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(54) ELASTIC NONWOVEN CLOTH AND FIBER PRODUCT

(57) To provide an elastic nonwoven cloth that is excellent in elastic recovery property and has pleasant texture without stickiness, and a fiber product using the elastic nonwoven cloth, by an elastic nonwoven cloth containing fibers that are spun at a spinning speed of from 500 to 2,500 m/min and contain a low crystalline polypropylene that satisfies (a) [mmmm] = 20 to 60% by mol, (b) [rrrr]/(1-[mmmm]) $\leq$ 0.1, (c) [rmrm] > 2.5% by mol, (d) [mm]$\times$[rr]/[mr]^2 $\leq$ 2.0, (e) weight average molecular weight (Mw) = 10,000 to 200,000, and (f) molecular weight distribution (Mw/Mn) < 4, and a fiber product using the elastic nonwoven cloth.

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Description

Technical Field

[0001] The present invention relates to an elastic nonwoven cloth that is excellent in elastic recovery property and has pleasant texture without stickiness, and a fiber product using the elastic nonwoven cloth.

Background Art

[0002] In recent years, elastic fibers and elastic nonwoven cloths are subjected to various applications including, for example, a disposable diaper, a sanitary product, a hygienic product, a clothing material, a bandage and a packaging material. In particular, a disposable diaper, a sanitary product and the like are used directly on the skin, and thus are demanded to have suitable elasticity and elastic recovery property from the standpoint of good wear feeling to the body and easiness of the body motion after wearing.
As elastic fibers having elastic recovery property imparted thereto, Patent Document 1 discloses elastic fibers containing an elastomer, such as an olefin copolymer or a styrene block copolymer, having another resin component mixed therewith. However, the elastomer has poor compatibility with polypropylene and is noncrystalline, and in the case where elastic fibers are formed by mixing the elastomer and polypropylene, the elastomer bleeds to the surface of the fibers. Accordingly, there are problems that an elastic nonwoven cloth formed of the elastic fibers has stickiness, and a fiber product using the elastic nonwoven cloth has unpleasant texture.
Patent Document 2 discloses processing a propylene polymer constituting a nonwoven cloth with a free radical initiator. The process enhances the flowability of the propylene polymer, but lowers the thermal stability of the propylene polymer.
Patent Document 3 discloses formation of fibers with a propylene composition containing propylene and ethylene, and formation of core-sheath composite fibers formed of the propylene composition including propylene and ethylene as a sheath component and high density polyethylene as a core component. However, the propylene composition containing propylene and ethylene is not necessarily sufficient in compatibility with a crystalline isotactic propylene homopolymer, and thus may suffer deterioration of the kneading property and deterioration of properties due to bleed on the surface of the fibers.
Patent Document 4 discloses an elastic nonwoven cloth formed of core-sheath composite fibers containing a composition containing low crystalline polypropylene and high crystalline polypropylene as a sheath component and low crystalline polypropylene as a core component. However, in the case where the spinning speed is high, the fibers may be oriented and crystallized, thereby providing such problems that the elastic recovery property may become insufficient, and the tensile properties, particularly the breaking elongation, may be deteriorated.

Related Art Documents

Patent Documents

[0003]

Patent Document 1: JP-A-2003-129330
Patent Document 2: JP-T-2007-511680
Patent Document 3: JP-A-2007-277755
Patent Document 4: JP-A-2009-209506

Summary of the Invention

Problems to be Solved by the Invention

[0004] The present invention has been made under the circumstances, and an object thereof is to provide an elastic nonwoven cloth that is excellent in elastic recovery property and breaking elongation, and has pleasant texture without stickiness, and a fiber product using the elastic nonwoven cloth.

Means for Solving the Problems

[0005] As a result of earnest investigations made by the present inventors, it has been found that the object has been accomplished by an elastic nonwoven cloth that contains a particular low crystalline polypropylene and is obtained under a particular formation condition. Specifically, it has been found that fibers containing a low crystalline polypropylene

having a particular stereoregularity is excellent in elastic recovery property and breaking elongation, has lowered stickiness, and thus is suitable as a material for forming an elastic nonwoven cloth. The present invention has been completed based on the findings.

The present invention provides the following.

1. An elastic nonwoven cloth containing fibers that are spun at a spinning speed of from 500 to 2,500 m/min and contain a low crystalline polypropylene that satisfies the following properties (a) to (f):

(a) [mmmm] = 20 to 60% by mol,
(b) [rrrr]/(1-[mmmm]) $\leq$ 0.1,
(c) [rmrm] > 2.5% by mol,
(d) [mm]$\times$[rr]/[mr]^2 $\leq$ 2.0,
(e) weight average molecular weight (Mw) = 10,000 to 200,000, and
(f) molecular weight distribution (Mw/Mn) < 4.

2. The elastic nonwoven cloth according to the item 1, wherein the fibers are core-sheath composite fibers.

3. The elastic nonwoven cloth according to the item 2, wherein the core-sheath composite fibers contain a sheath component containing an olefin polymer, and a core component containing from 90 to 100% by mass of a low crystalline polypropylene, and the core component contains the low crystalline polypropylene in a larger content than the sheath component.

4. The elastic nonwoven cloth according to the item 2 or 3, wherein the core-sheath composite fibers has a total low crystalline polypropylene content calculated by the following expression of from 90 to 99% by mass:

$$\text{total low crystalline polypropylene content (\%)} = (Ws \times Xs + Wc \times Xc) / 100$$

wherein

Ws represents a mass fraction of the sheath component,
Wc represents a mass fraction of the core component,
Xs represents a mass fraction of the low crystalline polypropylene in the sheath component, and
Xc represents a mass fraction of the low crystalline polypropylene in the core component.

5. A fiber product containing the elastic nonwoven cloth according to any one of the items 1 to 4.

Advantages of the Invention

[0006] According to the present invention, such an elastic nonwoven cloth may be provided that is excellent in elastic recovery property and breaking elongation, and has pleasant texture without stickiness. The elastic nonwoven cloth also has excellent capabilities, for example, the elastic nonwoven cloth is excellent in secondary processability with good releasing property from a winding roll, is excellent in heat resistance, and is free of contraction upon application of HMA (hot melt adhesive).

Embodiments for Carrying Out the Invention

[0007] The elastic nonwoven cloth of the present invention contains fibers that contain a low crystalline polypropylene that has particular properties and are spun at a spinning speed of from 500 to 2,500 m/min.

A crystalline polypropylene means a polypropylene that has a melting point observed by measurement with a differential scanning calorimeter (DSC) described later, a high crystalline polypropylene means a crystalline polypropylene having the melting point that is 155°C or more, and a low crystalline polypropylene means a crystalline polypropylene having the melting point that is from 0 to 120°C.

The melting point (Tm-D) is defined as a peak top of a peak observed on the highest temperature side of a melt endothermic curve obtained by maintaining the temperature at -10°C for 5 minutes and then increasing the temperature at 10°C per minute by using a differential scanning calorimeter (DSC) under a nitrogen atmosphere.

Low Crystalline Polypropylene

[0008] The low crystalline polypropylene used in the present invention has the following properties (a) to (f), which can be controlled by the selection of the catalyst and the reaction conditions upon producing the low crystalline polypropylene.

(a) Mesopentad Fraction [mmmm] = 20 to 60% by mol

[0009] When the mesopentad fraction [mmmm] is less than 20% by mol, the solidification may be considerably delayed, and the nonwoven cloth may be attached to or drawn to a calender roll or a belt, and thus may not be continuously formed. When the mesopentad fraction [mmmm] exceeds 60% by mol, the elastic recovery property may be deteriorated due to the high crystallinity. The mesopentad fraction [mmmm] is preferably from 30 to 50% by mol, and more preferably from 40 to 50% by mol.

(b) [rrrr]/(1-[mmmm]) $\leq$ 0.1

[0010] The value of [rrrr]/(1-[mmmm]) is an index representing the uniformity of the regularity distribution of the low crystalline polypropylene. When the value is too large, a mixture of a high regularity polypropylene and an atactic polypropylene is obtained as similar to an ordinary polypropylene produced with a magnesium-supported titanium catalyst, and causes stickiness.
In the low crystalline polypropylene, when [rrrr]/(1-[mmmm]) is larger than 0.1, the regularity distribution is broadened to form a mixture with an atactic polypropylene, which causes stickiness. In this point of view, [rrrr]/(1-[mmmm]) is preferably 0.05 or less, and more preferably 0.04 or less.

(c) [rmrm] > 2.5% by mol

[0011] When the racemic-meso-racemic-meso pentad fraction [rmrm] of the low crystalline polypropylene is 2.5% by mol or less, the randomness of the low crystalline polypropylene is lowered, and the crystallinity thereof is increased, thereby lowering the elastic recovery property. [rmrm] is preferably 2.6% by mol or more, and more preferably 2.7% by mol or more. The upper limit thereof is generally approximately 10% by mol.

(d) [mm]$\times$[rr]/[mr]^2 $\leq$ 2.0

[0012] The value of [mm]$\times$[rr]/[mr]^2 is an index of the randomness of the polymer, and when the value is close to 0.25, the randomness is increased, and excellent elastic recovery property may be provided. When the value is 2.0 or less, the fibers obtained by spinning may have sufficient elastic recovery property, and the stickiness thereof may be suppressed.
For providing the sufficient elastic recovery property, the value of [mm]$\times$[rr]/[mr]^2 is preferably from 0.25 to 1.8, and more preferably from 0.25 to 1.5.

(e) Weight Average Molecular Weight (Mw) = 10,000 to 200,000

[0013] When the weight average molecular weight of the low crystalline polypropylene is 10,000 or more, the viscosity of the low crystalline polypropylene is not too low and is moderate, and breakage of the thread upon spinning may be suppressed. When the weight average molecular weight thereof is 200,000 or less, the viscosity of the low crystalline polypropylene is not too high, and the spinning property may be enhanced. The weight average molecular weight is preferably from 30,000 to 150,000, and more preferably from 50,000 to 150,000.

(f) Molecular Weight Distribution (Mw/Mn) < 4.

[0014] The molecular weight distribution (Mw/Mn) of the low crystalline polypropylene is less than 4, the fibers obtained by spinning may be suppressed from suffering stickiness. The molecular weight distribution is preferably 3 or less.

[0015] The stereoregularity properties (a) to (d) are obtained by NMR.
In the present invention, the mesopentad fraction [mmmm], the racemic pentad fraction [rrrr] and the racemic-meso-racemic-meso pentad fraction [rmrm] are the meso fraction, the racemic fraction and the racemic-meso-racemic-meso fraction, respectively, in the pentad units of the polypropylene molecular chain that are measured with the signal of the methyl group in the ^{13}C-NMR spectrum according to the method proposed by A. Zambelli, et al., Macromolecules, vol. 6, p. 925 (1973). When the mesopentad fraction [mmmm] is increased, the stereoregularity is increased. The triad

fractions [mm], [rr] and [mr] are also calculated by the aforementioned method.
The ^{13}C-NMR spectrum may be measured according to the peak assignment proposed by A. Zambelli, et al., Macromolecules, vol. 8, p. 687 (1975), with the following apparatus and conditions.

[0016]

apparatus: ^{13}C-NMR apparatus, Model JNM-EX400, produced by JEOL, Ltd.
method: proton complete decoupling method
concentration: 220 mg/mL
solvent: mixed solvent of 1,2,4-trichlorobenzene and deuterated benzene at 90/10 (by volume)
temperature: 130°C
pulse width: 45°
pulse repetition time: 4 seconds
accumulation: 10,000

Calculating Expressions

[0017]

$$M = m/S \times 100$$

$$R = \gamma/S \times 100$$

$$S = P\beta\beta + P\alpha\beta + P\alpha\gamma$$

S: signal intensity of carbon atoms in side chain methyl of all the propylene units
P$\beta\beta$: 19.8 to 22.5 ppm
P$\alpha\beta$: 18.0 to 17.5 ppm
P$\alpha\gamma$: 17.5 to 17.1 ppm
γ: racemic pentad chain, 20.7 to 20.3 ppm
m: mesopentad chain, 21.7 to 22.5 ppm

[0018] The weight average molecular weight (Mw) (e) and the molecular weight distribution (Mw/Mn) (f) are obtained by measurement of gel permeation chromatography (GPC). The weight average molecular weight in the present invention is a polystyrene conversion weight average molecular weight measured with the following apparatus and conditions, and the molecular weight distribution is a value calculated from a number average molecular weight (Mn) measured in the same manner and the weight average molecular weight.

GPC Measurement Apparatus

[0019]

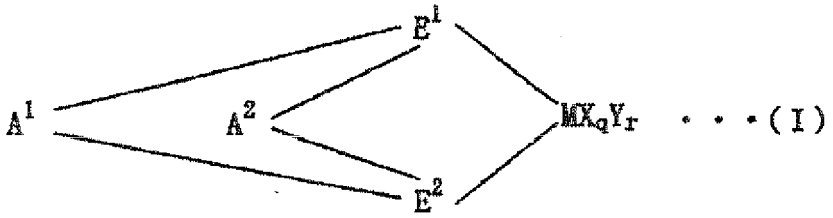
column: TOSO GMHHR-H(S)HT
detector: Waters 150C, RI detector for liquid chromatography Measurement Conditions
solvent: 1,2,4-trichlorobenzene
measurement temperature: 145°C
flow rate: 1.0 mL/min
specimen concentration: 2.2 mg/mL
injection amount: 160 μL
calibration curve: Universal Calibration
analysis software: HT-GPC (ver. 1.0)

[0020] The low crystalline polypropylene may be produced, for example, by using a metallocene catalyst disclosed in WO2003/087172. In particular, a metallocene catalyst containing a transition metal compound having a ligand forming a crosslinked structure through a crosslinking group is preferred, and a metallocene catalyst obtained by combining a

transition metal compound having a crosslinked structure through two crosslinking group, with a cocatalyst, is more preferable.

Specific examples thereof include a polymerization catalyst containing (A) a transition metal compound represented by the general formula (I):

[0021]



[0022] wherein M represents a metal element of Groups 3 to 10 in the Periodic Table or of lanthanoid series; E^1 and E^2 each represent a ligand selected from a substituted cyclopentadienyl group, an indenyl group, a substituted indenyl group, a heterocyclopentadienyl group, a substituted heterocyclopentadienyl group, an amide group, a phosphide group, a hydrocarbon group and a silicon-containing group, forming a crosslinked structure through A^1 and A^2, in which E^1 and E^2 may be the same as or different from each other; X represents a σ-bonding ligand, in which when there are plural ligands represented by X, the plural ligands may be the same as or different from each other, and may be crosslinked to another X, E^1, E^2 or Y; Y represents a Lewis base, in which when there are plural Lewis bases represented by Y, the plural Lewis bases may be the same as or different from each other, and may be crosslinked to another Y, E^1, E^2 or X; A^1 and A^2 are each a crosslinking group bonding the two ligands, and each represent a hydrocarbon group having from 1 to 20 carbon atoms, a halogen-containing hydrocarbon group having from 1 to 20 carbon atoms, a silicon-containing group, a germanium-containing group, a tin-containing group, -O-, -CO-, -S-, $-SO_2-$, -Se-, $-NR^1-$, $-PR^1-$, $-P(O)R^1-$, $-BR^1-$ or $-AlR^1-$, in which R^1 represents a hydrogen atom, a halogen atom, a hydrocarbon group having from 1 to 20 carbon atoms or a halogen-containing hydrocarbon group having from 1 to 20 carbon atoms, and A^1 and A^2 may be the same as or different from each other; q represents an integer of from 1 to 5 (i.e., (valency of M) - 2); and r represents an integer of from 0 to 3, and (B) a component selected from (B-1) a compound capable of forming an ionic complex through reaction with the transition metal compound as the component (A) or a derivative thereof, and (B-2) an aluminoxane.

[0023] The transition metal compound as the component (A) is preferably a (1,2') (2,1') double-crosslinked transition metal compound, and examples thereof include (1,2'-dimethylsilylene) (2,1'-dimethylsilylene) bis(3-trimethylsilylmethylindenyl)zirconium dichloride.

[0024] Specific examples of the compound as the component (B-1) include triethylammonium tetraphenylborate, tri-n-butylammonium tetraphenylborate, trimethylammonium tetraphenylborate, tetraethylammonium tetraphenylborate, methyl(tri-n-butyl)ammonium tetraphenylborate, benzyl(tri-n-butyl)ammonium tetraphenylborate, dimethylphenylammonium tetraphenylborate, triphenyl(methyl)ammonium tetraphenylborate, trimethylanilinium tetraphenylborate, methylpyridinium tetraphenylborate, benzylpyridinium tetraphenylborate, methyl(2-cyanopyridinium) tetraphenylborate, triethylammonium tetrakis(pentafluorophenyl)borate, tri-n-butylammonium tetrakis(pentafluorophenyl)borate, triphenylammonium tetrakis(pentafluorophenyl)borate, tetra-n-butylammonium tetrakis(pentafluorophenyl)borate, tetraethylammonium tetrakis(pentafluorophenyl)borate, benzyl(tri-n-butyl)ammonium tetrakis(pentafluorophenyl)borate, methyldiphenylammonium tetrakis(pentafluorophenyl)borate, triphenyl(methyl)ammonium tetrakis(pentafluorophenyl)borate, methylanilinium tetrakis(pentafluorophenyl)borate, dimethylanilinium tetrakis(pentafluorophenyl)borate, trimethylanilinium tetrakis (pentafluorophenyl)borate, methylpyridinium tetrakis(pentafluorophenyl)borate, benzylpyridinium tetrakis(pentafluorophenyl)borate, methyl(2-cyanopyridinium) tetrakis(pentafluorophenyl)borate, benzyl(2-cyanopyridinium) tetrakis(pentafluorophenyl)borate, methyl(4-cyanopyridinium) tetrakis(pentafluorophenyl)borate, triphenylphosphonium tetrakis (pentafluorophenyl)borate, dimethylanilinium tetrakis(bis(3,5-ditrifluoromethyl)phenyl)borate, ferrocenium tetraphenylborate, silver tetraphenylborate, trityl tetraphenylborate, tetraphenylporphyrin manganese tetraphenylborate, ferrocenium tetrakis(pentafluorophenyl)borate, (1,1'-dimethylferrocenium) tetrakis(pentafluorophenyl)borate, decamethylferrocenium tetrakis(pentafluorophenyl)borate, silver tetrakis(pentafluorophenyl)borate, trityl tetrakis(pentafluorophenyl)borate, lithium tetrakis(pentafluorophenyl)borate, sodium tetrakis(pentafluorophenyl)borate, tetraphenylporphyrin manganese tetrakis(pentafluorophenyl)borate, silver tetrafluoroborate, silver hexafluorophosphate, silver hexafluoro arsenate, silver perchlorate, silver trifluoroacetate and silver trifluoromethanesulfonate.

[0025] Examples of the aluminoxane as the component (B-2) include known linear aluminoxanes and cyclic aluminoxanes.

[0026] Furthermore, the low crystalline polypropylene may be produced by using, in combination, an organoaluminum compound, such as trimethylaluminum, triethylaluminum, triisopropylaluminum, triisobutylaluminum, dimethylaluminum chloride, diethylaluminum chloride, methylaluminum dichloride, ethylaluminum dichloride, dimethylaluminum fluoride,

diisobutylaluminum hydride, diethylaluminum hydride and ethylaluminum sesquichloride.

High Crystalline Polypropylene

[0027] As the high crystalline polypropylene used in the present invention, Y2000GP (a trade name, produced by Prime Polymer Co., Ltd.) and the like may be used, and any crystalline polypropylene that has a melting point of 155°C or more may be used without particular limitation. Examples thereof include a propylene homopolymer, an ethylene-propylene random copolymer and an ethylene-propylene block copolymer. The molecular weight of the high crystalline polypropylene may be selected from the standpoint of the moldability in any case. In the case of molding by a melt-blow method, one having a melt flow rate (MFR) measured according to JIS K7210 at a temperature of 230°C and a load of 21.18 N of approximately from 100 to 2,000 g/10 min is preferred, and in the case of molding by a spunbond method, one having an MFR of approximately from 10 to 100 g/10 min is preferred. The high crystalline polypropylene may be selected from these ranges in consideration of the target purpose of the fibers and the nonwoven cloth. Specifically, for the propose where the moldability is important, a polypropylene that has a high crystallization temperature and has high crystallinity is preferred, and one having a crystallization temperature (Tc) of 100°C or more is more preferred.

Spinning Conditions

[0028] The spinning conditions of the fibers preferably include a relatively low spinning speed for suppressing the orientation crystallization of the fibers, and the spinning speed is necessarily from 500 to 2,500 m/min, and preferably from 1,000 to 2,000 m/min. When the spinning speed exceeds 2,500 m/min, the breaking elongation of the elastic nonwoven cloth is decreased, thereby failing to provide sufficient elastic recovery property, and when the spinning speed is less than 500 m/min, the nonwoven cloth may be insufficient due to, for example, deteriorated appearance caused by a thick thread and an insufficient fiber amount.

Core-Sheath Composite Fibers

[0029] The fibers forming the nonwoven cloth of the present invention are preferably core-sheath fibers. The core-sheath fibers referred herein are fibers that has, on the cross sectional view thereof, a core as a center portion and a sheath as an outer layer.

1. Sheath Component

[0030] The sheath component of the core-sheath composite fibers preferably contains a low crystalline polypropylene and a high crystalline polypropylene, and the component amounts thereof are preferably from 50 to 99% by mass for the low crystalline polypropylene and from 1 to 50% by mass for the high crystalline polypropylene, more preferably from 60 to 95% by mass for the low crystalline polypropylene and from 5 to 40% by mass for the high crystalline polypropylene, and further preferably from 60 to 90% by mass for the low crystalline polypropylene and from 10 to 40% by mass for the high crystalline polypropylene. When the amount of the low crystalline polypropylene is 50% by mass or more, sufficient elastic recovery property may be obtained, and when it is 99% by mass or more, attachment to a calender roll is suppressed, thereby enhancing the continuous moldability.

[0031] The sheath component in the present invention may contain an internal releasing agent. The internal releasing agent is an additive that is added to the resin raw material for enhancing the releasing property of the nonwoven cloth, and specific examples thereof include a high melting point polymer, an organic carboxylic acid or a metal salt thereof, an aromatic sulfonic acid or a metal salt thereof, an organic phosphorus compound or a metal salt thereof, dibenzylidene sorbitol or a derivative thereof, a partial metal salt of rosin acid, inorganic fine particles, an imide compound, an amide compound, a quinacridone compound, a quinone compound, and mixtures thereof.

[0032] Examples of the high melting point polymer include a polyolefin, such as polyethylene and polypropylene. Examples of the organic carboxylic acid include an aliphatic acid, such as octylic acid, palmitic acid, lauric acid, stearic acid, behenic acid, montanic acid, 12-hydroxystearic acid, oleic acid, isostearic acid and ricinoleic acid, and an aromatic carboxylic acid, such as benzoic acid and p-t-butylbenzoic acid. Examples of the metal salt of an organic carboxylic acid include salts of Li, Ca, Ba, Zn, Mg, Al, Pb and the like of the aforementioned organic carboxylic acids and a metal soap which is a metal salt of the carboxylic acid, and specific examples thereof include aluminum benzoate, aluminum p-t-butylbenzoate, sodium adipate, sodium thiophene carboxylate and sodium pyrrole carboxylate.

[0033] Examples of the aromatic sulfonic acid include a linear alkylbenzenesulfonic acid, a branched alkylbenzenesulfonic acid, naphthalenesulfonic acid and dodecylbenzenesulfonic acid, and examples of the metal salt of an aromatic sulfonic acid include salts of Li, Ca, Ba, Zn, Mg, Al, Pb and the like of the aforementioned aromatic sulfonic acids.

[0034] Examples of the organic phosphorus compound include trimethyl phosphate, triethyl phosphate, tributyl phos-

phate, 2-ethylhexyl phosphate, butoxyethyl phosphate, triphenyl phosphate, tricresyl phosphate, trixylenyl phosphate, cresyldiphenyl phosphate, 2-ethylhexyldiphenyl phosphate, cresyldi-2,6-xylenyl phosphate, resorcinoldiphenol phosphate, various aromatic condensed phosphate esters, 2-chloroethyl phosphate, chloropropyl phosphate, dichloropropyl phosphate, tribromoneopentyl phosphate, a halogen-containing condensed phosphoric acid, bis-2-ethylhexyl phosphate, diisodecyl phosphate, 2-methacryloyloxyethyl acid phosphate, diphenyl-2-methacryloyloxyethyl phosphate, methyl acid phosphate, butyl acid phosphate, monoisodecyl phosphate, 2-butylhexyl acid phosphate, isodecyl acid phosphate, triphenyl phosphate, dibutyl hydrogen phosphate, dibutyl hydrogen phosphate, polyoxyethylene lauryl ether phosphoric acid, polyoxyalkyl ether phosphoric acid, polyoxyethylene alkyl phenyl ether phosphoric acid and polyoxyethylene dialkyl phenyl ether phosphoric acid, and examples of the metal salt of an organic phosphoric acid compound include metal salts of Li, Ca, Ba, Zn, Mg, Al, Pb and the like of the aforementioned organic phosphorus compounds. Examples of the commercially available products thereof include Adeka Stab NA-11 and Adeka Stab NA-21, produced by ADEKA Corporation.

[0035] Examples of dibenzylidene sorbitol or a derivative thereof include dibenzylidene sorbitol, 1,3:2,4-bis(o-3,4-dimethylbenzylidene) sorbitol, 1,3:2,4-bis(o-2,4-dimethylbenzylidene) sorbitol, 1,3:2,4-bis(o-4-ethylbenzylidene) sorbitol, 1,3:2,4-bis(o-4-chlorobenzylidene) sorbitol and 1,3:2,4-dibenzylidene sorbitol, and examples of the commercially available products thereof include Gel All MD and Gel All MD-R, produced by New Japan Chemical Co., Ltd.

[0036] Examples of the partial metal salt of rosin acid include Pine Crystal KM1600, Pine Crystal KM1500 and Pine Crystal KM1300, produced by Arakawa Chemical Industries, Ltd.

[0037] Examples of the inorganic fine particles include talc, clay, mica, asbestos, glass fibers, glass flakes, glass beads, calcium silicate, montmorillonite, bentonite, graphite, aluminum powder, alumina, silica, diatom earth, titanium oxide, magnesium oxide, pumicite, pumice balloons, aluminum hydroxide, magnesium hydroxide, basic magnesium carbonate, dolomite, calcium sulfate, potassium titanate, barium sulfate, calcium sulfite and molybdenum sulfide. Examples of the commercially available products thereof include Sylysia, produced by Fuji Sylysia Chemical Ltd., and Mizukasil, produced by Mizusawa Industrial Chemicals, Ltd.

[0038] The internal releasing agent may be used solely or as a combination of two or more kinds thereof. In the present invention, among these internal releasing agents, dibenzylidene sorbitol, 1,3:2,4-bis(o-3,4-dimethylbenzylidene) sorbitol, 1,3:2,4-bis(o-2,4-dimethylbenzylidene) sorbitol, 1,3-2,4-bis(o-4-ethylbenzylidene) sorbitol, 1,3:2,4-bis(o-4-chlorobenzylidene) sorbitol and 1,3:2,4-dibenzylidene sorbitol are preferred.

[0039] The content of the internal releasing agent is preferably from 10 to 10,000 ppm by mass based on the composite of the sheath component resin as a standard, and more preferably from 100 to 5,000 ppm by mass. When the content of the internal releasing agent is 10 ppm by mass or more, the function of the releasing agent may be exhibited, and when the content thereof is 10,000 ppm by mass or less, good balance may be obtained between the function of the releasing agent and the cost.

2. Core Component

[0040] The core component of the core-sheath composite fibers preferably contains a low crystalline polypropylene, and the content thereof is preferably from 90 to 100% by mass of the low crystalline polypropylene and from 0 to 10% by mass of a high crystalline polypropylene. When the content of the low crystalline polypropylene is 90% by mass or more, sufficient elastic recovery property may be obtained, and the content of the low crystalline polypropylene is preferably 100% by mass for providing the highest elastic recovery property.

3. Composite Fibers

[0041] The core-sheath composite fibers preferably satisfy the following conditions. In the following description, the parameters are abbreviated as follows.

Ws: mass fraction of the sheath component (%)
Wc: mass fraction of the core component (%)
Xs : mass fraction of the low crystalline polypropylene in the sheath component (%)
Xc: mass fraction of the low crystalline polypropylene in the core component (%)

[0042] In the core-sheath composite fibers of the present invention, the ratio of the sheath component and the core component (Ws/Wc) is preferably in a range of from 50/50 to 10/90. When the condition is satisfied, good elastic recovery property may be obtained.

[0043] The core-sheath composite fibers of the present invention preferably has a larger content of a low crystalline polypropylene in the core component than in the sheath component. In other words, Wc $\times$ Xc is preferably larger than Ws $\times$ Xs. When the core-sheath composite fibers satisfy the condition, both high elastic recovery property and good

continuous moldability may be obtained simultaneously.

[0044] In the core-sheath composite fibers of the present invention, the content of the total low crystalline polypropylene calculated by the following expression is preferably from 90 to 99% by mass. When it is 90% by mass or more, sufficient elastic recovery property may be obtained, and when it is 99% by mass or less, deterioration of the moldability due to attachment to a calender roll and stickiness of the nonwoven cloth may be prevented.

$$\text{total low crystalline propylene content (\%)} = (Ws \times Xs + Wc \times Xc) / 100$$

The mass fraction of the sheath component and the mass fraction of the core component may be controlled by changing the resin ejection amounts for the core part and the sheath part in the core-sheath composite nozzle used for forming the nonwoven cloth.

[0045] Various additives may be added depending on necessity to the resin compositions of the sheath component and the core component used for producing the core-sheath composite fibers of the present invention. Examples of the additives include an antioxidant, a neutralizing agent, a slipping agent, an antiblocking agent, an antifoggant and an antistatic agent. The additives may be used solely or as a combination of two or more kinds thereof. Examples of the antioxidant include a phosphorus antioxidant, a phenol antioxidant and a sulfur antioxidant. These may be added upon preparing the resin compositions of the sheath component and the core component, or may be added upon producing the low crystalline polypropylene.

Elastic Nonwoven Cloth and Fiber Product

[0046] The elastic nonwoven cloth of the present invention may be produced by such a method as a melt-blow method, a spunbond method and the like, and the production method may be appropriately selected depending on the purpose of the elastic nonwoven cloth.

In the melt-blow method, the elastic nonwoven cloth may be produced in such a manner that a molten resin is extruded from a nozzle and then made in contact with a high-speed heated gas flow to form fine fibers, and the fine fibers are collected on a moving collecting surface to form a nonwoven cloth. A nonwoven cloth produced by the melt-blow method contains fibers with a small average diameter, which constitute the nonwoven cloth, and thus has pleasant texture.

In the spunbond method, the elastic nonwoven cloth may be produced in such a manner that a resin having been melt-kneaded is spun, stretched and filamentized to form continuous long fibers, and continuously in the subsequent process step, the continuous long fibers are accumulated and entangled on a moving collecting surface. In the spunbond method, an elastic nonwoven cloth may be produced continuously, and an elastic nonwoven cloth produced by the spunbond method has a large strength since the fibers constituting the nonwoven cloth are stretched continuous long fibers.

[0047] The fiber product using the elastic nonwoven cloth of the present invention is not particularly limited, and examples thereof include the following fiber products. Specifically, examples thereof include a material for a diaper cover, an elastic material for a diaper cover, an elastic material for a sanitary product, an elastic material for a hygienic product, an elastic tape, an adhesive plaster, an elastic material for a clothing material, an electric insulating material for a clothing material, a thermal insulating material for a clothing material, a protective garment, a headwear, a face mask, a glove, an athletic supporter, an elastic bandage, a base cloth for a wet dressing, an antislipping base cloth, a vibration dampener, a finger stall, an air filter for a clean room, an electret filter having been subjected to an electret treatment, a separator, a thermal insulating material, a coffee bag, a food packaging material, a ceiling surface material for an automobile, an acoustic insulating material, a cushioning material, a dust proof material for a speaker, an air cleaner material, a insulator surface material, a backing material, an adhesive nonwoven cloth sheet, various automobile member, such as a door trim material, various cleaning material, such as a cleaning material for a duplicator, a surface material and a backing material of a carpet, an agricultural rolled cloth, a wood draining material, a shoe material, such as a surface material for sport shoes, a member for a bag, an industrial sealant, a wiping material, and a bed sheet.

Example

[0048] The present invention will be described in more detail with reference to examples, but the present invention is not limited to the examples.

Example 1

(1) Production of Low Crystalline Polypropylene

[0049] To a stainless steel vessel having an inner capacity of 20 L equipped with a stirrer, n-heptane at 20 L/h, triisobutylaluminum at 15 mmol/h, and a catalyst component, which was obtained by making dimethylanilinium tetrakis (pentafluorophenyl)borate, (1,2'-dimethylsilylene) (2,1'-dimethylsilylene) bis(3-trimethylsilylmethylindenyl)zirconium dichloride, triisobutylaluminum and propylene at a mass ratio of 1/2/20, at 6 μmol/h in terms of zirconium were continuously fed.
Polymerization reaction was performed at a polymerization temperature set at 67°C while continuously feeding propylene and hydrogen to maintain the hydrogen concentration in the gas phase of the reactor to 2% by mol and the total pressure in the reactor to 0.8 MPa·G.
To the resulting polymerization solution, Irganox 1010 (produced by Ciba Specialty Chemicals Co., Ltd.) as a stabilizer was added to make the content ratio thereof of 500 ppm by mass, and then n-heptane as a solvent was removed, thereby providing a low crystalline polypropylene (LMPP).
The resulting low crystalline polypropylene was measured for a melting point (Tm-D), a stereoregularity index ([mm]), a mesopentad fraction [mmmm], a racemic-meso-racemic-meso pentad fraction [rmrm], [rrrr]/(1-[mmmm]), [mm]×[rr]/[mr]^2, a weight average molecular weight (Mw) and a molecular weight distribution (Mw/Mn) according to the aforementioned methods. The results are shown in Table 1.

[0050]

Table 1

	Low Crystalline Polypropylene (LMPP)
melting point (Tm-D)	70
[mm] (% by mol)	65
[mmmm] (% by mol)	44.6
[rmrm] (% by mol)	2.7
[rrrr]/(1-[mmmm])	0.036
[mm]×[rr]/[mr]^2	1.4
Mw	110,000
Mw/Mn	2.0

(2) Formation of Nonwoven Cloth

[0051] As the sheath component, a mixture in a pellet form obtained by mixing 90% by mass of the low crystalline polypropylene (LMPP) obtained in the item (1) and 10% by mass of a high crystalline polypropylene (PP, Moplen HP561S, produced by Basell Polyolefins Company) having a melt flow rate (MFR) measured according to JIS K7210 at a temperature of 230°C and a load of 21.18 N of 33 g/10 min was used, and as the core component, only the low crystalline polypropylene was used.
The nonwoven cloth was produced by using a spunbond machine (Reicofil 4, produced by Reicofil GmbH). The raw materials of the sheath component resin and the core component resin were spun in such a manner that the materials were each separately melt-extruded with a single screw extruder at a resin temperature of 220°C, and were ejected from a core-sheath composite nozzle having a nozzle diameter of 0.6 mm (number of pores: 5,800 pores/m) at a rate of 0.60 g/min per single pore at a ratio of the sheath component to the core component of 20/80.
The fibers obtained by spinning were accumulated at a temperature of 16°C and a cabin pressure of 2,000 Pa on a net surface moving at a line speed of 40 m/min. The fiber bundle thus accumulated on the net surface was embossed with an embossing roll heated to 65°C at a line pressure of 20 N/mm, and wound to a winding roll.
The resulting elastic nonwoven cloth was measured and evaluated as follows. The results are shown in Table 2.

(3) Measurement of Elastic Recovery Rate

[0052] A test piece having a length of 200 mm and a width of 25 mm was taken from the resulting elastic nonwoven cloth in each of the machine direction (MD) and a transversal direction (TD) perpendicular to the machine direction. By

using a tensile tester (Autograph AG-I, produced by Shimadzu Corporation), the test piece set at an initial length L_0 of 100 mm was elongated by 100% at a tensile speed of 300 mm/min and then immediately retracted at 300 mm/min, and the length L (mm) at the time when the stress became 0 was measured. The elastic recovery rate (%) was calculated according to the following expression.

$$\text{elastic recovery rate (\%)} = (2 - L/L_0) \times 100$$

(4) Measurement of Breaking Strain and Maximum Stress

[0053] A test piece having a length of 200 mm and a width of 25 mm was taken from the resulting elastic nonwoven cloth in each of the machine direction (MD) and a transversal direction (TD) perpendicular to the machine direction. By using a tensile tester (Autograph AG-I, produced by Shimadzu Corporation), the test piece set at an initial length L_0 of 100 mm was elongated at a tensile speed of 300 mm/min until the test piece was broken, and the maximum stress immediately before the breakage and the length L (mm) at that point were measured. The breaking strain (%) was calculated according to the following expression.

$$\text{breaking strain (\%)} = (L - L_0)/L_0 \times 100$$

(5) Measurement of Areal Weight

[0054] The mass of the resulting nonwoven cloth of 5 cm × 5 cm was measured, and the areal weight (g/m^2) was calculated.

(6) Measurement of Fineness

[0055] The fibers in the nonwoven cloth were observed with a polarizing microscope for measuring an average value (d) of the fiber diameters of five fibers that were randomly selected, and the fineness of the specimen of the nonwoven cloth was calculated from the density of the resin (ρ = 900,000 g/m^3) according to the following expression.

$$\text{fineness (g/9,000 m)} = \rho \times \pi \times (d/2)^2 \times 9{,}000$$

(7) Spinning Speed

[0056] The spinning speed was calculated from the fineness in terms of denier obtained by the aforementioned manner according to the following expression.

$$\text{spinning speed (m/min)} = \frac{\text{single pore ejection amount (g/min)}}{\text{fineness (denier·g/9,000 m)}} \times 9{,}000 \text{ (m)}$$

Examples 2 to 4 and Comparative Example 1

[0057] Elastic nonwoven cloths were formed in the same manner as in Example 1 except that the sheath component and the spinning conditions in Example 1 were changed as shown in Table 2, and were measured and evaluated in the same manners. The results are shown in Table 2.

[0058]

Table 2

		Example 1	Example 2	Example 3	Example 4	Comparative Example 1
Sheath component (% by mass)	LMPP	90	90			90
	PP	10	10			10
	Engage			100	40	
	ASPUN				60	
Cabin pressure (Pa)		2,000	3,500	4,000	3,500	6,000
Embossing roll temperature (°C)		65	65	65	65	80
Line pressure (N/mm)		20	20	45	90	20
Areal weight (g/m^2)		68	66	179	68	60
Fineness (g/9,000 m)		4.2	2.7	3.4	2.2	2.0
Ejection amount per single pore (g/min)		0.60	0.60	0.60	0.60	0.60
Spinning speed (m/min)		1,286	2,000	1,588	2,455	2,700
MD	Breaking strain (%)	194	186	133	151	70
	Maximum stress (N)	21.9	29.7	43.0	24.7	20.7
	Elastic recovery rate (%)	84.2	83.9	84.1	76.2	-
TD	Breaking strain (%)	368	271	258	192	75
	Maximum stress (N)	8.5	12.1	22.0	10.2	4.8
	Elastic recovery rate (%)	81.5	82.0	82.1	71.9	-

LMPP: low crystalline polypropylene produced in Example 1 (1) PP: Moplen HP561S, produced by Basell Polyolefins Company, melting point: 160°C
Engage: ethylene polymer, Engage 8401, produced by Dow Chemical Company
ASPUN: ethylene polymer, ASPUN 6834, produced by Dow Chemical Company

Industrial Applicability

[0059] The elastic nonwoven cloth of the present invention may be favorably used, for example, as various fiber products including a disposable diaper, a sanitary product, a hygienic product, a clothing material, a bandage and a packaging material.

Claims

1. An elastic nonwoven cloth comprising fibers that are spun at a spinning speed of from 500 to 2,500 m/min and contain a low crystalline polypropylene that satisfies the following properties (a) to (f):

   (a) [mmmm] == 20 to 60% by mol,
   (b) [rrrr]/(1-[mmmm]) $\leq$ 0.1,
   (c) [rmrm] > 2.5% by mol,
   (d) [mm]$\times$[rr]/[mr]^2 $\leq$ 2.0,
   (e) weight average molecular weight (Mw) = 10,000 to 200,000, and
   (f) molecular weight distribution (Mw/Mn) < 4.

2. The elastic nonwoven cloth according to claim 1, wherein the fibers are core-sheath composite fibers.

3. The elastic nonwoven cloth according to claim 2, wherein the core-sheath composite fibers contain a sheath component containing an olefin polymer, and a core component containing from 90 to 100% by mass of a low crystalline polypropylene, and the core component contains the low crystalline polypropylene in a larger content than the sheath

component.

4. The elastic nonwoven cloth according to claim 2 or 3, wherein the core-sheath composite fibers has a total low crystalline polypropylene content calculated by the following expression of from 90 to 99% by mass:

$$\text{total low crystalline polypropylene content (\%)} = (Ws \times Xs + Wc \times Xc) / 100$$

wherein

Ws represents a mass fraction of the sheath component,
Wc represents a mass fraction of the core component,
Xs represents a mass fraction of the low crystalline polypropylene in the sheath component, and
Xc represents a mass fraction of the low crystalline polypropylene in the core component.

5. A fiber product comprising the elastic nonwoven cloth according to any one of claims 1 to 4.

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
D04H3/00(2006.01)i, *D01F8/06*(2006.01)i, *D04H3/16*(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D04H1/00-18/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2011
Kokai Jitsuyo Shinan Koho 1971-2011 Toroku Jitsuyo Shinan Koho 1994-2011

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2009-209506 A (Idemitsu Kosan Co., Ltd.), 17 September 2009 (17.09.2009), claims; examples & WO 2009/001871 A1	1-5 1-5
Y	JP 2007-277755 A (Chisso Corp.), 25 October 2007 (25.10.2007), paragraph [0035] (Family: none)	1-5

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

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Date of the actual completion of the international search	Date of mailing of the international search report
08 April, 2011 (08.04.11)	19 April, 2011 (19.04.11)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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REFERENCES CITED IN THE DESCRIPTION

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- **A. ZAMBELLI et al.** *Macromolecules,* 1973, vol. 6, 925 **[0015]**
- **A. ZAMBELLI et al.** *Macromolecules,* 1975, vol. 8, 687 **[0015]**