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(54) **PARTICLE-CONTAINING FIBRES**

TEILCHEN ENTHALTENDE FASERN

FIBRES CONTENANT DES PARTICULES

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- **PATENT ABSTRACTS OF JAPAN vol. 009, no. 078 (C-274), 6 April 1985 & JP 59 211611 A (ISHIMOTO MAORAN KK), 30 November 1984,**
- **PATENT ABSTRACTS OF JAPAN vol. 018, no. 533 (C-1259), 11 October 1994 & JP 06 184905 A (UNITIKA LTD), 5 July 1994,**

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EP 0 880 610 B1

Description

[0001] The present invention relates to particle-containing polyolefin fibres and filaments having improved properties with respect to their use in thermobonded nonwoven fabrics. The present invention also relates to nonwoven fabrics prepared from such particle-containing polyolefin fibres or filaments.

[0002] Nonwoven fabrics are porous sheets made by bonding together fibres or filaments. They can be flat or bulky and can have a variety of different properties, depending upon the process by which they are produced. Nonwovens are used in a variety of applications, including as components of apparel, construction, home furnishing, health care, engineering, industrial and consumer products. One important application is in the production of various parts of hygiene absorbent products such as disposable diapers, feminine hygiene products and adult incontinence products.

[0003] The bonding of the fibres or filaments in the fibrous web upon which the nonwoven is based gives strength to the web and influences its properties in general. One widely used method of bonding such fibrous webs is by means of heat to bond together thermoplastic fibres or filaments, e.g. of a polyolefin or a polyester. Manufacturing methods for nonwovens are described in a variety of publications, for example "The Nonwovens Handbook" (The Association of the Nonwoven Industry, 1988) and the "Encyclopaedia of Polymer Science and Engineering", Volume 10, Nonwoven Fabrics (John Wiley and Sons, 1987).

[0004] The growing consumption of nonwoven products has caused pressure to increase manufacturing capacity by increasing the production speed. However, the problem exists that when e.g. the calender bonding speed is increased, the temperature must be increased in order to maintain the bonding quality. This in turn leads to problems of sticking of the nonwoven to the calender.

[0005] Inorganic particles are used for a variety of purposes in the plastics industry in general, and the fibre prior art includes a number of examples of inorganic particle-containing fibres for use in nonwovens.

[0006] For example, JP 4194026 and JP 4170463 disclose polyester fibres containing 0.01-3.0 % by weight of inorganic inert particles, e.g. talc or silica, as a nucleating agent.

[0007] EP 569 860-A discloses a nonwoven web comprising spunbonded thermoplastic filaments of e.g. polypropylene or polyethylene containing 0.1-0.3% by weight of fumed silica with a particle size of up to 1 μm as a nucleating agent.

[0008] EP 539 890-A discloses a melt extrudable thermoplastic polyolefin composition containing a polysiloxane and hydrophobic fumed silica for the preparation of fibres for wettable nonwoven webs.

[0009] JP 3069675 discloses synthetic fibres of e.g. polypropylene or polyethylene containing 3-30% by weight of oxide ceramic particles radiating far infrared rays. The particles are e.g. Al_2O_3, MgO, SiO_2, ZrO_2 or TiO_2 and have a particle diameter of preferably less than 1 μm. The surface of these fibres was treated with a siloxane compound.

[0010] JP 2169718 discloses sheath-core composite fibres with a polyester core and a polyolefin sheath, the sheath containing 0.3-10% by weight of inorganic particles, e.g. TiO_2 or talc, with an average diameter of 0.05-5 μm. The inorganic particles were introduced in order to obtain a better softness and opacity of the web.

[0011] JP 1266216 discloses composite fibres with a high melting component of e.g. polypropylene or polyester and a low melting component of e.g. polyethylene, in which the high melting component contains 0.1-13 % by weight of the high melting component of an inorganic filler with a sheet particle form, e.g. talc, mica or alumina, and a particle size of up to 110 μm.

[0012] JP 61155437 discloses resin compositions for the production of continuous filament nonwovens, the resin containing polypropylene and 0.05-0.5 % by weight of a crystal nucleating agent, the nucleating agent being e.g. alumina or silica with a grain size of below 5 μm.

[0013] JP-A 61 84905 discloses the preparation of a spunbonded nonwoven fabric by melt spinning polypropylene containing 0.05-2.0% by weight of TiO_2 and 0.5-3.0% by weight of $CaCO_3$ into filaments which are subsequently bonded.

[0014] While the above-cited prior art references all disclose various particle-containing fibres or filaments for use in nonwovens, none of them address the problem of providing fibres or filaments that are particularly adapted to the high-speed production of nonwovens, for example nonwovens for use in the hygienic industry that are able to continuously be formed into a web and be calender bonded at high speeds of e.g. up to 200-250 m/min or more to result in nonwoven fabrics with excellent properties in terms of strength and uniformity.

[0015] It has now surprisingly been found that polyolefin-based fibres and filaments containing relatively small amounts of fine, soft inorganic particles such as talc are able to result in a number of advantages, included the ability to produce nonwovens using increased webforming and bonding speeds, while maintaining strength characteristics without increasing the bonding temperature, and/or to obtain improved strength without lowering the webforming, e.g. carding, and bonding speeds. These and other advantages will be explained in detail below.

BRIEF DESCRIPTION OF THE INVENTION

[0016] One object of the present invention is to provide particle-containing polyolefin fibres or filaments which, when

continuously formed into a web and thermobonded to a nonwoven fabric at a high speed, result in a nonwoven strength (bonding index) which is higher than the strength of a nonwoven fabric prepared in the same manner with corresponding fibres or filaments without said particles.

[0017] Another object of the invention is to provide particle-containing polyolefin fibres or filaments which have a broader bonding window than corresponding fibres or filaments without said particles.

[0018] A further object of the invention is to provide particle-containing polyolefin fibres or filaments which have less static electricity than corresponding fibres or filaments without said particles.

[0019] A still further object of the invention is to provide particle-containing polyolefin-containing fibres or filaments having a lower friction coefficient than corresponding fibres or filaments without said particles.

[0020] These and other objects of the invention will become apparent from the description below.

[0021] In one aspect, the present invention thus relates to fibres or filaments suitable for the production of nonwoven fabrics, the fibres or filaments consisting essentially of a polyolefin or a copolymer thereof and 0.01-20% by weight of inorganic particles, substantially all of these particles having a Mohs hardness of less than about 5, at least 90% by weight of the inorganic particles having a particle size of less than 10 μm.

DETAILED DESCRIPTION OF THE INVENTION

[0022] In the present description and claims, the term "bonding index" is defined as the square root of the product of the bonding strength in the machine direction (MD) and in the cross-direction (CD) quoted as N/5 cm.

[0023] The bonding index is indicative for the strength of the nonwoven fabric. As the strength in the machine direction (parallel to the movement of the web/nonwoven) is often different from the cross-directional strength, the bonding index is a function of both of these. In optimal instances the ratio between the MD-strength and the CD-strength is around unity.

[0024] The term "bonding window" is intended to mean a certain temperature interval in which an acceptable bonding index is obtained. In the present context the "bonding window" is defined as a temperature interval (quoted in Kelvin) wherein the bonding index differs from the maximum bonding index (Bi_{max}) by not more than 15% of BI_{max}. In the case of a typical good quality nonwoven for use in hygienic absorbent products, this corresponds to a difference in the bonding index of about 3 N/5 cm compared to BI_{max}.

[0025] A broad bonding window gives the producer of nonwoven fabrics a better possibility of obtaining a uniform product even when using a calender system with temperature variation over the calender surface, or when using a higher bonding speed or lower bonding temperature.

[0026] The present invention provides new and improved polyolefin-containing fibres and filaments for nonwoven fabrics. This is obtained by incorporating inorganic particles in the fibres or filaments, whereby the physical properties of the fibres or filaments are altered in a way which, surprisingly, has shown to be advantageous with respect to, e.g., the thermobonding properties of the fibres or filaments when incorporated in a coherent web for nonwoven fabrics. In the following description, although reference will often be made for the sake of simplicity to "fibres", it should be understood that the present invention is applicable to both fibres, e.g. staple fibres, and filaments, e.g. continuous spunbonded filaments.

[0027] In particular, the fibres and filaments according to the present invention have advantageous properties when "soft" inorganic particles, such as talc, kaolin (hydrated aluminium silicate), calcium carbonate, mica (aluminium silicate minerals), wollastonite (calcium silicate), calcium sulphate, barium sulphate, etc., are incorporated therein. With respect to hardness of the particles, the particles have a Mohs hardness (based on the original Mohs Hardness Scale ranging from 1-10) of not more than 5, in particular not more than 4, especially not more than 3. As talc and kaolin are especially suited for incorporation in the fibres or filaments, the Mohs hardness will often be even lower, e.g. not more than 2 or even 1, which corresponds to talc. It is preferred that at least a part of the inorganic particles are talc particles; in especially interesting embodiments substantially all of the particles are talc particles. Although fibres containing relatively hard particles, for example silica, which has a Mohs hardness of 7, may well have characteristics that make them suitable for the production of nonwovens, the soft inorganic particles are preferred for the reason that hard, abrasive particles would tend to damage the fibre-producing equipment. This is also one reason why talc, which is the softest mineral on the Mohs Hardness Scale, is a preferred type of inorganic particle for the purposes of the present invention.

[0028] The term "talc" used in accordance with the present invention refers to a wide range of natural minerals with a high magnesium silicate content (e.g. corresponding to more than about 90% of $MgO+SiO_2$). Most commercial talc grades are believed to be suitable for use according to the invention, although those having a small particle size and a uniform particle size distribution are preferred (see below regarding preferred particle size).

[0029] The inorganic particles may be introduced into the polymer mass before preparation of the polymer granulate normally used for preparation of fibres, or the particles may be introduced directly into the polymer melt. In order to be able to adjust the content of inorganic particles and at the same time obtain an even distribution of particles in the fibre product, it is often advantageous to prepare a masterbatch of polymer granulates having a high content of particles, e.g. 30%, 40% or 50% by weight, and to mix a part of the masterbatch granulates with ordinary polymer granulates

without particles before preparation of the polymer melt in the extruder to obtain the desired concentration of particles.

[0030] With respect to the content of inorganic particles in the polyolefin-containing fibres, the content should not be too low, since a sufficient amount of particles should be located in the proximity of the fibre surface (taking into consideration that the particles will be substantially homogeneously distributed in the polymer melt and thus also uniformly distributed throughout the fibres), and the amount should not be too high since the mechanical strength of the fibres should not be impaired (a reduction of the strength of the fibres of less than 10%, such as less than 5%, will for most purposes be acceptable), and since an excessive particle content may cause problems in the spinning process. For a number of the most relevant polymer types, the content of inorganic particles will be of 0.01-20% by weight of the fibres, typically 0.1-15% by weight, more typically 0.2-10% by weight, in particular 0.5-5% by weight, such as 1.0-2.5% by weight. The amount may be varied according to various factors, including the particle fineness and particle size distribution (finer particles being able to be incorporated in a larger amount) and the speed at which the fibres or filaments are to be consolidated into a nonwoven (as it has been found that the effect of the particles is particularly pronounced at higher nonwoven production speeds, so that it may be advantageous to increase the particle content for higher production speeds).

[0031] With regard to the quality of the inorganic particles, it is envisaged that the size should be adapted to the cross-sectional dimension of the fibres. However, even if the fibres are relatively coarse the particle size should not be too large, because fibres having a relatively smooth surface are desired. Thus, with respect to the fibre dimensions of fibres typically used in the production of nonwovens for the hygienic industry (i.e. a fibre diameter generally in the range of about 0.5-7 dtex, as further described below), the particles have a size and distribution so that at least 90% by weight of the particles have a particle size (largest dimension) of less than 10 μm. The particles are preferably as small as possible, and it is thus preferred that at least 90% by weight of the particles have a particle size of less than 8 μm, more preferably less than 6 μm, most preferably less than 4 μm.

[0032] It is also preferred that the particle size distribution is relatively narrow so that the stability of the fibre spin process is not disturbed, and so that fibre breaks due to large inhomogenities are avoided. Thus, the particle size distribution should preferably be so that the ratio between the particle size at of 90% percentile (by weight) and the particle size of the 10% percentile (by weight) is at the most about 20:1, more preferably at the most about 15:1, most preferably at the most about 10:1, in particular as narrow as at the most about 8:1.

[0033] The polyolefin in the fibres and filaments of the invention may comprise a polyolefin homopolymer or a copolymer. Suitable polyolefins are e.g. isotactic polypropylene homopolymers as well as random copolymers thereof with ethylene, 1-butene, 4-methyl-1-pentene, 1-hexane, etc., and linear polyethylenes of different densities, such as high density polyethylene, low density polyethylene and linear low density polyethylene. A preferred polyolefin is a homopolymer of propylene or a copolymer thereof containing up to 10% by weight of another alpha-olefin, e.g. ethylene, 1-butene, 4-methylpentene or 1-hexene. A suitable melt flow rate (MFR) for such a polymer as a starting material for the production of fibres is below 500 g/10 min, such as below 25 g/10 min. The melts used to produce the polyolefin-based fibres may also contain various conventional fibre additives, such as calcium stearate, antioxidants, process stabilizers, and pigments, including whiteners and colourants such as TiO_2, etc.

[0034] As indicated above, the present invention is directed towards both fibres, e.g. staple fibres to be used in carded webs, and continuous filaments such as spunbonded filaments. With respect to staple fibres, these may be either monocomponent or bicomponent fibres, the latter being for example sheath-and-core type bicomponent fibres with the core being located either eccentrically (off-center) or concentrically (substantially in the center). Bicomponent fibres will typically have a core and sheath which comprise, respectively, polypropylene/polyethylene, high density polyethylene/linear low density polyethylene, polypropylene random copolymer/polyethylene, or polypropylene/polypropylene random copolymer.

[0035] Within the context of the present invention, at least the low-melting (sheath) comprises inorganic particles.

[0036] For purposes of fibres and filaments for use in nonwovens for hygienic absorbent products, the fibres or filaments will typically have a fineness in the range of 0.5-7 dtex, such as 1-7 dtex, more typically 1.5-5 dtex, e.g. 1.7-3.3 dtex.

[0037] Spinning of fibres according to the invention may be performed by the "short spinning" process or by conventional melt spinning (also known as "long spinning"). Both of these spinning processes are well-known in the art. Conventional spinning is a two-step process, the first step being the extrusion of the melts and the actual spinning of the filaments, which takes place at a very high speed, and the second step being the stretching of the spun filaments and subsequent crimping, drying and cutting to form staple fibres. Short spinning is a one-step process in which the fibres are both spun and stretched in a single operation. These spinning processes are described e.g. in Ahmed, "Polypropylene Fibers - Science and Technology", 1982. Long spinning processes for the production of polyolefin-based fibres adapted for use in nonwovens for hygiene absorbent products are described e.g. in WO 89/10989, WO 93/01334, WO 94/20664, WO 95/19465 and in WO 96/33303. Spunbonding processes are, e.g., described in "Spunbond Technology Today 2 - Onstream in the 90's", Miller Freeman, 1992. During the spinning process, the filaments may be treated with appropriate surfactants, antistatic agents, etc.

[0038] As apparent from the discussion above, the present invention also relates to a nonwoven fabric comprising the inorganic particle-containing fibres or filaments described herein.

[0039] The present invention further relates to a method for preparing a nonwoven fabric from staple fibres, the method comprising the steps of (a) forming a fibrous web comprising staple fibres according to the fibre specifications herein, and (b) bonding the fibrous web. In particular, the bonding process is preferably performed at a speed of at least 150 m/min, more preferably least 200 m/min, most preferably at least 250 m/min. The bonding is preferably performed by thermobonding, e.g. calender bonding or hot air bonding, infrared bonding or ultrasound bonding.

[0040] The present invention also relates to a method for preparing a nonwoven fabric from filaments, the method comprising the steps of (a) forming a web comprising filaments according to the filament specifications herein, and (b) bonding the fibrous web. The embodiments mentioned in the above method (staple fibres) also applies for the method where filaments are used.

[0041] As indicated above, it has been found that the novel particle-containing fibres or filaments of the invention result in a number of surprising advantages, including the ability of the fibres or filaments to form a web and be thermobonded at high speeds as compared to corresponding fibres without the inorganic particles. While not wishing to be bound by any theory, it is believed that this is due to a combination of a number of advantageous effects of the particles on the fibres or filament. One of the main advantages is believed to be an improvement of the thermodynamic properties of the fibre or filament, in particular an increased heat conductivity, which is believed to be responsible for the fact that the fibres are able to be thermobonded, e.g. calender bonded, at higher speeds, i.e. at speeds that for corresponding fibres or filaments without the inorganic particles would result in poor bonding and thus a poor quality nonwoven. Thus, it has been found that the fibres of the invention have a broad bonding window, i.e. a broader temperature range in which satisfactory bonding can take place under a given set of conditions. This is of course also of importance, in particular with higher production speeds that require more carefully controlled conditions in order to result in nonwovens with satisfactory properties in terms of strength, etc.

[0042] Another advantage observed in the fibres of the invention is a reduction of the static electricity which facilitates the carding process allowing the fibres to be carded at higher speeds. It has further been found that, at least in fibres containing talc, the currently preferred type of inorganic particle, a reduction of friction is obtained. This too facilitates the carding process and helps to make possible higher production speeds without loss of quality in the resulting nonwovens. It has in addition been found that talc-containing polyolefin fibres have a reduced hydrophobicity, which may be valuable in nonwoven fabrics which are designed to be wetted.

[0043] The overall effect of the particles is thus two-fold: first of all, improvements in the static electricity and friction properties allow staple fibres according to the invention to be carded at higher speeds without a loss in uniformity of the web, and secondly, improvements in the thermal properties allow thermobonding, e.g. calender bonding, at higher speeds without having to increase the bonding temperature. Since the nonwoven production process is dependent both upon the webformation speed, e.g. the carding speed, and the bonding speed, which in continuous production lines must be substantially identical, the result is greatly improved productivity, i.e. higher speeds of the production line without any significant loss of quality. Higher nonwoven line speeds are not the only possible advantage, however, as it is also possible by means of the present invention e.g. to obtain instead of (or perhaps in addition to) a speed increase, an advantage in terms of nonwovens with a lower base weight but without reduced strength.

[0044] Thus, for the manufacturer of nonwoven fabrics, the above-mentioned improved characteristics of the fibres according to the invention, which may include an enlarged bonding window, an improved bonding index, and reduction of static electricity and friction, lead to reduced production costs due to the modification of the production parameters outlined below:

- nonwovens with an unchanged base weight can be produced at increased production speeds, with unchanged thermobonding temperatures, while the strength of the nonwoven fabric is maintained;

- nonwovens with a reduced base weight can be produced with unchanged production speeds and thermobonding temperatures, while the strength of the nonwoven fabric is maintained;

- nonwovens can be produced by using a reduced calender pressure at unchanged production speed and thermobonding temperature, while the strength of the nonwoven is maintained;

- nonwovens with an unchanged base weight can be produced with unchanged production speeds and reduced thermobonding temperatures, while the strength of the nonwoven fabric is maintained;

[0045] In these cases, the invention thus allows nonwoven strength and quality to be maintained in spite of the cost-reducing arrangements applied.

[0046] Thus, in an embodiment of the present invention fibres comprising a polyolefin and containing 0.1-20% by

weight of inorganic particles, at least 90% by weight of the particles having a particle size of less than 10 microns, are able to be continuously formed into a web and be calender bonded at a speed of 100 m/min within a bonding window that is at least 10%, preferably at least 20%, more preferably at least 30% broader than the bonding window of a nonwoven fabric produced in the same manner with corresponding fibres without the inorganic particles, the bonding window being defined as the temperature interval in which the bonding index is not more than 15% lower than BI_{max}.

[0047] In a further embodiment of the present invention fibres comprising a polyolefin and containing 0.1-20% by weight of inorganic particles, at least 90% by weight of the particles having a particle size of less than 10 microns, are able to be continuously formed into a web and be calender bonded at a speed of 100 m/min to result in a nonwoven fabric with a base weight of 20 g/m_2 and a bonding index that is at least 10%, preferably at least 20%, more preferably at least 30% higher than the bonding index of a nonwoven fabric produced in the same manner with corresponding fibres without the inorganic particles.

[0048] In a still further embodiment of the present invention the fibres comprise a polyolefin and contain 0.1-20% by weight of inorganic particles, at least 90% by weight of the particles having a particle size of less than 10 microns, and are able to be continuously formed into a web and be calender bonded at a speed of 100 m/min to result in a nonwoven fabric with a base weight of 20 g/m_2, where the numerical value of the static electricity measured 3 cm over the nonwoven fabric roll is at least 20%, such as at least 30%, preferably at least 40%, more preferably at least 50%, in particular at least 70%, lower than that measured for a nonwoven produced in the same manner from corresponding fibres without the inorganic particles.

[0049] With respect to the polyolefin chosen for the embodiments mentioned above (bonding window, bonding index and static electricity), polypropylene or a copolymer thereof (as describe above) is preferred. Monocomponent fibres or filaments are generally preferred due to the lower production costs, however, in special cases bicomponent fibres or filaments may be used, either alone or in combination with monocomponent fibres or filaments.

[0050] In even more interesting embodiments of the present invention, the above-mentioned characteristics with respect to bonding window, bonding index and static electricity can also be obtained when using even higher bonding speeds, such as 175 m/min or 200 m/min or 250 m/min, or even 300 m/min or 350 m/min.

[0051] As described above, a reduction of the friction of the fibres or filaments may be obtained by incorporation of soft inorganic particles. Obviously, this reduces the wear on the equipment used for producing the fibres or filaments and nonwoven fabrics produced from these fibres or filaments, and the cost with respect to replacement of machine parts and consumption of energy will thereby be reduced. Thus, in an embodiment of the present invention the particle-containing fibres or filaments have a friction coefficient that is reduced by at least 10%, such as at least 20%, preferably at least 30%, more preferably at least 40%, in particular 50%, compared to corresponding fibres or filaments without the inorganic particles.

TEST METHODS

Determination of bonding index

[0052] Tensile strength is determined according to EDANA 70.2-89 in the machine direction (MD) and the cross direction (CD). A bonding index (BI), expressed in N/5 cm, is calculated at different bonding temperatures, the bonding index being defined as the square root of the product of the machine direction strength and the cross direction strength. In order to arrive at a standard bonding index for a standard nonwoven base weight of 20 g/m^2 (BI_{20} - simply BI herein), the calculated bonding index for a given sample is multiplied by 20 and divided by the actual base weight in g/m^2, thereby compensating for the fact that the strength of a nonwoven varies with the base weight. BI_{max} refers to the maximum bonding index within a range of bonding temperatures.

Determination of bonding window

[0053] The bonding indices at a number of temperatures within the temperature interval limited by the upper temperature at which the fibres or filaments sticks to the calender and the lower temperature where no bonding occurs, are measured. The maximum bonding index (BI_{max}) is then determined. The bonding window (quoted in Kelvin) is estimated as the temperature interval wherein the bonding index differs from BI_{max} by less than 15%.

Determination of particle size distribution

[0054] The particle size distribution of inorganic particles may be determined by using an automatic sedimentation particles size analyzer, such as a SediGraph 5000 Particle Size Analyzer (Micromeritics, Georgia, U.S.A.), following the recommendation of the Scandinavian Pulp, Paper and Board Testing Committee (P 115 X Fourth proposal, 1987).

Measurement of static electricity

[0055] Measurement of static electricity over the nonwoven fabric is performed after the nonwoven is collected on a roll by using an Electrostatic Meter Statiron M, Type 7204, Haug GmbH, Germany.

[0056] The invention is further described in the following examples.

EXAMPLES

Examples 1-6

[0057] All polypropylene grades used in these examples were produced by Borealis Polymers Oy, Finland.

[0058] The nonwoven fabrics were made using a dry laid nonwoven fibre line. The most important equipment used for carding and calendering were: Hergeth Card Akg-1-5-FI-dl-R2 (working width 1000 mm) and Küsters Three-bowl Calender 410.30. The calender was equipped with two bowls, cylinder diameter 400 mm, cylinder width 600 mm, maximum material width 500 mm and bonding area 21.8%. The maximum speed is 350 m/min. All the nonwovens had a base weight of about 20 g/m^2.

[0059] The amount of talc was from 0.5 to 20% by weight and 0% in the reference materials.

Example 1

[0060] Polypropylene having MFR 12 was compounded in the molten stage with 0, 5, 10, 15 and 20% talc (Finntalc M03, Finnminerals Oy, Finland). The talc had the following particle size distribution (percentages by weight):

< 10 μm: 99%
< 5 μm: 96%
< 2 μm: 74%
< 1 μm: 40%

[0061] Fibres with a fineness of 2.5 dtex were spun from the filler-containing polymer in a conventional spinning type pilot line. The fibres were texturized to a level of about 12 crimps/cm and cut to 40 mm staple fibres, which were used to produce a nonwoven fabric. The strength of the nonwovens containing up to 15% talc particles was on the same level as the reference nonwoven without talc. However, with the particle-containing fibres bonding could be achieved using a broader bonding window and it was possible to use higher bonding temperatures without the nonwoven sticking to the calender.

[0062] In this example, it was not possible to spin fibres with 20% talc particles due to blockage of the spin packs. This is believed to be related to the particle size used, and it is thus believed that with finer particles, it would be possible to spin fibres with a particle content of 20% or more.

Example 2

[0063] Polypropylene having MFR 8 was blended while molten with 0, 0.5 and 1.0% by weight of talc (Micro-Talc I. T. Extra, Norwegian Talc AS, Norway). The talc had the following particle size distribution:

< 20 μm: 100%
< 10 μm: 99%
< 5 μm: 85%
< 3 μm: 60%
< 2 μm: 43%

[0064] This rather white talc had no influence on the colour of the fibre. (The fibre spinning was slightly more difficult because of the slightly larger particle size compared to the talc used in Example 1.)

[0065] Another test was made with an additional talc grade, 1% by weight of Luzenac Prever-M8 (Luzenac, Italy), which has a smaller particle size as follows:

< 8 μm: 97.5%
< 5 μm: 85.4%
< 2 μm: 34.5%
< 1 μm: 12.8%

[0066] The results in this case were similar to those obtained using Finntalc (Example 1).

Example 3

[0067] Polypropylene having MFR 18 was compounded with 0, 0.5 and 1.0% talc (Finntalc M03, Finnminerals Oy,

Finland). It was found that the bonding window was broader with 0.5 or 1% talc compared to the reference fibres without talc.

Example 4

[0068] A masterbatch was made from polypropylene having MFR 15 and talc (Finntalc M03, Finnminerals Oy, Finland). The masterbatch contained 40% by weight talc. Fibres containing 0, 0.5, 1.0 and 1.5% by weight talc were spun as described above, and nonwoven fabrics were made from these fibres at various carding speeds from 100 to 295 m/min. It was found that at low speeds, there was no significant difference in either the maximum bonding index or the window breadth (the window breadth being defined as width of the temperature interval allowing the obtainment of a given bonding index; in the table below, the window breadth is shown for a bonding index of at least 15 and 10, respectively). At higher speeds, however, it was found that increasing amounts of talc resulted in both a higher maximum bonding index and a greater window breadth. The results are shown in the following table.

Table 1.

Results of Example 4				
Talc %	BI_{max}	Window breadth		Speed m/min
		°C, BI >15	°C, BI >10	
0	25	15	15	100
0.5	25	15	17	100
1.0	24	16	18	100
1.5	25	15	17	100
0	14	0	7	175
0.5	17	4	14	175
1.0	15	3	13	175
1.5	17	5	15	175
0	12	0	2	250
0.5	14	0	3	250
1.0	14	0	3	250
1.5	15	1	6	250
0	6	0	0	295
0.5	9	0	0	295
1.0	10	0	1	295
1.5	10	0	2	295

Example 5

[0069] Fibres were prepared from polypropylene having MFR 12 and containing no talc or 1.5% talc, spinning at 270 °C. The fibres were subsequently used to prepare nonwovens using a line speed of 30 m/min and various calender bonding temperatures. The nonwovens containing talc had a very soft feel even when high calender bonding temperatures were used. The maximum bonding index at the different bonding temperatures is given in Table 2 below, from which it may be seen that nonwovens with excellent strength can be produced from the particle-containing fibres at high bonding temperatures at which calender bonding of the fibres without the talc particles is not possible.

Table 2.

Results of Example 5		
Temp. °C	% Talc	
	0	1.5
130	0	2
133	3	8
136	7	17

Table 2. (continued)

Results of Example 5		
Temp. °C	% Talc	
	0	1.5
139	16	24
142	18	23
145	23	26
148	24	25
151	22	25
154	*)	24
156	-	23
159	-	*)

*) sticks to the calender

Example 6

[0070] Fibres were spun at 270 °C from polypropylene having MFR 12 and used to produce nonwovens at a line speed of 100 m/min and a bonding temperature of 149 °C.

[0071] For nonwovens prepared from fibres without inorganic particles, the static electricity measured 3 cm over the nonwoven roll was in the range of from -5.0 to -8.0 kV (strong variations).

[0072] For nonwovens prepared from fibres containing 1.0% by weight Finntalc M03, the static electricity was from +2.0 to +3.0 kV (small variations).

Example 7

[0073] Staple fibres were produced from different grades of polypropylene from Borealis OY according to conventional long spinning procedures using a commercially available pilot spinning and stretching equipment (Fourné, Germany). The spinning corresponds to the long spinning (conventional spinning) described herein. The results of Example 7 are shown in the enclosed Table 3.

[0074] From Table 3 it may be seen that the fibre strength characteristics are substantially preserved in the particle-containing fibres compared to the fibres without the particles.

[0075] From the DSC analysis it appears that the ΔT value is reduced for the particle-containing fibres compared to the fibres without particles. Without being bound to any theory, this might be an indication of the improved thermodynamic properties of the particle-containing fibres.

Examples 8-9

[0076] Nonwoven fabrics were produced using a Spinbau Random Card with two doffers and a Ramisch - Kleinewerfers 2 Bowl Calender, both having a width of 700 mm. The calender was equipped with a plain roll (diameter: 250 mm) and an engraved roll (diameter: 240 mm). The engravings (Type NW 99) were made by Casaretto and corresponded to a bonding area of 21.78% (60,1 points per cm^2). The speed of the process-line was 175 m/min. The results from experiments with two different raw materials ("HD 350 J" and "HE 350 J") are shown in the enclosed Tables 4 and 5.

[0077] From the illustrations it appears that the bonding index of a nonwoven is increased when using staple fibres containing talc compared to nonwovens where corresponding fibres without talc were used.

Table 3: Results of Example 7
Fibre characteristics and DSC Analysis

No.	Raw Material Grade Name	MFR g/10min	Talc %	Fibre MFR g/min	Fineness dtex	Tensile Strength CN/dtex	Elongation %
1	HD 350 J	8	0,0	38,5	2,3	1,9	315,0
2	HD 350 J	8	2,5	46,3	2,4	1,7	362,0
3	HD 350 J	8	0,0	27,3	2,2	2,0	405,0
4	HD 350 J	8	2,0	26,3	2,3	1,9	387,0
5	HD 350 J	8	2,5	31,4	2,1	1,9	370,0
6	HD 950 K	8 CR	0,0	27,9	2,2	2,5	301,0
7	HD 950 K	8 CR	1,5	30,3	2,2	2,3	284,0
8	HE 350 J	12	0,0	39,3	2,3	1,8	387,0
9	HE 350 J	12	0,5	46,2	2,3	1,8	377,0
10	HE 350 J	12	1,0	46,1	2,4	1,8	392,0
11	HE 350 J	12	1,5	42,8	2,3	1,8	396,0
12	HE 350 J	12	0,0	42,3	2,3	1,8	401,0
13	HE 350 J	12	1,5	44,0	2,2	1,7	420,0
14	HE 350 J	12	2,0	44,0	2,3	1,7	411,0
15	HE 350 J	12	2,5	40,7	2,4	1,7	409,0

DSC Analysis

	1st Heating		Cooling		2nd Heating		
No.	H J/g	T peak °C	H J/g	T peak °C	H J/g	T peak °C	Delta T °C
1	90,5	160,1	79,4	104,0	-	-	56,1
2	93,2	160,8	64,4	117,0	106,6	161,1	43,8
3	92,8	161,6	65,5	102,9	115,1	160,7	58,8
4	94,4	161,9	70,3	115,5	112,2	161,8	46,4
5	88,7	162,1	66,1	116,1	100,1	161,0	46,0
6	88,8	159,1	61,6	102,8	113,4	159,9	56,3
7	91,3	159,6	54,4	115,1	112,0	155,5	44,5
8	84,3	166,1	83,1	101,4	93,7	161,5	64,7
9	90,2	161,5	59,2	111,6	115,5	160,7	49,9
10	95,3	163,1	45,7	112,1	-	-	51,0
11	89,8	160,8	57,2	112,9	98,2	161,7	47,9
12	92,6	161,6	77,3	102,5	95,6	160,0	59,1
13	98,4	161,1	58,1	113,0	112,7	156,6	48,4
14	90,9	161,0	58,1	116,1	134,5	156,8	44,9
15	91,1	162,5	63,9	117,3	113,8	158,3	45,2

Table 4: Results of Example 8

Talc %	Fibre MFR g/min	Fine-ness dtex	Tensile Strength CN/dtex	Elonga-tion %	NW Weight g/m²	MD Tensile N/5cm	MD Elon-gation %	CD Tensile N/5cm	CD Elon-gation %	Bonding Index N/5cm	Carding Speed m/min
0,0	27,3	2,2	2,0	405	20,0	40,5	40,6	5,4	54,1	14,7	175
1,5	30,8	-	-	-	20,0	37,8	46,0	7,9	73,5	16,9	175
2,5	31,4	2,1	1,9	370	20,0	37,7	37,0	8,2	77,4	15,5	175

Table 5: Results of Example 9

Talc %	Fibre MFR g/min	Fine-ness dtex	Tensile Strength CN/dtex	Elonga-tion %	NW Weight g/m²	MD Tensile N/5cm	MD Elon-gation %	CD Tensile N/5cm	CD Elon-gation %	Bonding Index N/5cm	Carding Speed m/min
0,0	39,3	2,3	1,8	387	20,0	41,5	43,6	8,4	71,4	17,7	155
0,5	46,2	2,3	1,8	377	20,0	41,2	37,8	7,7	72,0	17,8	175
1,0	46,1	2,4	1,8	392	20,0	44,8	44,6	8,1	79,3	18,7	175
1,5	42,8	2,3	1,8	396	20,0	44,1	49,4	8,8	83,7	19,7	175

Claims

1. Fibres or filaments suitable for the production of nonwoven fabrics, the fibres or filaments consisting essentially of a polyolefin or a copolymer thereof, in amount of 0.01-20% by weight of the fibres, inorganic particles having a Mohs hardness of less than 5, at least 90% by weight of the inorganic particles having a particle size of less than 10 μm, and optionally conventional fibre additives.

2. Fibres or filaments according to claim 1 wherein the inorganic particles are selected from the group consisting of talc, kaolin, calcium carbonate, mica, wollastonite, calcium sulphate and barium sulphate.

3. Fibres or filaments according to claim 1 wherein the inorganic particles have a Mohs hardness of less than 4.0.

4. Fibres or filaments according to claim 3 wherein the inorganic particles have a Mohs hardness of less than 3.0.

5. Fibres or filaments according to claim 4 wherein the inorganic particles have a Mohs hardness of less than 2.0.

6. Fibres or filaments according to claim 1 wherein the inorganic particles comprise talc particles.

7. Fibres or filaments according to claim 1 wherein substantially all of the inorganic particles are talc particles.

8. Fibres or filaments according to any of the preceding claims which contain 0.2-10% by weight of the inorganic particles.

9. Fibres or filaments according to claim 8 which contain 0.5-5% by weight of the inorganic particles.

10. Fibres or filaments according to claim 9 which contain 1.0-2.5% by weight of the inorganic particles.

11. Fibres or filaments according to any of the preceding claims wherein the polyolefin or copolymer thereof is polypropylene or a polypropylene copolymer.

12. Fibres or filaments according to claim 11 wherein the polypropylene or copolymer thereof is a homopolymer of propylene or a copolymer containing up to 10% by weight of another α-olefin, e.g. ethylene, 1-butene, 4-methylpentene or 1-hexene.

13. Fibres or filaments according to any of the preceding claims selected from staple fibres and spunbonded filaments.

14. Fibres or filaments according to any of the preceding claims wherein at least 90% by weight of the inorganic particles have a particle size of less than 8 μm.

15. Fibres or filaments according to claim 14 wherein at least 90% by weight of the inorganic particles have a particle size of less than 6 μm.

16. Fibres or filaments according to claim 15 wherein at least 90% by weight of the inorganic particles have a particle size of less than 4 μm.

17. Fibres according to any of the preceding claims which are monocomponent fibres.

18. Fibres according to any of claims 1-16 which are bicomponent fibres with a high melting component comprising a polypropylene or copolymer thereof and a low melting component comprising a polyethylene or copolymer thereof, at least the low melting component comprising the inorganic particles.

19. Fibres or filaments according to any of the preceding claims which have a fineness in the range of 0.5-7 dtex.

20. Fibres or filaments according to claim 19 which have a fineness in the range of 1.5-5 dtex.

21. Particle-containing fibres or filaments according to any of the preceding claims, where the friction coefficient of the fibres or filaments is reduced by at least 10% compared to the corresponding fibres or filaments without the inorganic particles.

22. Particle-containing fibres or filaments according to claim 21, wherein the friction coefficient of the fibres or filaments is reduced by at least 20% compared to the corresponding fibres or filaments without the inorganic particles.

23. A nonwoven fabric comprising inorganic particle-containing fibres or filaments according to any of claims 1-22.

24. A method for preparing a nonwoven fabric, comprising forming a fibrous web comprising staple fibres according to any of claims 1-22 and bonding the fibrous web.

25. A method according to claim 24 wherein the fibrous web is carded and subsequently bonded at a speed of at least 150 m/min.

26. A method according to claim 25, wherein the speed is at least 200 m/min.

27. A method according to claim 26, wherein the speed is at least 250 m/min.

28. A method according to any of claims 24-27 wherein the fibrous web is bonded by thermobonding, e.g. calender bonding or hot air bonding, infrared bonding or ultrasound bonding.

29. A method for preparing a nonwoven fabric, comprising forming a spunbonded web comprising filaments according to any of claims 1-16 and 19-22 and bonding the web.

Patentansprüche

1. Fasern oder Fäden, die zur Herstellung von Vlieswaren geeignet sind, wobei die Fasern oder Fäden im wesentlichen aus einem Polyolefin oder einem Copolymer davon, anorganischen Teilchen mit einer Mohs-Härte von weniger als 5 in einer Menge von 0,01 bis 20 Gew.-% der Fasern, wobei mindestens 90 Gew.-% der anorganischen Teilchen eine Teilchengröße von weniger als 10 μm aufweisen, und gegebenenfalls herkömmlichen Faseradditiven bestehen.

2. Fasern oder Fäden nach Anspruch 1, wobei die anorganischen Teilchen aus Talkum, Kaolin, Calciumcarbonat, Glimmer, Wollastonit, Calciumsulfat und Bariumsulfat ausgewählt sind.

3. Fasern oder Fäden nach Anspruch 1, wobei die anorganischen Teilchen eine Mohs-Härte von weniger als 4,0 aufweisen.

4. Fasern oder Fäden nach Anspruch 3, wobei die anorganischen Teilchen eine Mohs-Härte von weniger als 3,0 aufweisen.

5. Fasern oder Fäden nach Anspruch 4, wobei die anorganischen Teilchen eine Mohs-Härte von weniger als 2,0 aufweisen.

6. Fasern oder Fäden nach Anspruch 1, wobei die anorganischen Teilchen Talkumteilchen umfassen.

7. Fasern oder Fäden nach Anspruch 1, wobei im wesentlichen alle anorganischen Teilchen Talkumteilchen sind.

8. Fasern oder Fäden nach einem der vorhergehenden Ansprüche, welche 0,2 bis 10 Gew.-% der anorganischen Teilchen enthalten.

9. Fasern oder Fäden nach Anspruch 8, welche 0,5 bis 5 Gew.-% der anorganischen Teilchen enthalten.

10. Fasern oder Fäden nach Anspruch 9, welche 1,0 bis 2,5 Gew.-% der anorganischen Teilchen enthalten.

11. Fasern oder Fäden nach einem der vorhergehenden Ansprüche, wobei das Polyolefin oder das Copolymer davon Polypropylen oder ein Polypropylen-Copolymer ist.

12. Fasern oder Fäden nach Anspruch 11, wobei das Polypropylen oder das Copolymer davon ein Homopolymer von Propylen oder ein Copolymer, das bis zu 10 Gew.-% eines anderen α-Olefins, z.B. Ethylen, 1-Buten, 4-Methyl-

penten oder 1-Hexen, enthält, ist.

13. Fasern oder Fäden nach einem der vorhergehenden Ansprüche, ausgewählt aus Stapelfasern und Spinnvliesfäden.

14. Fasern oder Fäden nach einem der vorhergehenden Ansprüche, wobei mindestens 90 Gew.-% der anorganischen Teilchen eine Teilchengröße von weniger als 8 µm aufweisen.

15. Fasern oder Fäden nach Anspruch 14, wobei mindestens 90 Gew.-% der anorganischen Teilchen eine Teilchengröße von weniger als 6 µm aufweisen.

16. Fasern oder Fäden nach Anspruch 15, wobei mindestens 90 Gew.-% der anorganischen Teilchen eine Teilchengröße von weniger als 4 µm aufweisen.

17. Fasern nach einem der vorhergehenden Ansprüche, bei welchen es sich um Einkomponentenfasern handelt.

18. Fasern nach einem der Ansprüche 1 bis 16, bei welchen es sich um Zweikomponentenfasern mit einer hochschmelzenden Komponente, die ein Polypropylen oder ein Copolymer davon umfaßt, und einer niedrigschmelzenden Komponente, die ein Polyethylen oder ein Copolymer davon umfaßt, handelt, wobei zumindest die niedrigschmelzende Komponente die anorganischen Teilchen umfaßt.

19. Fasern oder Fäden nach einem der vorhergehenden Ansprüche, welche eine Feinheit im Bereich von 0,5 bis 7 dtex aufweisen.

20. Fasern oder Fäden nach Anspruch 19, welche eine Feinheit im Bereich von 1,5 bis 5 dtex aufweisen.

21. Teilchen enthaltende Fasern oder Fäden nach einem der vorhergehenden Ansprüche, bei welchen der Reibungskoeffizient der Fasern oder Fäden verglichen mit den entsprechenden Fasern oder Fäden ohne die anorganischen Teilchen um mindestens 10% verringert ist.

22. Teilchen enthaltende Fasern oder Fäden nach Anspruch 21, bei welchen der Reibungskoeffizient der Fasern oder Fäden verglichen mit den entsprechenden Fasern oder Fäden ohne die anorganischen Teilchen um mindestens 20% verringert ist.

23. Vlies, welches anorganische Teilchen enthaltende Fasern oder Fäden nach einem der Ansprüche 1 bis 22 umfaßt.

24. Verfahren zur Herstellung eines Vlieses, umfassend das Bilden einer Fasermatte, welche Stapelfasern nach einem der Ansprüche 1 bis 22 umfaßt, und Verfestigung der Fasermatte.

25. Verfahren nach Anspruch 24, wobei die Fasermatte kardiert und anschließend mit einer Geschwindigkeit von mindestens 150 m/min verfestigt wird.

26. Verfahren nach Anspruch 25, wobei die Geschwindigkeit mindestens 200 m/min beträgt.

27. Verfahren nach Anspruch 26, wobei die Geschwindigkeit mindestens 250 m/min beträgt.

28. Verfahren nach einem der Ansprüche 24 bis 27, wobei die Fasermatte durch Thermoverfestigung, z.B. Kalanderverfestigung oder Heißluftverfestigung, Infrarotverfestigung oder Ultraschallverfestigung, verfestigt wird.

29. Verfahren zur Herstellung eines Vlieses, umfassend das Bilden einer Spinnvliesmatte, die Fäden nach einem der Ansprüche 1 bis 16 und 19 bis 22 umfaßt, und Verfestigung der Matte.

Revendications

1. Fibres ou filaments appropriés pour la production d'étoffes non tissées, les fibres ou filaments étant constitués essentiellement d'une polyoléfine ou d'un copolymère de celle-ci, de particules inorganiques présentant une dureté Mohs inférieure à 5 en une quantité de 0,01 à 20 % en poids des fibres, au moins 90 % en poids des particules

inorganiques ayant une dimension des particules inférieure à 10 μm, et facultativement d'additifs classiques pour fibres.

2. Fibres ou filaments selon la revendication 1, dans lesquels les particules inorganiques sont choisies dans le groupe constitué du talc, du kaolin, du carbonate de calcium, du mica, de la wollastonite, du sulfate de calcium et du sulfate de baryum.

3. Fibres ou filaments selon la revendication 1, dans lesquels les particules inorganiques ont une dureté Mohs inférieure à 4,0.

4. Fibres ou filaments selon la revendication 3, dans lesquels les particules inorganiques ont une dureté Mohs inférieure à 3,0.

5. Fibres ou filaments selon la revendication 4, dans lesquels les particules organiques ont une dureté Mohs inférieure à 2,0.

6. Fibres ou filaments selon la revendication 1, dans lesquels les particules inorganiques comportent des particules de talc.

7. Fibres ou filaments selon la revendication 1, dans lesquels essentiellement la totalité des particules inorganiques sont des particules de talc.

8. Fibres ou filaments selon l'une quelconque des revendications précédentes, qui renferment 0,2 à 10 % en poids de particules inorganiques.

9. Fibres ou filaments selon la revendication 8, qui renferment de 0,5 à 5 % en poids de particules inorganiques.

10. Fibres ou filaments selon la revendication 9, qui renferment de 1,0 à 2,5 % en poids de particules inorganiques.

11. Fibres ou filaments selon l'une quelconque des revendications précédentes, dans lesquels la polyoléfine ou le copolymère de celle-ci est du polypropylène ou un copolymère de polypropylène.

12. Fibres ou filaments selon la revendication 11, dans lesquels le polypropylène ou le copolymère de celui-ci est un homopolymère de propylène ou un copolymère renfermant jusqu'à 10% en poids d'une autre alpha-oléfine, par exemple l'éthylène, le 1-butène, le 4-méthylpentène ou le 1-hexène.

13. Fibres ou filaments selon l'une quelconque des revendications précédentes, choisis parmi les fibres discontinues et les filaments liés par filage.

14. Fibres ou filaments selon l'une quelconque des revendications précédentes, dans lesquels au moins 90 % en poids des particules inorganiques ont une dimension des particules inférieure à 8 μm.

15. Fibres ou filaments selon la revendication 14, dans lesquels au moins 90 % en poids des particules inorganiques ont une dimension des particules inférieure à 6 μm.

16. Fibres ou filaments selon la revendication 15, dans lesquels au moins 90 % en poids des particules inorganiques ont une dimension des particules d'au moins 4 μm.

17. Fibres selon l'une quelconque des revendications précédentes, qui sont des fibres de type monocomposant.

18. Fibres selon l'une quelconque des revendications 1 à 16, qui sont des fibres de type bicomposant avec un composant de point de fusion élevé, comportant un polypropylène ou un copolymère de celui-ci et un composant de faible poids de fusion, comportant un polyéthylène ou un copolymère de celui-ci, au moins le composant de faible poids moléculaire comportant les particules inorganiques.

19. Fibres ou filaments selon l'une quelconque des revendications précédentes, qui ont une finesse dans la gamme de 0,5 à 7 dtex.

20. Fibres ou filaments selon la revendication 19, qui ont une finesse dans la gamme de 1,5 à 5 dtex.

21. Particules contenant des fibres ou des filaments selon l'une quelconque des revendications précédentes, dans lesquelles le coefficient de frottement des fibres ou des filaments est réduit d'au moins 10 % par comparaison aux fibres ou filaments correspondants sans particules inorganiques.

22. Fibres ou filaments renfermant des particules, selon la revendication 21, dans lesquels le coefficient de frottement des fibres ou des filaments est réduit d'au moins 20 % par comparaison avec les fibres ou filaments correspondant sans particules inorganiques.

23. Une étoffe non tissée comportant des fibres ou filaments renfermant des particules inorganiques, selon une quelconque des revendications 1 à 22.

24. Un procédé pour préparer une étoffe non tissée, consistant à former une toile fibreuse comportant des fibres discontinues selon l'une des revendications 1 à 22, et à lier la toile fibreuse.

25. Un procédé selon la revendication 24, dans lequel la toile fibreuse est cardée et liée par la suite à une vitesse d'au moins 150 m/mn.

26. Un procédé selon la revendication 25, dans lequel la vitesse est d'au moins 200 m/mn.

27. Un procédé selon la revendication 26, dans lequel la vitesse est d'au moins 250 m/mn.

28. Un procédé selon l'une quelconque des revendications 24 à 27, dans lequel la toile fibreuse est liée par thermoliaison, c'est-à-dire une liaison par calendrage ou une liaison à l'air chaud, une liaison par radiation infrarouge ou une liaison par ultrasons.

29. Un procédé pour préparer une étoffe non tissée, consistant à former une toile liée par filage comportant des filaments selon l'une quelconque des revendications 1 à 16 et 19 à 22 et à lier la toile.