

DESCRIPTION

TITLE

POLYURETHANE ELASTIC FIBERS, PRODUCT CONTAINING SAME, AND SURFACE
TREATMENT AGENT FOR POLYURETHANE ELASTIC FIBERS

FIELD

[0001]

The present invention relates to a polyurethane elastic fiber and a product containing the fiber,
as well as a surface treatment agent for polyurethane elastic fibers.

BACKGROUND

[0002]

Polyurethane elastic fibers have high elongation and excellent elastic properties. However,
since polyurethane polymer is a flexible and tacky material, in the manufacturing process of
products using polyurethane elastic fibers, issues such as yarn breakage due to frictional resistance
on guides or rollers during the unwinding or running of a yarn from a wound body of polyurethane
elastic fibers and production variations occur easily. These issues are very prominent particularly
with the use of a wound body after long-term storage.

To resolve these issues, a method of applying a treatment agent composed of silicone oil to
the yarn is known. Because silicone oil is expensive, generally silicone oil is diluted using an
inexpensive mineral oil to prepare a treatment agent to be applied to the yarn. Although cost
reduction is possible with a treatment agent obtained by diluting silicone oil with a mineral oil, the
unwindability from a wound body and the frictional property of the polyurethane elastic fiber
having the treatment agent applied thereto are reduced, and thus sufficient unwindability and
frictional property cannot be obtained.

[0003]

PTL 1 below reports a method in which a specific amine and an organic acid are added into
a surface treatment agent for polyurethane elastic fibers obtained by diluting a silicone oil with a
mineral oil. However, there are concerns regarding the storage stability of a treatment agent in the
method in which a basic or acidic compound is added into the mineral oil. There are also issues of
increased man-hours of preparation and a cost increase.

[0004]

PTL 2 below reports a method for applying to a yarn a treatment agent in which a hydrocarbon
oil (mineral oil) having a specific viscosity range is used in a specific amount or more, as a means
for improving unwindability via a surface treatment agent for polyurethane elastic fibers, obtained

by diluting a silicone oil with a mineral oil. However, when a highly viscous hydrocarbon oil is used, the viscosity of the treatment agent itself becomes high and stable coating of a yarn therewith becomes difficult. There are also issues of poor blending and storage stability due to the high viscosity of the treatment agent itself.

[0005]

PTL 3 below reports a method for obtaining a polyurethane elastic fiber with good unwindability by dry-spinning a spinning dope into which a modifier consisting of a silicone oil and a high fatty acid metal salt is kneaded. Although there are definite technical improvements, the cohesiveness between single yarns of a multifilament is weakened due to the kneading of a modifier therein, and the phenomenon of single yarns peeling from the multifilament (hereinafter referred to as single-yarn unraveling) is likely to occur. There is an issue of single-yarn unraveling causing yarn breakage when using the polyurethane elastic fiber in, for example, knitting.

[0006]

As described, a polyurethane elastic fiber in which the unwindability is improved with a low silicone oil content and the single-yarn unraveling of a multifilament is low has yet to be obtained.

[CITATION LIST]

[PATENT LITERATURE]

[0007]

[PTL 1] Japanese Unexamined Patent Publication (Kokai) No. 2007-270414

[PTL 2] Japanese Unexamined Patent Publication (Kokai) No. 2017-110319

[PTL 3] Japanese Unexamined Patent Publication (Kokai) No. 2009-287126

SUMMARY

[TECHNICAL PROBLEM]

[0008]

In view of the issues of the prior art described above, the object of the present invention is to provide a polyurethane elastic fiber having good unwindability and few single-yarn unraveling of a multifilament, even with a low silicone oil content, and a product containing the fiber, as well as a surface treatment agent for polyurethane elastic fibers suitable for the manufacture of the polyurethane elastic fiber.

[SOLUTION TO PROBLEM]

[0009]

The present inventors have intensively studied and experimented so as to achieve the above object. As a result, the present inventors have unexpectedly discovered that the above object can

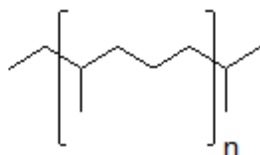
be achieved by including a specific amount of a specific branched hydrocarbon compound in a polyurethane elastic fiber, thus arriving at the present invention.

[0010]

The present invention is described as follows.

[1] A polyurethane elastic fiber containing a hydrocarbon compound represented by formula (1) below:

[Chem. 1]



where n is an integer of 2 to 5, at 10 ppm to 10000 ppm relative to the weight of the polyurethane elastic fiber.

[2] The polyurethane elastic fiber according to [1], containing the hydrocarbon compound represented by the formula (1), where n is 3, at 10 ppm to 8000 ppm relative to the weight of the polyurethane elastic fiber.

[3] The polyurethane elastic fiber according to [1] or [2], further containing a hydrocarbon compound other than the hydrocarbon compound represented by formula (1) where n is an integer of 2 to 5.

[4] The polyurethane elastic fiber according to any of [1] to [3], wherein the area of a component occupying a retention time longer than the retention time of triacontane is less than 5% of the total area of a peak derived from the hydrocarbon compound, in GC/MS measurement of an extract with hexane.

[5] The polyurethane elastic fiber according to any of [1] to [4], wherein the area of a component occupying a retention time longer than a retention time of octacosane is less than 5% of the total area of a peak derived from the hydrocarbon compound, in GC/MS measurement of an extract with hexane.

[6] The polyurethane elastic fiber according to any of [1] to [5], wherein the area of a component occupying a retention time shorter than a retention time of hexadecane is less than 5% of the total area of a peak derived from the hydrocarbon compound, in GC/MS measurement of an extract with hexane.

[7] The polyurethane elastic fiber according to any of [1] to [6], wherein the area occupying a retention time shorter than a retention time of octadecane is less than 20% of the total area of a peak derived from the hydrocarbon compound, in GC/MS measurement of an extract with hexane.

[8] The polyurethane elastic fiber according to any of [1] to [7], wherein the area of a

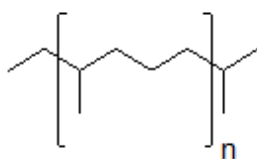
component occupying between the retention time of octadecane and octacosane is 80% or greater of the total area of a peak derived from the hydrocarbon compound, in GC/MS measurement of an extract with hexane.

[9] A fabric comprising the polyurethane elastic fiber according to any of [1] to [8].

5 [10] A hygienic material product comprising the polyurethane elastic fiber according to any of [1] to [8].

[11] A surface treatment agent for polyurethane elastic fibers, containing a hydrocarbon compound represented by formula (1) below:

[Chem. 2]



10

where n is an integer of 2 to 5, at 0.10% by weight to 25% by weight.

[12] The surface treatment agent for polyurethane elastic fibers according to [11], containing the hydrocarbon compound represented by the formula (1), where n is 3, at 0.10% by weight to 20% by weight.

15 [13] The surface treatment agent for polyurethane elastic fibers according to [11] or [12], further containing a hydrocarbon compound other than the hydrocarbon compound represented by the formula (1) where n is an integer of 2 to 5.

[14] The surface treatment agent for polyurethane elastic fibers according to any of [11] to [13], wherein the area of a component occupying a retention time longer than a retention time of triacontane is less than 5% of the total area of a peak derived from the hydrocarbon compound, in GC/MS measurement of a solution dissolved in hexane.

20 [15] The surface treatment agent for polyurethane elastic fibers according to any of [11] to [14], wherein the area of a component occupying a retention time longer than a retention time of octacosane is less than 5% of the total area of a peak derived from the hydrocarbon compound, in GC/MS measurement of a solution dissolved in hexane.

25 [16] The surface treatment agent for polyurethane elastic fibers according to any of [11] to [15], wherein the area occupying a retention time shorter than a retention time of hexadecane is less than 5% of the total area of a peak derived from the hydrocarbon compound, in GC/MS measurement of a solution dissolved in hexane.

30 [17] The surface treatment agent for polyurethane elastic fibers according to any of [11] to [16], wherein the area occupying a retention time shorter than a retention time of octadecane is less than 20% of the total area of a peak derived from the hydrocarbon compound, in GC/MS

measurement of a solution dissolved in hexane.

[18] The surface treatment agent for polyurethane elastic fibers according to any of [11] to [17], wherein the area of a component occupying between the retention time of octadecane and octacosane is 80% or greater of the total area of a peak derived from the hydrocarbon compound, in GC/MS measurement of a solution dissolved in hexane.

[19] The surface treatment agent for polyurethane elastic fibers according to any of [11] to [18], further containing a silicone oil at 20% by weight to 70% by weight.

[ADVANTAGEOUS EFFECTS OF INVENTION]

[0011]

The polyurethane elastic fiber containing a specific amount of a specific branched hydrocarbon compound according to the present invention is a polyurethane elastic fiber having good unwindability, even with a low silicone oil content, and few single-yarn unraveling of a multifilament. Therefore, the polyurethane elastic fiber according to the present invention can be suitably used for fabrics, hygienic material products, etc.

BRIEF DESCRIPTION OF DRAWINGS

[0012]

FIG. 1 is a graph showing a calculation example of the total peak area in GS/MS measurement of hydrocarbon compounds.

FIG. 2 is a graph showing a calculation example of the area of a component having a shorter retention time than octadecane in the total peak area of hydrocarbon compounds.

FIG. 3 shows a calculation example of the area of a component having a retention time between octadecane and octacosane in the total peak area of hydrocarbon compounds, measured by GS/MS of an extract in hexane.

FIG. 4 is an explanatory drawing showing a state of single-yarn unraveling.

DESCRIPTION OF EMBODIMENTS

[0013]

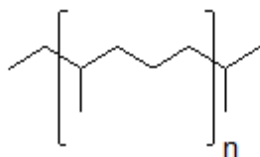
Embodiments for carrying out the present invention (hereinafter simply referred to as “present embodiment”) will be described in detail below. The present invention is not limited to the following embodiments, and various modifications can be made without departing from the scope of the present invention.

[0014]

In one embodiment of the present invention, a polyurethane elastic fiber contains a hydrocarbon compound (hereinafter referred to as “specific compound”) represented by formula

(1) below:

[Chem. 3]

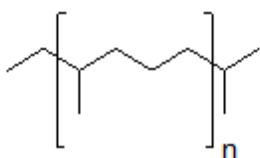


where n is an integer of 2 to 5, at 10 ppm to 10000 ppm relative to the weight of the polyurethane elastic fiber.

[0015]

In another embodiment of the present invention, a surface treatment agent for polyurethane elastic fibers contains a hydrocarbon compound represented by formula (1) below:

[Chem. 4]



where n is an integer of 2 to 5, at 0.10% by weight to 25% by weight.

[0016]

In the polyurethane elastic fiber of the present embodiment, the reason for the improvement in unwindability by setting the content of the specific compound to the specific range is not clear. However, it is considered that the specific compound is more easily localized thereby on the surface of the polyurethane elastic fiber, and the unwindability can be improved due to the high flowability of the specific compound on the surface.

When the content of the specific compound is less than 10 ppm, it is difficult to exhibit a sufficient effect of improving unwindability. From the viewpoint of obtaining a higher unwindability, the content is preferably 30 ppm or greater. When the content is greater than 10000 ppm, single-yarn unraveling is more likely to occur, and unwindability tends to deteriorate with time. The upper limit of the content of the specific compound is preferably 9000 ppm or less, and more preferably 5000 ppm or less.

As the state of the specific compound contained in the polyurethane elastic fiber, the specific compound may be contained inside the polyurethane elastic fiber or may be deposited on the surface thereof. As a method of including the specific compound into the polyurethane elastic fiber, either of the following methods can be used: The specific compound or a mixture consisting of the specific compound and a hydrocarbon compound other than the specific compound is kneaded directly into the spinning dope, or the specific compound or a mixture consisting of the specific compound and a hydrocarbon compound other than the specific compound is added to the surface

treatment agent, and the yarn surface is coated therewith.

[0017]

The content of the specific compound in the surface treatment agent is preferably 0.10% by weight to 25% by weight. From the viewpoint of suppressing single-yarn unraveling, the content of the hydrocarbon mixture is preferably 20% by weight or less, and more preferably 17% by weight or less.

[0018]

From the viewpoint of single-yarn unraveling suppression and smoothness, the compound is preferably a hydrocarbon compound represented by the formula (1), where n is 2 to 3, and more preferably a compound where n is 3, i.e., phytane.

The polyurethane elastic fiber of one embodiment preferably contains the hydrocarbon compound represented by the formula (1), where n is 3, at 10 ppm to 8000 ppm relative to the weight of the polyurethane elastic fiber.

The surface treatment agent for polyurethane elastic fibers, which is another embodiment, preferably contains the hydrocarbon compound represented by the formula (1), where n is 3, at 0.10% by weight to 20% by weight.

[0019]

The polyurethane elastic fiber of the present embodiment is a fiber obtained by spinning a polyurethane polymer. For the method for producing the polyurethane polymer, a publicly known polyurethanization reaction technique can be used. A polymer polyol, for example, polyalkylene ether glycol, and diisocyanate are reacted under the condition of excess diisocyanate to synthesize a urethane prepolymer having a terminal isocyanate group, followed by subjecting the urethane prepolymer to a chain extension reaction with an active hydrogen-containing compound, such as a bifunctional amine, to obtain a polyurethane polymer. If necessary, a monofunctional active hydrogen atom may be mixed with the bifunctional amine and used as an end terminating agent. From the viewpoint of obtaining a uniform polymer with less gelling, the molar ratio of the diisocyanate to the polymer polyol is preferably 1.70 or less, more preferably 1.65 or less, and still more preferably 1.60 or less.

[0020]

Examples of the polymer polyol include various diols consisting of substantially linear homo- or copolymers, such as polyester diols, polyether diols, polyesteramide diols, polyacrylic diols, polythioester diols, polythioether diols, polycarbonate diols, mixtures thereof, and copolymers thereof; and preferably, polyalkylene ether glycols, such as polyoxyethylene glycol, polyoxypropylene glycol, polytetramethylene ether glycol, polyoxypentamethylene glycol, copolymerized polyether glycol consisting of a tetramethylene group and a 2,2-dimethylpropylene group, copolymerized polyether glycol consisting of a tetramethylene group and a 3-

methyltetramethylene group, and mixtures thereof. Among these polymer polyols, polytetramethylene ether glycol and copolymerized polyether glycol consisting of a tetramethylene group and a 2,2-dimethylpropylene group are more preferable, from the viewpoint of exhibiting a superior elastic function.

[0021]

To obtain superior elastic performance, the number average molecular weight calculated from the hydroxyl value of the polymer polyol is preferably 500 or greater, more preferably 1000 or greater, and still more preferably 1500 or greater. From the viewpoint of obtaining a yarn having high heat resistance, the number average molecular weight is preferably 5000 or less. To obtain more superior heat resistance, the number average molecular weight is preferably 3000 or less, and more preferably 2500 or less.

[0022]

Examples of the diisocyanate include aliphatic, alicyclic, and aromatic diisocyanates, such as 4,4'-diphenylmethane diisocyanate, 2,4'-diphenylmethane diisocyanate, 2,4- or 2,6-tolylene diisocyanate, m- or p-xylylene diisocyanate, $\alpha,\alpha,\alpha',\alpha'$ -tetramethyl-xylylene diisocyanate, 4,4'-diphenyl ether diisocyanate, 4,4'-dicyclohexyl diisocyanate, 1,3- or 1,4-cyclohexylene diisocyanate, 3-(α -isocyanatoethyl)phenyl isocyanate, 1,6-hexamethylene diisocyanate, trimethylene diisocyanate, tetramethylene diisocyanate, isophorone diisocyanate, mixtures thereof, and copolymers thereof. Among the above, 4,4'-diphenylmethane diisocyanate is more preferable.

[0023]

Examples of the active hydrogen-containing compound, i.e., chain extender with polyfunctional active hydrogen atom include low molecular weight diols such as hydrazine, polyhydrazine, ethylene glycol, 1,2-propylene glycol, 1,3-propylene glycol, 1,3-butanediol, 1,4-butanediol, 1,5-pentanediol, 1,6-hexanediol, 2,2-dimethyl-1,3-propanediol, diethylene glycol, dipropylene glycol, 1,4-cyclohexanedimethanol, and phenyldiethanolamine; or bifunctional amines such as ethylenediamine, 1,2-propylenediamine, 1,3-propylenediamine, 2-methyl-1,5-pentanediamine, triethylenediamine, m-xylenediamine, piperazine, o-, m-, or p-phenylenediamine, 1,3-diaminocyclohexane, 1,4-diaminocyclohexane, 1,6-hexamethylenediamine, and N,N'-(methylenedi-4,1-phenylene)bis[2-(ethylamino)-urea].

[0024]

The above compounds can be used alone or in combination. Bifunctional amines are preferable to low molecular weight diols. Ethylenediamine mixtures containing 5 to 40 mol% of at least one selected from the group of ethylenediamine, 1,2-propylenediamine, 1,3-diaminocyclohexane, and 2-methyl-1,5-pentadiamine are preferable. Ethylenediamine alone is more preferable.

[0025]

Examples of the end terminating agent having a monofunctional active hydrogen atom include monoalcohols such as methanol, ethanol, 2-propanol, 2-methyl-2-propanol, 1-butanol, 2-ethyl-1-hexanol, and 3-methyl-1-butanol; monoalkylamines such as isopropylamine, n-butylamine, t-butylamine, and 2-ethylhexylamine; or dialkylamines such as diethylamine, dimethylamine, di-n-butylamine, di-t-butylamine, diisobutylamine, di-2-ethylhexylamine, and diisopropylamine. These can be used alone or in combination. Monoalkylamines and dialkylamines, which are monofunctional amines, are preferable to monoalcohols.

[0026]

Regarding the procedure of the polyurethanization reaction, amide-based polar solvents such as dimethylformamide, dimethylsulfoxide, and dimethylacetamide can be used during the urethane prepolymer synthesis and the reaction between the urethane polymer and the active hydrogen-containing compound. Dimethylacetamide is preferable.

[0027]

The polyurethane polymer composition may contain various stabilizers, pigments, etc., for example, hindered phenol-based, benzotriazole-based, benzophenone-based, phosphorus-based, or various hindered amine-based antioxidants; metal soaps typified by magnesium stearate; inorganic substances such as titanium oxide, iron oxide, zinc oxide, cerium oxide, or magnesium oxide; carbon black, various pigments, silver, zinc, antibacterial agents containing these compounds; deodorants, antistatic agents, nitrogen oxide trapping agents, thermal oxidation stabilizers, or light stabilizers, which may be contained in combination.

An ester compound or a phosphate ester compound, consisting of a condensate of an alcohol and carboxylic acid or phosphoric acid may be contained to suppress single-yarn unraveling. Preferable examples of the ester compound and phosphate ester compound include trimethyl citrate, bis(2-ethylhexyl) adipate, methyl benzoate, benzyl benzoate, diethylene glycol dibenzoate, dipropylene glycol dibenzoate, trimethyl trimellitate, dibutyl phthalate, tricresyl phosphate, and diphenyl 2-ethylhexyl phosphate, or any two or more of the compounds above may be used in combination.

[0028]

The polyurethane polymer thus obtained can be formed into a fiber by a publicly known dry spinning, melt spinning, or wet spinning method to obtain a polyurethane elastic fiber. Polyurethane polymers polymerized using different raw materials may be blended at a pre-spinning stage to be spun. The spinning method is preferably dry spinning of a polyurethane spinning dope obtained by dissolving the polyurethane polymer in an amide-based polar solvent. Compared to melt spinning and wet spinning, dry spinning is able to form the strongest physical cross-links due to hydrogen bonds between hard segments.

[0029]

The polyurethane elastic fiber of the present embodiment can be used by containing a surface treatment agent to reduce resistance during unwinding and friction during use. The surface treatment agent may be pre-kneaded into the spinning dope, or may be applied thereto by a publicly known method such as roll oiling or guide oiling before winding on a paper tube during spinning. Alternatively, the surface treatment agent may be applied at the rewinding for making another wound body, after winding without applying the surface treatment agent. When including the surface treatment agent in the polyurethane elastic fiber, the content of the surface treatment agent relative to the weight of the polyurethane elastic polymer is preferably 1.0% by weight to 4.0% by weight, from the viewpoint of cost and quality. The surface treatment agent preferably exhibits the desired effect in the entire range of the above content percentages.

[0030]

The composition of the surface treatment agent is not particularly limited. Publicly known surface treatment agents, for example, silicone oils, such as polydimethylsiloxane, polyester-modified silicone, polyether-modified silicone, and amino-modified silicone; hydrocarbon compounds described later; mineral fine particles, for example, silica, colloidal alumina, and talc; higher fatty acid metal salt powders, for example, magnesium stearate and calcium stearate; higher aliphatic carboxylic acids, higher aliphatic alcohols, and solid waxes at room temperature, such as paraffin and polyethylene can be used in combination. The silicone oil is preferably polydimethylsiloxane. The kinematic viscosity at 25 °C is preferably 15 mm²/s or less from the viewpoint of reducing friction. The silicone oil content relative to the polyurethane elastic fiber is preferably 2.0% by weight or less, more preferably 1.5% by weight or less, and still more preferably 1.0% by weight or less, from the viewpoint of suppressing single-yarn unraveling.

[0031]

The hydrocarbon compound contained in the polyurethane elastic fiber of the present embodiment is a compound consisting only of carbon and hydrogen. The polyurethane elastic fiber of the present embodiment may contain a hydrocarbon compound other than the specific compound.

[0032]

The polyurethane elastic fiber of the present embodiment is based on the total area of the peaks derived from the hydrocarbon compound represented by the sum of the peak area of the specific compound measured by GC/MS of a solution extracted with hexane using a method described later and the peak area of the hydrocarbon compound other than the specific compound. The area of a component having a retention time longer than that of triacontane measured under the same condition is preferably less than 5%. When the area of the component with a retention time longer than the retention time of triacontane is less than 5% of the total area of the peaks derived from the hydrocarbon compound, the flowability of the specific compound of the formula

(1), where n is 2 to 5, is good. It is considered that the specific compound of the formula (1), where n is 2 to 5, is more easily localized thereby on the surface of the polyurethane elastic fiber, and the unwindability can be further increased. The area of the component having a retention time longer than that of triacontane is more preferably less than 3%.

5 The polyurethane elastic fiber of the present embodiment is based on the total area of the peaks derived from the hydrocarbon compound represented by the sum of the peak area of the specific compound measured by GC/MS, extracted with hexane using a method described later and the peak area of the hydrocarbon compound other than the specific compound. The area of a component having a retention time longer than that of octacosane measured under the same
10 condition is preferably less than 5%. When the area of the component with a retention time longer than the retention time of octacosane is less than 5% of the total area of the peaks derived from the hydrocarbon compound, the flowability of the specific compound of the formula (1), where n is 2 to 5, is good. It is considered that the specific compound of the formula (1), where n is 2 to 5, is more easily localized thereby on the surface of the polyurethane elastic fiber, and the unwindability
15 can be further increased. The area of the component having a retention time longer than that of octacosane is more preferably less than 3%.

[0033]

 The polyurethane elastic fiber of the present embodiment is based on the total area of the peaks derived from the hydrocarbon compound represented by the sum of the peak area of the
20 specific compound measured by GC/MS, extracted with hexane using a method described later and the peak area of the hydrocarbon compound other than the specific compound. The area of a component having a retention time shorter than that of hexadecane measured under the same condition is preferably less than 5%. When the area of the component with a retention time shorter than the retention time of hexadecane is less than 5% of the total area of the peaks derived from
25 the hydrocarbon compound, the flowability of the hydrocarbon compound is moderate. Thus, it is considered that single-yarn unraveling and yarn breakage in the polyurethane elastic fiber are less likely to occur. The area of the component having a retention time shorter than that of hexadecane is more preferably less than 3%.

[0034]

30 The polyurethane elastic fiber of the present embodiment is based on the total area of the peaks derived from the hydrocarbon compound represented by the sum of the peak area of the specific compound measured by GC/MS, extracted with hexane using a method described later and the peak area of the hydrocarbon compound other than the specific compound. The area of a component having a retention time shorter than that of octadecane measured under the same
35 condition is preferably less than 20%. When the area of the component with a retention time shorter than the retention time of octadecane is less than 20% of the total area of the peaks derived from

the hydrocarbon compound, the flowability of the hydrocarbon compound is moderate. Thus, it is considered that single-yarn unraveling and yarn breakage in the polyurethane elastic fiber are less likely to occur. The area of the component having a retention time shorter than that of octadecane is more preferably less than 15%.

[0035]

The polyurethane elastic fiber of the present embodiment is based on the total area of the peaks derived from the hydrocarbon compound represented by the sum of the peak area of the specific compound measured by GC/MS, extracted with hexane using a method described later and the peak area of the hydrocarbon compound other than the specific compound. The area of a component having a retention time between octadecane and octacosane measured under the same condition is preferably 80% or greater. When the area of the component with a retention time between octadecane and octacosane is 80% or greater of the total area of the peaks derived from the hydrocarbon compound, the flowability of the hydrocarbon compound is moderate. Thus, the effect of improving unwindability can be further enhanced without increasing the occurrence rate of single-yarn unraveling. The area of the component having a retention time between octadecane and octacosane is preferably 90% or greater, and more preferably 95% or greater.

[0036]

The area of each component measured by the GC/MS is the same for the surface treatment agent, which is another embodiment of the present invention.

[0037]

The hydrocarbon compound other than the specific compound is not particularly limited as long as the compound consists only of carbon and hydrogen. Examples thereof include light isoparaffin, synthetic squalane, plant-based squalane, squalane, ceresin, paraffin, petrolatum, machine oil, spindle oil, naphthenic oil, liquid paraffin, liquid isoparaffin, polyalphaolefin, polyisobutylene, and polybutene, and may be used alone or in combination of two or more. The specific compound may be preliminarily included in the hydrocarbon compounds. As a preferred example in which a synergistic effect with the specific compound of the formula (1), where n is 2 to 5, the hydrocarbon compound is preferably liquid paraffin, and more preferably liquid paraffin having an average molecular weight of less than 450. Additionally, the hydrocarbon compound preferably consists only of saturated hydrocarbons. More preferably, the paraffin/naphthene ratio is in the range of 50/50 to 80/20. Even more preferably, when the liquid paraffin is produced by removing impurities with sulfuric acid wash instead of a hydrogenation method, a hydrocarbon compound satisfying the properties described above can be easily obtained. From the viewpoint of suppressing single-yarn unraveling, the total content of the specific compound and the hydrocarbon compound other than the specific compound is preferably 2.0% by weight or less, more preferably 1.5% by weight or less, relative to the yarn.

[0038]

High-quality fabrics without unevenness can be obtained by interweaving the polyurethane elastic fibers of the present embodiment with natural fibers such as cotton, silk, or wool; polyamide fibers such as nylon 6 or nylon 66; polyester fibers such as polyethylene terephthalate, polytrimethylene terephthalate, or polytetramethylene terephthalate; cationic dyeable polyester fibers, cuprammonium rayon, viscose rayon, and acetate rayon, or by coating, entangling, or twisting using these fibers to form processed yarns and thereafter interweaving the processed yarns. Fabrics using polyurethane elastic fibers particularly have a large production volume and are supplied as bare yarns, and are thus suitable for warp knitting, which is greatly affected by the quality of the yarn. The warp-knitted fabrics include a power net, satin net, Russell lace, two-way tricot, etc. By using the polyurethane elastic fiber of the present embodiment, a high-quality fabric with few streaks in the warp direction can be obtained.

[0039]

The fabric using the polyurethane elastic fiber of the present embodiment can be used in applications such as swimwear, girdles, brassieres, tights, pantyhose, waistbands, body suits, spats, stretch sportswear, stretch outerwear, medical attire, and stretch lining.

[0040]

The polyurethane elastic fiber of the present embodiment can be suitably used in hygienic material products such as sanitary items and paper diapers, and has good smoothness and small variations in frictional property, thus high productivity and product stability can be obtained. Due to the effect of the specific compound of the formula (1), where n is 2 to 5, in improving unwindability, the amount of silicone oil, which is an inhibitor of adhesiveness in various adhesive methods can be reduced. Thus, the polyurethane elastic fiber is also suitable for various bonding methods in hygienic material manufacturing equipment, such as hot melt adhesives, hot presses, and ultrasonic bonding. A hygienic material product with high stretchability and a low occurrence of a phenomenon called slip-in, which is one of the product defects that cause issues such as urine leakage, in the polyurethane elastic fiber can be obtained.

[0041]

Another embodiment of the present invention, as described before, is a surface treatment agent for polyurethane elastic fibers, containing the specific compound of the formula (1), where n is an integer of 2 to 5, at 0.10% by weight to 0.25% by weight. The reason for the improvement in unwindability of the polyurethane elastic fiber by setting the content of the specific compound of formula (1), where n is an integer of 2 to 5, to the specific range above is not clear. However, it is considered that the specific compound is more easily localized thereby on the surface of the polyurethane elastic fiber, and the unwindability can be improved due to the high content of the specific compound on the surface. From the viewpoint of obtaining higher unwindability, the

content of the specific compound is preferably 0.10% by weight to 20% by weight, and more preferably 0.10% by weight to 17% by weight.

[0042]

The hydrocarbon compound contained in the surface treatment agent for fibers of the present embodiment is a compound consisting only of carbon and hydrogen. The surface treatment agent for fibers of the present embodiment may contain a hydrocarbon compound other than the specific compound. Examples of the hydrocarbon compound other than the specific compound include light isoparaffin, synthetic squalene, plant-based squalene, squalene, ceresin, paraffin, petrolatum, machine oil, spindle oil, naphthenic oil, liquid paraffin, liquid isoparaffin, polyalphaolefin, polyisobutylene, and polybutene, and may be used alone or in combination of two or more. The specific compound may or may not be preliminarily included in the hydrocarbon compounds. As a preferred example in which a synergistic effect with the specific compound of the formula (1), where n is 2 to 5, the hydrocarbon compound is preferably liquid paraffin, and more preferably liquid paraffin having an average molecular weight thereof of less than 450. Additionally, the hydrocarbon compound preferably consists only of saturated hydrocarbons. More preferably, the paraffin/naphthene ratio is in the range of 50/50 to 80/20. Even more preferably, the liquid paraffin is produced by removing impurities with sulfuric acid wash instead of a hydrogenation method.

[0043]

The surface treatment agent for fibers of the present embodiment preferably further contains a silicone oil at 20% by weight to 70% by weight. By containing the specific compound of the formula (1), where n is 2 to 5, and further setting the silicone oil content within the above range, the surface treatment agent, despite having a silicone oil content of 70% by weight or less, can exhibit an unwinding performance the same as or higher than that of a surface treatment agent for fibers having a silicone oil content of greater than 70% by weight. Since the silicone oil content is small, the occurrence of single-yarn unraveling can be suppressed. Since the amount of expensive silicone oil used can be reduced, a cost reduction effect can be expected, compared to a surface treatment agent for fibers in which a silicone oil content is greater than 70% by weight. If the silicone oil content is less than 20% by weight, sufficient unwinding performance cannot be obtained. If the silicone oil content is greater than 70% by weight, single-yarn unraveling is likely to occur and cost becomes an issue. The silicone oil may be polydimethylsiloxane. From the viewpoint of reducing friction, the kinematic viscosity at 25 °C is preferably 15 mm²/s or less.

[0044]

For the surface treatment agent for fibers of the present embodiment, publicly known surface treatment agents, such as the silicone oil described above, the specific compound; in addition to hydrocarbon compounds other than the specific compound, polyester-modified silicone, polyether-modified silicone, and amino-modified silicone; mineral fine particles, for example,

silica, colloidal alumina, and talc; higher fatty acid metal salt powders, for example, magnesium stearate and calcium stearate; higher aliphatic carboxylic acids, higher aliphatic alcohols typified by isostearyl alcohol, and solid waxes at room temperature such as paraffin and polyethylene can be used in combination.

5 An ester compound or a phosphate ester compound, consisting of a condensate of an alcohol and carboxylic acid or phosphoric acid, may be contained in the surface treatment agent for fibers to suppress single-yarn unraveling. Preferable examples of the ester compound or phosphate ester compound include trimethyl citrate, bis(2-ethylhexyl) adipate, methyl benzoate, benzyl benzoate, diethylene glycol dibenzoate, dipropylene glycol dibenzoate, trimethyl trimellitate, dibutyl
10 phthalate, tricresyl phosphate, and diphenyl 2-ethylhexyl phosphate. Any two or more of the above compounds may be used in combination.

[0045]

The surface treatment agent of the present embodiment can be applied by a publicly known method such as roll oiling, guide oiling, or spray oiling.

EXAMPLES

[0046]

The present invention will be specifically described below with reference to Examples and Comparative Examples. However, the present invention is not limited to the Examples. The
20 measurement methods and evaluation methods used in the following Examples and Comparative Examples were as follows.

[0047]

(1) Method for identifying/quantifying the specific compound of formula (1), where n is 2 to 5

Polyurethane elastic fibers precisely weighed to 2 g were immersed in 50 g of hexane. After
25 extraction by applying ultrasonic waves for 10 minutes, the hexane was distilled away with an evaporator. Subsequently, the polyurethane elastic fibers after extraction were then immersed again in 50 g of hexane in the same container. After extraction by applying ultrasonic waves for 10 minutes, the polyurethane elastic fibers were removed, and the hexane was distilled away with an evaporator to obtain an extract with hexane. A sample from the extract, diluted with hexane to
30 a concentration of 1600 ppm, served as an extract sample for GC/MS measurement. Note that when the amount of extract is small, the amount of polyurethane elastic fibers may be increased accordingly to carry out the same procedure.

Detailed conditions of the GC/MS were as described below.

Device: Agilent 6890 GC, MSD-5973

35 Column: DB-5MS (30 m, 0.25 μ m, ID 0.25 mm)

Oven: 40 °C (2 minutes) – 8 °C/minute – 320 °C (5 minutes)

INJ/DET: 325 °C/325 °C

Gas: Helium

Flow rate: 1.0 mL/minute

Injection volume: 1.0 µL

5 Injection method: Split 10:1

[0048]

(2) Calculation of each area of hydrocarbon compound in GC/MS measurement

10 The extract from the polyurethane elastic fiber was measured by GC/MS in the same manner as in (1) above. It was calculated as percentages that the area of the component having a longer retention time than triacontane was the area of the component of C30 or more; the area of the component having a longer retention time than octacosane was the area of the component of C28 or more; the area of the component having a shorter retention time than hexadecane was the area of the component of C16 or less; the area of the component having a shorter retention time than octadecane was the area of the component of C18 or less; the area of the component having a retention time between the retention times of hexadecane and triacontane was the area of the component of C16 to C30; the area of the component having a retention time between the retention times of octadecane and triacontane was the area of the component of C18 to C30; and the area of the component having a retention time between the retention times of octadecane and octacosane was the area of the component of C18 to C28, respectively, relative to the total peak area derived from the hydrocarbon compound. Components not derived from the hydrocarbon compound were removed by GC/MS in the calculation of each area. Peaks of hydrocarbon compounds can be detected broadly in the case of a mixture. In that case, the point where the peak begins to rise was set as the start point, the point where the detected value of the peak begins to disappear to a negligible level was set as the end point, and the area was calculated from the baseline connecting the start point and the end point with a straight line.

[0049]

(3) Calculation of each area of hydrocarbon compound in surface treatment agent for fibers in GC/MS measurement

30 The surface treatment agent was diluted with hexane to 1600 ppm. The value of each component in the surface treatment agent was calculated in the same manner as in (1) and (2) above. When the raw material before blending the surface treatment agent was obtained, the hydrocarbon compound itself was diluted with hexane to 1600 ppm to simplify the measurement. The measurement was carried out in the same manner as in (1) and (2) above.

[0050]

35 (4) Unwindability

After winding the polyurethane elastic fiber on a paper tube such that the wound width is 60

mm and the total weight was 3 kg, the polyurethane elastic fiber was allowed to settle in an environment of 20 °C at 60% RH for 2 days. Thereafter, the yarn was stripped from the paper tube down to 2 cm to make a measurement sample; the yarn was unwound passively at 15 m/min in the end face direction of the measurement sample; the tension at that time was measured for 5 minutes; the average value was taken as the unwinding tension; and a determination was made in 7 stages following the evaluation criteria below. It can be expected that the lower the unwinding tension is, the more smoothly the polyurethane elastic fiber unwinds, and the less likely the yarn is to break during unwinding. Passive unwinding refers to a method of unwinding in a vertical manner.

7: Less than 10 g

6: 10 g to less than 13 g

5: 13 g to less than 15 g

4: 15 g to less than 25 g

3: 25 g to less than 30 g

2: 30 g to less than 35 g

1: 35 g or more or yarn breakage

[0051]

(5) Single-yarn unraveling occurrence rate (%)

10 multifilaments having a length of 40 mm lined up in parallel were set in a Dematcher tester, stretched in the yarn length direction until the length reached 240 mm, and relaxed back to the original 40 mm. The stretching procedure was repeated 5000 times at a rate of 200 rpm. In a state where a multifilament having a length of 40 mm was laid flat, as shown in FIG. 4, it was determined that a single-yarn unraveling occurred when a separation of a single yarn occurred by a distance of 0.5 mm or more at the maximum from a portion of the multifilament where most of single yarns converged or when a single yarn was broken. The measurement was carried out 5 times with a set of 10 yarns from the same sample; the number of unraveled yarns out of a total of 50 yarns was counted; the occurrence rate was calculated; and the evaluation was made in the 7 stages below. It can be expected that the lower the single-yarn unraveling occurrence rate is, the less likely a yarn breakage due to single-yarn splitting is to occur when the polyurethane elastic fiber is used.

7: Occurrence rate of 0% to less than 3%

6: Occurrence rate of 3% to less than 5%

5: Occurrence rate of occurrence rate of less than 5%

4: Occurrence rate of 5% to less than 10%

3: Occurrence rate of 10% to less than 15%

2: Occurrence rate of 15% to less than 20%

1: Occurrence rate of 20% or greater

[0052]

[Examples 1 to 12 and Comparative Examples 1 to 7 by kneading the specific compound of formula (1), where n is 2 to 5, into spinning dope]

[Example 1]

2000 g of polytetramethylene ether glycol having a number average molecular weight of 2000 and 400 g of 4,4'-diphenylmethane diisocyanate were reacted in a dry nitrogen atmosphere at 60 °C for 3 hours under stirring to obtain a polyurethane prepolymer end-capped with isocyanate. After cooling to room temperature, dimethylacetamide was added and dissolved to prepare a polyurethane prepolymer solution. An amine solution in which ethylenediamine and diethylamine were dissolved in dry dimethylacetamide was separately prepared and added to the polyurethane prepolymer solution such that the ratio of isocyanate groups in the urethane prepolymer to amino groups in the amine solution was 1:1.03, and reacted while cooling at 10 °C. A polyurethane solution having a polyurethane solid content concentration of 30% by mass and a viscosity of 450 Pa·s (30 °C) was obtained.

1 wt% of 4,4'-butylidene bis(3-methyl-6-t-butylphenol) and 0.5 wt% of 2-(2'-hydroxy-3'-t-butyl-5'-methylphenyl)-5-chlorobenzotriazole relative to the polyurethane solid content, 0.5 wt% of polydimethylsiloxane having a kinematic viscosity at 25 °C of 10 mm²/s relative to the yarn weight, and 50 ppm of phytane (n = 3) relative to the yarn weight as the specific compound of formula (1), where n is 2 to 5, were weighed, dissolved in dimethylacetamide, and thereafter blended with a polyurethane solution to form a uniform solution, which was then defoamed at room temperature under reduced pressure to obtain a spinning dope.

The spinning dope was dry-spun at a winding speed of 500 m/minute and a hot air temperature of 300 °C using a spinneret having 48 nozzles, and the fibers were bundled with a false twister using compressed air. Thereafter, the polyurethane elastic fibers were wound on paper tubes made of paper to obtain a wound package of polyurethane elastic fibers of 470 dt/48 filaments.

[0053]

[Examples 2 to 12]

Except that a hydrocarbon mixture consisting of the specific compound and a hydrocarbon compound other than the specific compound was contained accordingly so as to have the content of the specific compound and the area ratios of the hydrocarbon compound shown in Table 1 below, each of the polyurethane elastic fibers was obtained in the same manner as in Example 1.

[0054]

[Comparative Example 1]

Except that phytane was not contained, the polyurethane elastic fiber was obtained in the same manner as in Example 1.

[0055]

[Comparative Example 2]

Except that the polydimethylsiloxane content was changed to 1.0 wt%, the polyurethane elastic fiber was obtained in the same manner as in Comparative Example 1.

[0056]

5 [Comparative Examples 3 to 6]

Except that a hydrocarbon mixture consisting of the specific compound and a hydrocarbon compound other than the specific compound and a hydrocarbon compound other than the specific compound were contained accordingly so as to have the content of the specific compound and the area ratios of the hydrocarbon compounds shown in Table 1 below, each of the polyurethane elastic

10

[0057]

[Comparative Example 7]

Except that the polydimethylsiloxane content was set as shown in Table 1, the polyurethane elastic fiber was obtained in the same manner as in Comparative Example 4.

15

[0058]

[Table 1]

	Poly dimethyl siloxane content (wt%)	Content of formula 1 compound in fiber (ppm)							Each area of hydrocarbon compound in GC/MS measurement of hexane extract from fiber (%)							Evaluation	
		n						Total for n = 2 to 5	C16 or less	C18 or less	C28 or more	C30 or more	C16 to 30	C18 to 30	C18 to 28	Unwind-ability	Single-yarn unraveling occurrence rate (%)
		1	2	3	4	5	6 or more										
Ex. 1	0.5	0	0	50	0	0	0	50	0	0	0	0	100	100	100	7	7
Ex. 2	0.5	0	10	30	10	0	0	50	0	0	1	0	100	100	99	7	7
Ex. 3	0.5	0	5	15	5	0	0	25	2	9	1	0	98	91	90	6	7
Ex. 4	0.5	0	100	300	100	0	0	500	2	9	1	0	98	91	90	7	7
Ex. 5	0.5	0	1800	5400	1800	0	0	9000	2	9	1	0	98	91	90	7	5
Ex. 6	0.5	0	0	100	300	100	0	500	0	0	6	2	98	98	94	6	7
Ex. 7	0.5	0	0	0	100	400	0	500	0	0	7	4	96	96	93	5	6
Ex. 8	0.5	0	0	0	0	500	0	500	0	0	10	7	93	93	90	4	6
Ex. 9	0.5	100	300	100	0	0	0	400	7	11	0	0	93	89	89	7	5
Ex. 10	0.5	300	200	0	0	0	0	200	9	28	0	0	91	72	72	7	4
Ex. 11	0.5	100	100	100	100	100	0	400	13	27	9	6	81	67	64	4	4
Ex. 12	0.0	0	1800	5400	1800	0	0	9000	2	9	1	0	98	91	90	5	6
Comp. Ex. 1	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3
Comp. Ex. 2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	3
Comp. Ex. 3	0.5	0	0	0	0	0	0	0	0	0	0	0	100	100	100	4	2
Comp. Ex. 4	0.5	0	2900	8700	2900	0	0	14500	0	0	1	0	98	91	90	4	2
Comp. Ex. 5	0.5	100	0	0	0	0	0	0	100	100	0	0	0	0	0	3	2
Comp. Ex. 6	0.5	0	0	0	0	0	100	0	0	0	100	100	0	0	0	2	3
Comp. Ex. 7	0.0	0	2900	8700	2900	0	0	14500	0	0	1	0	98	91	90	2	3

[0059]

[Examples 13 to 20 and Comparative Examples 8 to 12, which are preparation methods of surface treatment agents for polyurethane elastic fibers]

Polydimethylsiloxane and the specific compound, a mixture of hydrocarbons consisting of the specific compound and a hydrocarbon compound other than the specific compound, or a hydrocarbon compound other than the specific compound were blended accordingly so as to have the content of the specific compound and the area ratios of the hydrocarbon compound shown in Table 2 below, and were blended using stirring blades for 30 minutes at room temperature to obtain surface treatment agents for polyurethane elastic fibers.

[0060]

[Table 2]

	Polydimethyl siloxane content (wt%)	Content of formula 1 compound in fiber surface treatment agent (wt%)						Each area of hydrocarbon compound contained in fiber treatment agent (%)								Raw material cost
		n						Total for n = 2 to 5	C16 or less	C18 or less	C28 or more	C30 or more	C16 to 30	C18 to 30	C18 to 28	
		1	2	3	4	5	6 or greater									
Ex. 13	99	0	0	1	0	0	0	1.0	0	0	0	0	100	100	100	H
Ex. 14	60	0	0	1	0	0	0	1.0	0	0	1	0	100	100	99	L
Ex. 15	60	0	0	0.1	0	0	0	0.1	0	0	1	0	100	100	99	L
Ex. 16	60	0	0	15	0	0	0	15.0	0	0	1	0	100	100	99	L
Ex. 17	50	0	0.1	0.3	0.1	0	0	0.5	0	0	1	0	100	100	99	L
Ex. 18	50	0	0	0	0	0.5	0	0.5	0	0	10	7	93	93	90	L
Ex. 19	30	0	0.3	0.9	0.3	0	0	1.5	0	0	1	0	100	100	99	L
Ex. 20	10	0	1	3	1	0	0	5.0	0	0	1	0	100	100	99	L
Comp. Ex. 8	100	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	H
Comp. Ex. 9	60	0	0	0	0	0	0	0.0	0	0	0	0	100	100	100	L
Comp. Ex. 10	60	0	7	21	7	0	0	35.0	0	0	1	0	98	91	90	L
Comp. Ex. 11	60	0.2	0	0	0	0	0	0.0	100	100	0	0	0	0	0	L
Comp. Ex. 12	60	0	0	0	0	0	0.2	0.0	0	0	100	100	0	0	0	L

[0061]

In Table 2, a surface treatment agent for polyurethane elastic fibers having a polydimethylsiloxane content of greater than 70% was marked with “H” as having a high cost of raw materials, and one having less than 70% was marked with “L” as having a low cost of raw materials.

[0062]

[Examples 21 to 28 and Comparative Examples 13 to 18 of polyurethane elastic fibers having applied thereto a surface treatment agent for polyurethane elastic fibers]

2000 g of polytetramethylene ether glycol having a number average molecular weight of 2000 and 400 g of 4,4'-diphenylmethane diisocyanate were reacted in a dry nitrogen atmosphere at 60

°C for 3 hours under stirring to obtain a polyurethane prepolymer end-capped with isocyanate. After cooling to room temperature, dimethylacetamide was added and dissolved to prepare a polyurethane prepolymer solution. An amine solution in which ethylenediamine and diethylamine were dissolved in dry dimethylacetamide was separately prepared and added to the polyurethane prepolymer solution such that the ratio of isocyanate groups in the urethane prepolymer to amino groups in the amine solution was 1:1.03, and reacted while cooling at 10 °C. A polyurethane solution having a polyurethane solid content concentration of 30% by mass and a viscosity of 450 Pa·s (30 °C) was obtained.

1 wt% of 4,4'-butylidene bis(3-methyl-6-t-butylphenol) and 0.5 wt% of 2-(2'-hydroxy-3'-t-butyl-5'-methylphenyl)-5-chlorobenzotriazole relative to the polyurethane solid content were weighed, dissolved in dimethylacetamide, and thereafter blended with a polyurethane solution to form a uniform solution, which is then defoamed at room temperature under reduced pressure to obtain a spinning dope.

The spinning dope was dry-spun at a winding speed of 500 m/minute and a hot air temperature of 300 °C using a spinneret having 48 perfectly circular holes, and the fibers were bundled with a false twister using compressed air. Thereafter, surface treatment agents of the application amounts and types indicated in Table 3 were applied to the polyurethane elastic fibers by nozzle oiling. The polyurethane elastic fibers were then wound on paper tubes to obtain a wound package of polyurethane elastic fibers of 470 dt/48 filaments.

[0063]

[Example 29 and Comparative Example 19]

Except that the treatment agent for polyurethane elastic fibers was kneaded into the spinning dope instead of nozzle oiling, each of the wound packages of polyurethane elastic fibers of 470 dt/48 filaments was obtained in the same manner as in Examples 21 to 28 and Comparative Examples 13 to 18.

[0064]

[Table 3]

	Fiber treatment agent	Amount of fiber treatment agent applied (wt%)	Content of formula 1 compound in fiber (ppm)						Each area of hydrocarbon compound in GC/MS measurement of hexane extract from fiber (%)							Evaluation		
			n						Total for n = 2 to 5	C16 or less	C18 or less	C28 or more	C30 or more	C16 to 30	C18 to 30	C18 to 28	Unwind-ability	Single-yarn unraveling occurrence rate (%)
			1	2	3	4	5	6 or greater										
Ex. 21	Ex. 13	1.0	0	0	100	0	0	0	100	0	0	0	0	100	100	100	7	5
Ex. 22	Ex. 14	1.0	0	0	100	0	0	0	100	0	0	1	0	100	100	99	7	7
Ex. 23	Ex. 15	1.0	0	0	10	0	0	0	10	0	0	1	0	100	100	99	6	6
Ex. 24	Ex. 16	1.0	0	0	1500	0	0	0	1500	0	0	1	0	100	100	99	7	7
Ex. 25	Ex. 17	1.0	0	10	30	10	0	0	50	0	0	1	0	100	100	99	7	7
Ex. 26	Ex. 18	1.0	0	0	0	0	50	0	50	0	0	10	7	93	93	90	4	6
Ex. 27	Ex. 19	1.0	0	30	90	30	0	0	150	0	0	1	0	100	100	99	6	6
Ex. 28	Ex. 20	1.0	0	100	300	100	0	0	500	0	0	1	0	100	100	99	5	6

Ex. 29	Ex. 14 (kneaded)	1.0	0	0	100	0	0	0	100	0	0	1	0	100	100	99	7	7
Comp. Ex. 13	Comp. Ex. 8	1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	3
Comp. Ex. 14	Comp. Ex. 8	2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	3
Comp. Ex. 15	Comp. Ex. 9	1.0	0	0	0	0	0	0	0	0	0	0	0	100	100	100	4	3
Comp. Ex. 16	Comp. Ex. 10	4.0	0	2800	8400	2800	0	0	14000	0	0	1	0	98	91	90	4	3
Comp. Ex. 17	Comp. Ex. 11	1.0	20	0	0	0	0	0	0	100	100	0	0	0	0	0	3	3
Comp. Ex. 18	Comp. Ex. 12	1.0	0	0	0	0	0	0.2	0	0	0	100	100	0	0	0	3	3
Comp. Ex. 19	Comp. Ex. 9 (kneaded)	1.0	0	0	0	0	0	0	0	0	0	0	0	100	100	100	4	3

INDUSTRIAL APPLICABILITY

[0065]

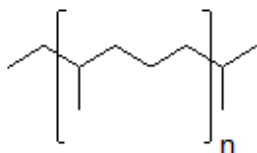
5 The polyurethane elastic fiber containing a specific amount of the specific branched hydrocarbon compound according to the present invention is a polyurethane elastic fiber having good unwindability, even with a low silicone oil content, and few single-yarn unraveling of a multifilament. Therefore, polyurethane elastic fibers of the polyurethane elastic fiber according to the present invention can be suitably used for fabrics, hygienic material products, etc.

CLAIMS

[Claim 1]

A polyurethane elastic fiber containing a hydrocarbon compound represented by formula (1)
below:

[Chem. 1]



where n is an integer of 2 to 5, at 10 ppm to 10000 ppm relative to the weight of the polyurethane elastic fiber.

[Claim 2]

The polyurethane elastic fiber according to claim 1, containing the hydrocarbon compound represented by the formula (1), where n is 3, at 10 ppm to 8000 ppm relative to the weight of the polyurethane elastic fiber.

[Claim 3]

The polyurethane elastic fiber according to claim 1 or 2, further containing a hydrocarbon compound other than the hydrocarbon compound represented by formula (1) where n is an integer of 2 to 5.

[Claim 4]

The polyurethane elastic fiber according to any one of claims 1 to 3, wherein the area of a component occupying a retention time longer than a retention time of triacontane is less than 5% of the total area of a peak derived from the hydrocarbon compound, in GC/MS measurement of an extract with hexane.

[Claim 5]

The polyurethane elastic fiber according to any one of claims 1 to 4, wherein the area of a component occupying a retention time longer than a retention time of octacosane is less than 5% of the total area of a peak derived from the hydrocarbon compound, in GC/MS measurement of an extract with hexane.

[Claim 6]

The polyurethane elastic fiber according to any one of claims 1 to 5, wherein the area of a component occupying a retention time shorter than a retention time of hexadecane is less than 5% of the total area of a peak derived from the hydrocarbon compound, in GC/MS measurement of an extract with hexane.

[Claim 7]

The polyurethane elastic fiber according to any one of claims 1 to 6, wherein the area occupying a retention time shorter than a retention time of octadecane is less than 20% of the total area of a peak derived from the hydrocarbon compound, in GC/MS measurement of an extract with hexane.

[Claim 8]

The polyurethane elastic fiber according to any one of claims 1 to 7, wherein the area of a component occupying between the retention time of octadecane and octacosane is 80% or greater of the total area of a peak derived from the hydrocarbon compound, in GC/MS measurement of an extract with hexane.

[Claim 9]

A fabric comprising the polyurethane elastic fiber according to any one of claims 1 to 8.

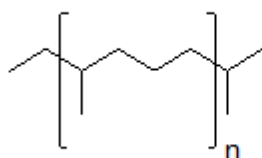
[Claim 10]

A hygienic material product comprising the polyurethane elastic fiber according to any one of claims 1 to 8.

[Claim 11]

A surface treatment agent for polyurethane elastic fibers, containing a hydrocarbon compound represented by formula (1) below:

[Chem. 2]



where n is an integer of 2 to 5, at 0.10% by weight to 25% by weight.

[Claim 12]

The surface treatment agent for polyurethane elastic fibers according to claim 11, containing the hydrocarbon compound represented by the formula (1), where n is 3, at 0.10% by weight to 20% by weight.

5

[Claim 13]

The surface treatment agent for polyurethane elastic fibers according to claim 11 or 12, further containing a hydrocarbon compound other than the hydrocarbon compound represented by the formula (1) where n is an integer of 2 to 5.

10

[Claim 14]

The surface treatment agent for polyurethane elastic fibers according to any one of claims 11 to 13, wherein the area of a component occupying a retention time longer than a retention time of triacontane is less than 5% of the total area of a peak derived from the hydrocarbon compound, in GC/MS measurement of a solution dissolved in hexane.

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[Claim 15]

The surface treatment agent for polyurethane elastic fibers according to any one of claims 11 to 14, wherein the area of a component occupying a retention time longer than a retention time of octacosane is less than 5% of the total area of a peak derived from the hydrocarbon compound, in GC/MS measurement of a solution dissolved in hexane.

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[Claim 16]

The surface treatment agent for polyurethane elastic fibers according to any one of claims 11 to 15, wherein the area occupying a retention time shorter than a retention time of hexadecane is less than 5% of the total area of a peak derived from the hydrocarbon compound, in GC/MS measurement of a solution dissolved in hexane.

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[Claim 17]

The surface treatment agent for polyurethane elastic fibers according to any one of claims 11 to 16, wherein the area occupying a retention time shorter than a retention time of octadecane is less than 20% of the total area of a peak derived from the hydrocarbon compound, in GC/MS measurement of a solution dissolved in hexane.

30

[Claim 18]

The surface treatment agent for polyurethane elastic fibers according to any one of claims 11

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to 17, wherein the area of a component occupying between the retention time of octadecane and octacosane is 80% or greater of the total area of a peak derived from the hydrocarbon compound, in GC/MS measurement of a solution dissolved in hexane.

5 [Claim 19]

The surface treatment agent for polyurethane elastic fibers according to any one of claims 11 to 18, further containing a silicone oil at 20% by weight to 70% by weight.