07 mm, slit length ratio: $m/n = 5/2$). The physical properties and
evaluation results of the fabric obtained are shown in Tables 2 and 3. Because of
the nearly round cross section, the fabric obtained had high air permeability after
20 fifty washing and was poor in the down proof test, failing to provide mild glossiness.

[0092]

Comparative Example 7

A fabric was obtained using the nylon 6 fiber of 22 dtex and 20 filaments
having a round cross section as warp and a nylon 6 fiber of 22 dtex and 5 filaments
25 having a flat cross section with eight leaves prepared in the same manner as in
Example 1 except that the number of outlet ports of the spinneret was changed to 5
and the total fiber fineness was 22 dtex. The physical properties and evaluation

results of the fabric obtained are shown in Tables 2 and 3. Because of the large single filament fineness, satisfactory results were not obtained in the down proof test.

[0093]

Comparative Example 8

- 5 A fabric was obtained in the same manner as in Example 1 except that the cover factor was 976. The physical properties and evaluation results of the fabric obtained are shown in Tables 2 and 3. Because of the low density, the fabric obtained was poor in initial air permeability and poor in the down proof test.

[0094]

10 Comparative Example 9

 A fabric was obtained in the same manner as in Example 1 except that the fabric was not subjected to calender processing. The physical properties and evaluation results of the fabric obtained are shown in Tables 2 and 3. The overlap of filaments was insufficient, and the fabric obtained was poor in the down proof test.

[0095]

Table 1

	Warp				Weft			
	Cross-section shape	dtex/f	Flat ratio	Modeled shape ratio	Cross-section shape	dtex/f	Flat ratio	Modeled shape ratio
Example 1	Circle	22/20	1.0	—	Flat eight-leaf	33/26	1.6	7.5
Example 2	Circle	22/20	1.0	—	Flat eight-leaf	33/26	2.1	5.5
Example 3	Circle	22/20	1.0	—	Flat eight-leaf	33/26	2.4	4.0
Example 4	Circle	22/20	1.0	—	Flat six-leaf	33/26	2.2	5.5
Example 5	Circle	22/20	1.0	—	Flat ten-leaf	33/26	2.2	5.5
Example 6	Circle	22/20	1.0	—	Flat eight-leaf	22/20	1.6	7.5
Example 7	Circle	22/20	1.0	—	Flat eight-leaf	44/40	1.8	5.5
Example 8	Circle	22/20	1.0	—	Flat eight-leaf	22/12	2.4	1.2
Example 9	Circle	22/20	1.0	—	Flat eight-leaf	44/58	1.7	6.2
Example 10	Circle	22/20	1.0	—	Flat eight-leaf	11/8	1.8	6.0
Example 11	Circle	22/20	1.0	—	Flat eight-leaf	33/26	1.6	7.5
Example 12	Circle	22/20	1.0	—	Flat eight-leaf	33/26	1.6	7.5
Example 13	Circle	22/20	1.0	—	Flat eight-leaf	33/26	1.6	7.5
Example 14	Circle	22/20	1.0	—	Flat eight-leaf	33/26	1.6	7.5
Example 15	Flat eight-leaf	33/26	1.6	7.5	Circle	22/20	1.0	—
Example 16	Flat eight-leaf	33/26	1.6	7.5	Flat eight-leaf	33/26	1.6	7.5
Comparative Example 1	Circle	22/20	1.0	—	Circle	22/20	1.0	—
Comparative Example 2	Circle	22/20	1.0	—	Y	33/24	1.1	3.0
Comparative Example 3	Circle	22/20	1.0	—	X	33/24	1.0	3.5
Comparative Example 4	Circle	22/20	1.0	—	Flat eight-leaf	33/26	1.3	8.5
Comparative Example 5	Circle	22/20	1.0	—	Flat eight-leaf	33/26	3.5	0.8
Comparative Example 6	Circle	22/20	1.0	—	Flat twelve-leaf	33/26	2.5	5.0
Comparative Example 7	Circle	22/20	1.0	—	Flat eight-leaf	22/5	2.2	1.2
Comparative Example 8	Circle	22/20	1.0	—	Flat eight-leaf	33/26	1.6	7.5
Comparative Example 9	Circle	22/20	1.0	—	Flat eight-leaf	33/26	1.6	7.5

[0096]

Table 2

	Polyamide	Warp					Weft					Woven fabric					Tear strength (N)		Weight g/m ²
		Crosssection shape	Total fineness	Single filament fineness	Flat ratio (W)	Number of leaf portions	Crosssection shape	Total fineness	Single filament fineness	Flat ratio (W)	Number of leaf portions	Textile weave	Warp	Weft	CF	Calendering	Warp	Weft	
Example 1	N6	Circle	25	1.3	1.1	0	Flat eight-leaf	38	1.5	1.7	8	Plain weave	210	135	1761	Both surfaces	7.5	7.3	40
Example 2	N6	Circle	25	1.3	1.1	0	Flat eight-leaf	38	1.5	2.0	8	Plain weave	210	135	1761	Both surfaces	7.5	7.0	40
Example 3	N6	Circle	25	1.3	1.1	0	Flat eight-leaf	38	1.5	2.4	8	Plain weave	210	135	1761	Both surfaces	7.5	6.8	40
Example 4	N6	Circle	25	1.3	1.1	0	Flat six-leaf	38	1.5	2.2	6	Plain weave	210	135	1761	Both surfaces	7.5	7.2	40
Example 5	N6	Circle	25	1.3	1.1	0	Flat ten-leaf	38	1.5	2.2	10	Plain weave	210	135	1761	Both surfaces	7.5	6.9	40
Example 6	N6	Circle	25	1.3	1.1	0	Flat eight-leaf	25	1.3	1.6	8	Plain weave	210	160	1735	Both surfaces	7.5	6.5	36
Example 7	N6	Circle	25	1.3	1.1	0	Flat eight-leaf	49	1.2	1.8	8	Plain weave	190	110	1621	Both surfaces	7.5	6.4	48
Example 8	N6	Circle	25	1.3	1.1	0	Flat eight-leaf	25	2.1	2.4	8	Plain weave	210	160	1735	Both surfaces	7.5	6.0	36
Example 9	N6	Circle	25	1.3	1.1	0	Flat eight-leaf	49	0.8	1.8	8	Plain weave	190	110	1621	Both surfaces	7.5	5.8	48
Example 10	N6	Circle	25	1.3	1.1	0	Flat eight-leaf	13	1.6	2.0	8	Plain weave	210	190	1615	Both surfaces	7.5	5.6	32
Example 11	N6	Circle	25	1.3	1.1	0	Flat eight-leaf	38	1.5	1.7	8	Plain weave	210	135	1761	Single surface	7.7	7.3	40
Example 12	N6	Circle	25	1.3	1.1	0	Flat eight-leaf	38	1.5	1.7	8	Plain weave	240	160	2045	Both surfaces	7.8	7.5	44
Example 13	N6	Circle	25	1.3	1.1	0	Flat eight-leaf	38	1.5	1.7	8	Rip stop weave	210	135	1761	Both surfaces	7.5	7.3	40
Example 14	N6	Circle	25	1.3	1.1	0	Flat eight-leaf	38	1.5	1.7	8	Plain weave	210	135	1761	Both surfaces	7.5	7.3	40
Example 15	N6	Flat eight-leaf	38	1.5	1.6	8	Circle	25	1.3	1.1	8	Plain weave	190	160	1842	Both surfaces	7.2	7.6	42
Example 16	N6	Flat eight-leaf	38	1.5	1.6	8	Flat eight-leaf	38	1.5	1.7	8	Plain weave	190	135	1867	Both surfaces	7.2	7.3	43
Comparative Example 1	N6	Circle	25	1.3	1.1	0	Circle	25	1.3	1.1	0	Plain weave	210	160	1735	Both surfaces	7.5	7.5	36
Comparative Example 2	N6	Circle	25	1.3	1.1	3	Y	38	1.5	1.9	3	Plain weave	210	135	1761	Both surfaces	7.5	4.5	40
Comparative Example 3	N6	Circle	25	1.3	1.1	4	X	38	1.5	1.7	4	Plain weave	210	135	1761	Both surfaces	7.5	4.4	40
Comparative Example 4	N6	Circle	25	1.3	1.1	8	Flat eight-leaf	38	1.5	1.3	8	Plain weave	210	135	1761	Both surfaces	7.5	7.4	40
Comparative Example 5	N6	Circle	25	1.3	1.1	8	Flat eight-leaf	38	1.5	3.5	8	Plain weave	210	135	1761	Both surfaces	7.5	6.7	40
Comparative Example 6	N6	Circle	25	1.3	1.1	12	Flat twelve-leaf	38	1.5	2.5	12	Plain weave	210	135	1761	Both surfaces	7.5	6.4	40
Comparative Example 7	N6	Circle	25	1.3	1.1	8	Flat eight-leaf	25	5.0	2.2	8	Plain weave	210	160	1735	Both surfaces	7.5	7.3	36
Comparative Example 8	N6	Circle	25	1.3	1.1	8	Flat eight-leaf	38	1.5	1.7	8	Plain weave	110	80	976	Both surfaces	7.3	7.2	32
Comparative Example 9	N6	Circle	25	1.3	1.0	8	Flat eight-leaf	38	1.5	1.7	8	Plain weave	210	135	1761	none	7.8	7.5	42

[0097]

Table 3

	Initial air permeability (A)	Air permeability after fifty washing (B)	Difference (B)-(A)	Glossiness	Down proof test	Overall evaluation
	cc/cm ² /s	cc/cm ² /s	cc/cm ² /s			
Example 1	0.5	0.7	0.2	5	5	10
Example 2	0.5	0.7	0.2	5	5	10
Example 3	0.4	0.7	0.3	5	5	10
Example 4	0.5	0.8	0.3	4	5	9
Example 5	0.5	0.7	0.2	4	5	9
Example 6	0.5	0.7	0.2	5	5	10
Example 7	0.5	0.7	0.2	5	5	10
Example 8	0.7	0.9	0.2	5	5	10
Example 9	0.8	1.0	0.2	4	5	9
Example 10	0.6	0.9	0.3	5	5	10
Example 11	0.6	0.8	0.2	5	5	10
Example 12	0.4	0.6	0.2	5	5	10
Example 13	0.5	0.7	0.2	5	5	10
Example 14	1.0	1.2	0.2	4	4	8
Example 15	0.4	0.6	0.2	5	5	10
Example 16	0.4	0.5	0.1	5	5	10
Comparative Example 1	1.2	2.2	1.0	3	1	4
Comparative Example 2	0.6	1.5	0.9	1	3	4
Comparative Example 3	0.6	1.4	0.8	1	3	4
Comparative Example 4	0.8	1.3	0.5	3	3	6
Comparative Example 5	0.5	0.6	0.1	2	5	7
Comparative Example 6	0.5	1.5	1.0	3	3	6
Comparative Example 7	1.1	1.7	0.6	4	2	6
Comparative Example 8	2.2	3.8	1.6	4	1	5
Comparative Example 9	1.8	2.8	1.0	4	1	5

[0098]

5 As is clear from the results in Tables 2 and 3, the fabrics according to Examples of the present invention were fabrics having high strength by keeping the fiber outline flat, excellent air permeability (which is because movement of polyamide single filaments tends to be restricted by having large numbers of lobe parts, and upon being pressed and fixed by calender processing, concavities and

10 convexities of the single filaments overlap each other with a small gap therebetween),

and reduced slipping-out of downs. Furthermore, the cross section of single filaments constituting the fabric had appropriate concavities and convexities, due to which the fabric surface became uniformly smooth by calender processing, providing a high-quality and delicate gloss. Such excellent characteristics allow to provide a ticking of, for example, down wear, down jackets, and sportswear.

Industrial Applicability

[0099]

The fabric of the present invention is lightweight and thin and has high strength, low air permeability, and excellent glossiness, and thus can be suitably used for a ticking of, for example, down wear, down jackets, and sportswear.

Description of Symbols

[0100]

1 to 3: Polyamide single filaments located at the fabric surface after calender processing

4 to 6: Polyamide single filaments not located at the fabric surface

A: Longest line segment connecting any two apexes of convex portions of a flat multifoliar shape

B: Line segment of a circumscribed quadrangle formed by lines that are parallel to the line segment A and are tangent lines containing outermost apexes (the angle between adjacent sides is 90°), the line segment B being other than the lines that are parallel to the line segment A

C: Line segment connecting the apexes of adjacent convex portions of the largest concavity and convexity formed by the flat multifoliar shape

D: Perpendicular drawn from the bottom of a concave portion between the convex portions to the line segment C connecting the apexes of the convex portions

e: Slit length of flat eight-leave-shaped outlet port used in Example 1

f: Slit length of flat eight-leave-shaped outlet port used in Example 1

g: Slit length of flat six-leave-shaped outlet port used in Example 4

h: Slit length of flat six-leave-shaped outlet port used in Example 4

i: Slit length of flat ten-leave-shaped outlet port used in Example 5

j: Slit length of flat ten-leave-shaped outlet port used in Example 5

5 k: Slit length of Y-shaped outlet port used in Comparative Example 2

l: Slit length of cross-shaped outlet port used in Comparative Example 3

m: Slit length of flat twelve-leave-shaped outlet port used in Comparative
Example 6

10 n: Slit length of flat twelve-leave-shaped outlet port used in Comparative
Example 6

Area O: Area where a concave portion of a single filament and a convex
portion of an adjacent single filament overlap each other

Area X: Area where a concave portion of a single filament and a concave
portion of an adjacent single filament overlap each other

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CLAIMS

1. A fabric subjected to calender processing on one or both surfaces, comprising a polyamide fiber used as warp or/and woof having, after calender processing of the fabric, a single filament fineness of 0.5 to 2.5 dtex and a total fiber fineness of 5 to 50 dtex, the single filament having a cross-sectional shape that is flat multifoliar with 6 to 10 lobe parts and has a flat ratio (W) (α/β) of 1.5 to 3.0, wherein α is a length of a line segment A, which is a longest line segment connecting any two apexes of convex portions of the flat multifoliar shape, and β is a length of a line segment B of a circumscribed quadrangle formed by lines that are parallel to the line segment A and are tangent lines containing outermost apexes (the angle between adjacent sides is 90°), the line segment B being other than the lines that are parallel to the line segment A, the fabric having a cover factor of 1200 to 2500.

2. The fabric according to claim 1, wherein the polyamide fiber has, before calender processing of the fabric, a single filament fineness of 0.4 to 2.2 dtex and a total fiber fineness of 4 to 44 dtex, the single filament having a cross-sectional shape that is flat multifoliar with 6 to 10 leaves and satisfies both equations below:

$$\text{Flat ratio (F) } (a/b) = 1.5 \text{ to } 3.0$$

$$\text{Modified shape ratio (F) } (c/d) = 1.0 \text{ to } 8.0$$

wherein a is a length of a longest line segment A connecting any two apexes of convex portions of the flat multifoliar shape; b is a length of a line segment B of a circumscribed quadrangle formed by lines that are parallel to the line segment A and are tangent lines containing outermost apexes (the angle between adjacent sides is 90°), the line segment B being other than the lines that are parallel to the line segment A; c is a length of a line segment C connecting the apexes of adjacent convex portions of the largest concavity and convexity among concavities and convexities formed by the flat multifoliar shape; and d is a length of a perpendicular D drawn from the bottom of a concave portion between the convex portions to the

line segment C connecting the apexes of the convex portions

3. The fabric according to claim 1 or 2, having a tear strength of 5.0 N or more and an initial air permeability of 1.0 cc/cm²/s or lower.

5 4. The fabric according to any one of claims 1 to 3, having an air permeability after fifty washing of 1.0 cc/cm²/s or lower.

5. The fabric according to any one of claims 1 to 4, wherein the difference between the initial air permeability and the air permeability after fifty washing is 0.4 cc/cm²/s or less.

10 6. A sewn product obtained by using the fabric according to any one of claims 1 to 5 at least in part.

7. A down shell or a down jacket obtained by using the fabric according to any one of claims 1 to 5 at least in part.