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(57)   **ABSTRACT**

A bi-component fiber (1), in particular for the production of spunbond fabrics (4), with a first component (2) and a second component (3), whereby the first component (2) has a first polymer as an integral part and the second component has a second polymer as an integral part. The polymer of one of the two components (2, 3) has been polymerized with a metallocene catalyst and the polymer of the other component (2, 3) has been polymerized with a Ziegler-Natta catalyst and subjected to a subsequent visbreaking treatment.
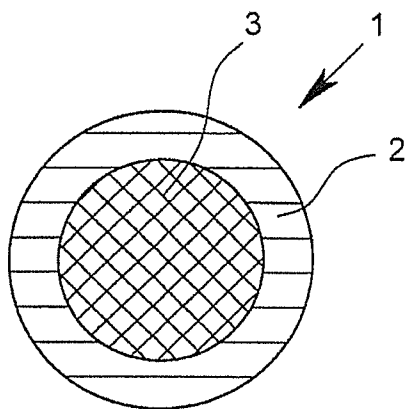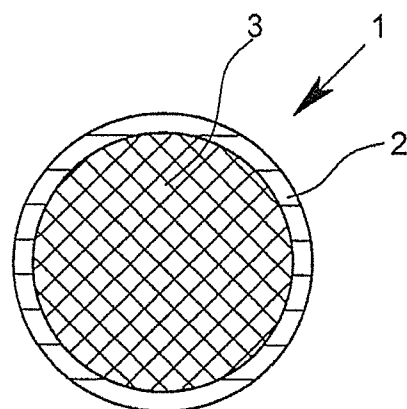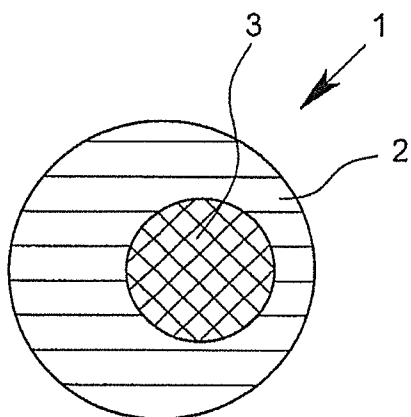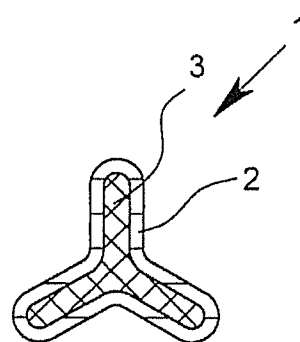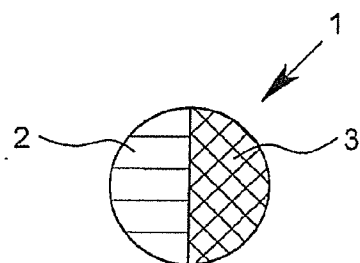
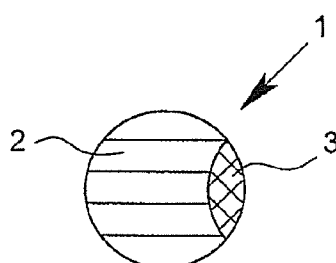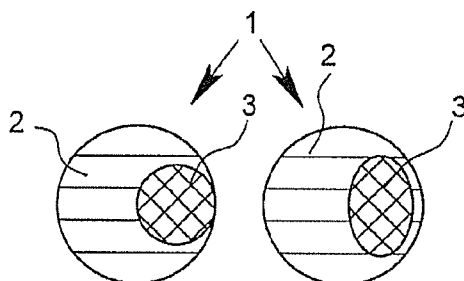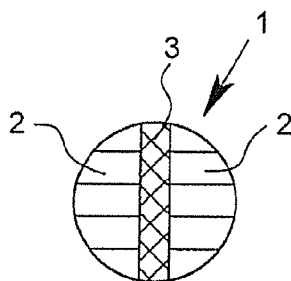3   1

2

Fig. 1

3   1

2

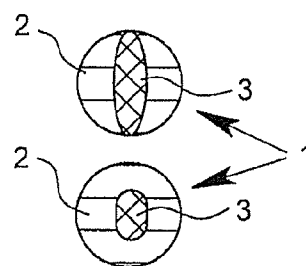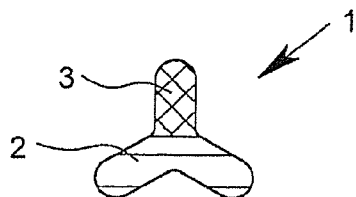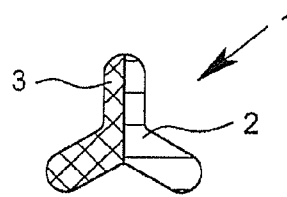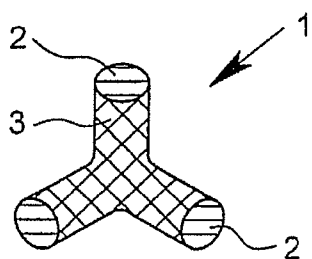# Fig. 2

3   1

2

Fig. 3

1

3

2
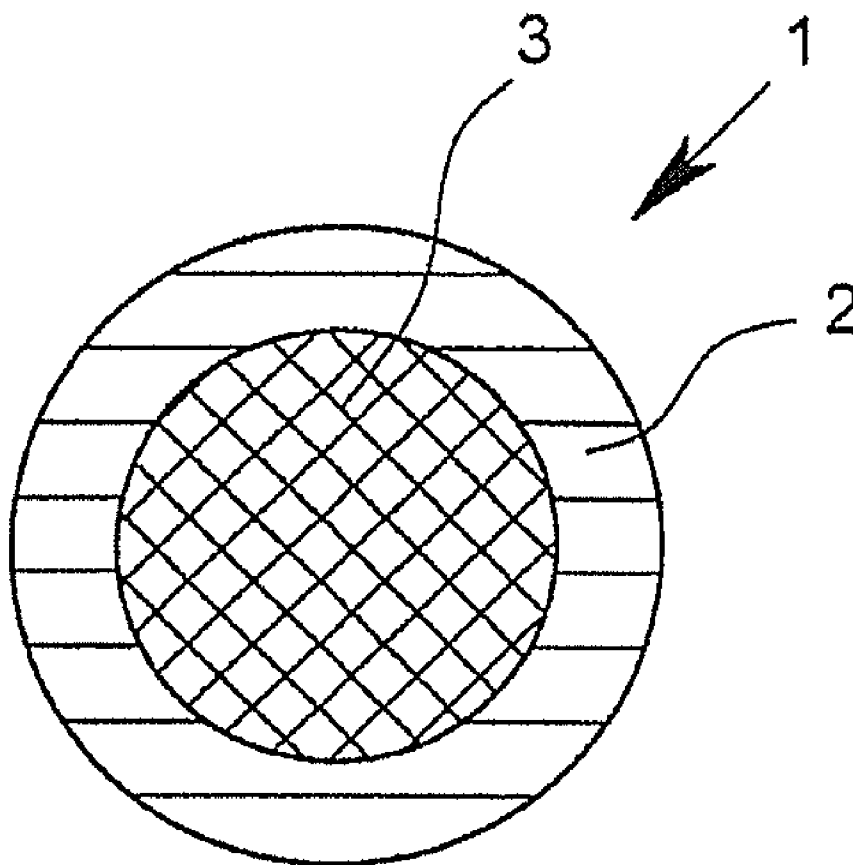
Fig. 4

Fig. 5

Fig. 6

Fig. 7

Fig. 8

Fig. 9

Fig. 10

Fig. 11

Fig. 12
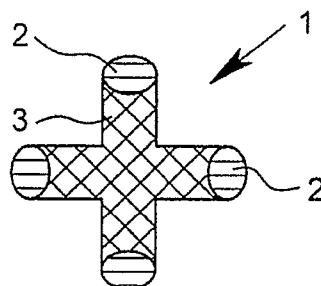
Fig. 13

Fig. 14

Fig. 15

Fig. 16

Fig. 17
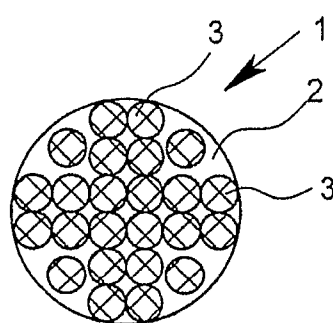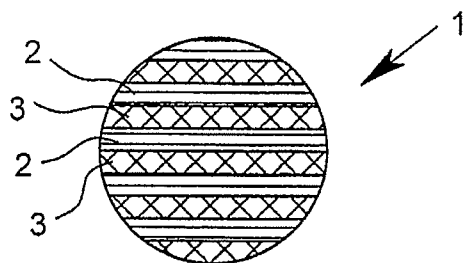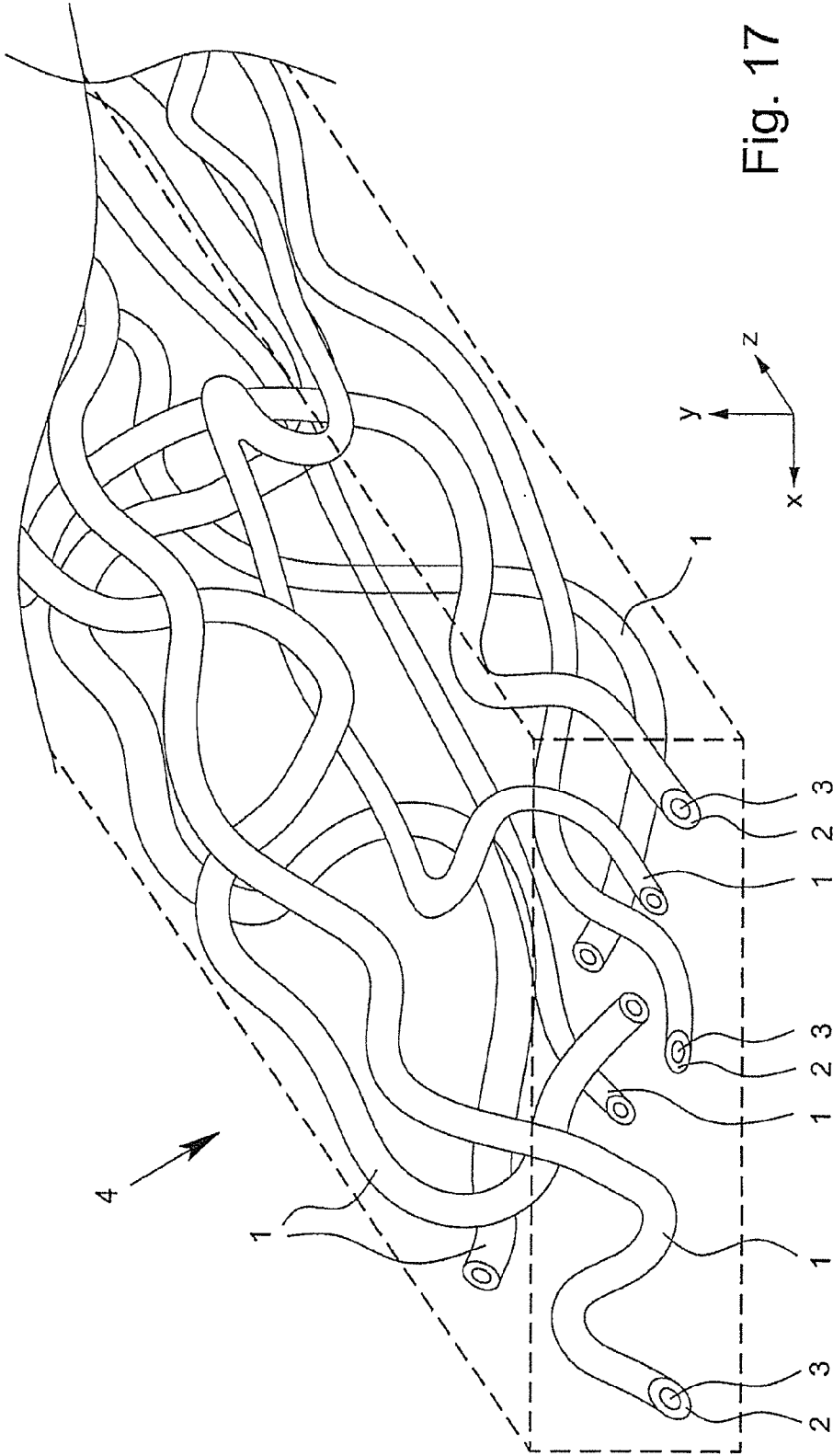
BI-COMPONENT FIBER FOR THE PRODUCTION OF SPUNBONDED FABRIC

BACKGROUND OF THE INVENTION

[0001]   1. Field of the Invention

[0002]   The invention relates to a bi-component fiber, in particular for the production of spunbond fabric, with a first component and a second component, whereby as integral parts, the first component has a first polymer and the second component has a second polymer. In addition, the invention relates to a spunbond fabric with at least one bi-component fiber of the above-mentioned type.

[0003]   2. Description of Related Art

[0004]   Bi-component fibers of the type in question usually have a first component that consists of a first polymer and a second component that consists of a second polymer. In this case, different types of bi-component fibers can be distinguished, which in each case have different characteristic distributions of the components in the fiber cross-section. Bi-component fibers, in which the first component surrounds and thus encompasses the second component in the cross-section of the fiber, are referred to as core-sheath fibers. Bi-component fibers, in which both the first component and the second component form a portion of the fiber surface in the cross-section of the fiber, are referred to as side-by-side fibers. Fibers with structures, in which several strands of a component are embedded in a strand of the other component, so that an image is produced in the cross-section that resembles a large number of islands formed from a component, are referred to as island-in-the-sea fibers. Bi-component fibers, in which in the cross-section, in each case, a large number of areas of the respective components are present and form the outer fiber surface, are referred to as segmented-pie fibers, since the areas of the individual components in the cross-section routinely have a pie-wedge-like division. Defined as bi-component fibers in terms of this application are in this case also expressly those fibers that have more than 2 components.

[0005]   The purpose of the bi-component fibers is to improve the properties of the fibers or the properties of the spunbond fabric produced from the fibers. The properties of a spunbond fabric in this case depend on a host of factors. Some of these factors in the properties of a spunbond fabric are in this case properties of the fibers that are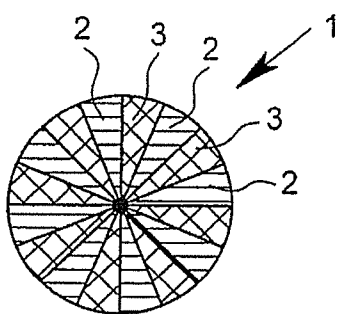 used in each case, such as, e.g., their strength. It is a theory that is widely available and acknowledged at least in its basic idea that the properties of the resulting bi-component fiber then represent a combination of the properties of the individual components of the bi-component fiber, in which the properties of the individual components complement each other to the greatest extent possible so that the advantages of the properties of the two components are combined in the bi-component fiber. If, for example, a fiber is desired that both has high strength and shows advantageous behavior when interconnecting the fibers among themselves in the production of non-woven fabric, it is thus reasonable to combine a first component with high strength with a second component that has good connectivity.

[0006]   In practice, however, the use of these synergistic effects is limited to the extent that the properties of the components cannot routinely be combined in the described, only advantageous way. Rather, in practice, it is often thus that only a more advantageous compromise can be achieved by the bi-component fibers from the properties of the pure com-

ponents. In this case, in particular from an improvement of the connectivity of the bi-component fibers relative to mono-component fibers, the result is that a non-woven fabric with improved properties, in particular with improved strength values, can be produced from the fibers.

SUMMARY OF THE INVENTION

[0007]   The object of the invention is now to provide a bi-component fiber, in particular for the production of a spunbond fabric, as well as a spunbond fabric with at least one bi-component fiber with improved properties, in particular with improved mechanical properties.

[0008]   The above-mentioned object is essentially achieved according to the invention by a bi-component fiber and a spunbond fabric with the features described herein.

[0009]   According to the invention, the polymer of one of the two components has been polymerized with a metallocene catalyst, and the polymer of the other component has been polymerized with a Ziegler-Natta catalyst and subjected to a subsequent visbreaking treatment. In this case, the polymer is preferably a polyolefin, in particular, polypropylene, polyethylene or their copolymers or a mixture thereof. The other polymer is preferably also polyolefin or a polyolefin-copolymer. In this case, it is especially advantageous when both polymers are composed of the same monomer or are at least predominantly composed of the same monomer.

[0010]   In connection with the selection, according to the invention, of the polymers polymerized with the two different types of catalysts, it has been shown, surprisingly enough, that in the case of bi-component fibers, in which the two components are selected based on the catalysts in the way according to the invention, an improvement of the synergistic effects between the properties of the two components can be achieved. This relates in particular to mechanical properties. For example, it is possible, in the case of a spunbond fabric produced from bi-component fibers according to the invention, to increase both the specific tearing force (or tensile strength) and the specific nail tear resistance (or nail-tear-out strength). In the case of conventional fibers according to the state of the art, measures in the production of spunbond fabrics from these fibers, which were used to increase the specific tearing forces, routinely accompanied a dropping of the specific nail tear resistance. In the reverse case, measures for increasing the specific nail tear resistances routinely resulted in dropping the specific tearing forces. These disadvantageous effects can be avoided with the advantageous bi-component fibers according to the invention or at least lessened.

[0011]   Advantageously, in this case, the component whose polymer has been polymerized with a metallocene catalyst forms the outer surface of the bi-component fiber in the cross-section of the fiber. The component whose polymer has been polymerized with a metallocene catalyst especially preferably surrounds—in particular completely—the component whose polymer has been polymerized with a Ziegler-Natta catalyst.

[0012]   Metallocene catalysts are structurally uniform catalysts, which contain transition metals coordinated by cyclopentadiene ligands. Such catalysts are described in detail in U.S. Pat. No. 5,374,696 and U.S. Pat. No. 5,064,802. Reference is made expressly to their disclosures which are hereby incorporated by reference. The advantage of these catalysts is that the polymers that are produced with these catalysts have a narrow molecular weight distribution. The narrow molecu-

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lar weight distribution results in non-woven fabrics with high elongation at break. In this case, the elongation at break is the expansion of fibers that occurs at the peak tearing force, which is applied when tearing a strip of non-woven fabric. Primarily, however, a narrow molecular weight distribution results in an increase in the process safety in the production of spunbond fabric. The frequency of spinning disruptions, such as, for example, fiber fracture, is reduced. In addition, a higher stretching of the fibers is possible, higher spinning speeds can be reached, and the yarn counts that can be achieved are lower. In this case, lower yarn counts mean a higher fineness of fibers and/or of the yarns obtained from the fibers.

[0013] Another advantage of the metallocene catalysts or the polymers produced by means of metallocene catalysts is that the residual content of the catalyst in the polymer is very low. The residual content of the catalyst in the polymer represents a contamination of the polymer and can result in the properties of the polymer being changed in an undesirable way. Thus, for example, staining can occur during the processing of the polymer.

[0014] One drawback of the metallocene catalysts is their slightly higher price in comparison to the Ziegler-Natta catalysts. In addition, thermal solidification of the fibers in the production of non-woven fabric can be impeded when metallocene catalysts are used. This may be the case if the possibility opened up by the use of metallocene catalysts to increase the crystallinity and the strength of the individual fibers by their higher level of stretchability is used to a large extent.

[0015] Ziegler-Natta catalysts are heterogeneous mixed catalysts, which contain organometallic compounds of main group elements and transition metal compounds. As main group elements, in particular elements of the first to third main groups are used. The transition metal compounds contain in particular metals of the titanium group. A host of variants of these catalysts exist. In terms of this invention, the Ziegler-Natta catalysts are essentially defined by their distinction compared to the metallocene catalysts.

[0016] The Ziegler-Natta catalysts are more economical than the metallocene catalysts, however, polymers produced with the Ziegler-Natta catalysts have a considerably broader molecular weight distribution than polymers produced with metallocene catalysts. To improve the stretchability of the fibers, which serves in particular to increase the safety of the process, the polymers produced with Ziegler-Natta catalysts are therefore usually after-treated. This after-treatment is referred to as "visbreaking." In the visbreaking treatment, polymer chains are cleaved, by which the molecular weight of the individual molecules is reduced, and the number of molecules is increased. In this case, the width of the molecular weight distribution is also reduced. The cleavage of the polymer chains is brought about by heat, irradiation, the addition of peroxide, or by similar measures. Examples of such visbreaking treatments are described in, i.a., U.S. Pat. No. 4,282, 076 and U.S. Pat. No. 5,723,217.

[0017] By such a visbreaking treatment, however, neither the narrow molecular weight distribution of the polymers produced with metallocene catalysts nor the good stretchability of the fibers obtained from these polymers can be achieved. Also, polymers that have been produced with Ziegler-Natta catalysts have a higher content of contaminants than polymers that have been produced with metallocene catalysts. On the one hand, this depends on a comparatively higher catalyst content being required in the production of the

polymer with a Ziegler-Natta catalyst, which content produces a comparatively higher proportion of catalyst residues in the polymer, and, on the other hand, this depends on adjuvants, which are added within the scope of visbreaking treatment, by which they represent an additional source for contaminations of the finished polymer.

[0018] The advantage of polymers that are produced with use of Ziegler-Natta catalysts with a subsequent visbreaking treatment is primarily their favorable price and their high level of availability on the market. Another advantage is the good thermal connectivity of the fibers produced from these polymers.

[0019] It has now been shown, surprisingly enough, that the advantageous selection of the polymers based on the catalysts that were used in their production has the effect that a combination of the advantages of the use of the respective catalyst types makes possible the resulting bi-component fibers. Thus, it is possible to drop the costs relative to the use of pure polymer fibers produced by means of metallocene catalysts, but in this case at the same time to implement the advantages of the use of metallocene catalysts. In addition, in this case, a better connectivity of the fibers in comparison to bi-components made from polymers that were produced exclusively by using metallocene catalysts can be achieved.

[0020] Preferably, the proportion by weight of the components, whose polymer has been polymerized with a metallocene catalyst, is at most 50% in the bi-component fiber, more preferably at most 25%, even more preferably at most 10%, and in particular at most 5%. In this case, the bi-component fiber especially preferably is a core-sheath fiber, whereby the component whose polymer has been polymerized with a metallocene catalyst forms the sheath.

[0021] Advantageously, the difference between the melting points of the first component and the second component is less than or equal to 8° C. It should be pointed out that any individual intervals or individual values are contained in the indicated intervals and are to be considered disclosed as essential to the invention, even if they are not mentioned in detail.

[0022] In connection with the advantageous selection of the melting points, it has been shown, surprisingly enough, that in the case of bi-component fibers, in which the two components have similar melting points, an improvement in the synergistic effects between the properties of the two components can be achieved. This relates in particular to mechanical properties. For example, in the case of a spunbond fabric that is produced from bi-component fibers according to the invention, it is possible to increase both the specific tearing force (or tensile strength) and the specific nail tear resistance (or nail-tear-out strength).

[0023] The positive effects of this invention also include the fact that the proportion of recycled materials, which can be added to one of the components in the production of the bi-component fiber, increases relative to conventional fibers. It has been shown that when components with combined melting points according to the invention are used, the change in the properties of a component, which is caused by the addition of recycled material, turns out to be far less than in conventional fibers.

[0024] In this case, the component with the lower melting point in the cross-section of the fiber preferably forms the outer surface of the fiber. The component with the lower melting point preferably surrounds the component with the higher melting point. The effect of this advantageous configu-

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ration is that the low-melting component in the sheath area of the fibers ensures better solidification of the material, and, moreover, improves the spinning stability and the expandability of the fibers. This results in an improvement in the softness and/or surface feel of the spunbond fabric; in addition, the drapability of the fibers or of a spunbond fabric obtained from the fibers is improved.

[0025] In connection with the invention, it is advantageous when the difference between the melting points of the first component and the second component is at most 6° C. or between 1° C. to 8° C., and preferably between 1° C. to 6° C. Within these advantageous parameter ranges, the positive effects of this invention come significantly strongly to the fore.

[0026] Preferably, the proportion by weight of the component with the lower melting point in the bi-component fiber is at most 50%, more preferably at most 25%, even more preferably at most 10%, and in particular at most 5%. In this case, the bi-component fiber is especially preferably a core-sheath fiber, whereby the component with the lower melting point forms the sheath.

[0027] Advantageously, the difference between the melt-flow indices of the first component and the second component is less than or equal to 25 g/10 minutes, whereby the melt-flow indices (MFI below) of the first component and the second component in each case are less than or equal to 50 g/10 minutes. Preferably, the difference between the melt-flow indices of the first component and the second component is less than or equal to 20 g/10 minutes, especially preferably 15 g/10 minutes, and/or the MFIs of the first component and the second component are in each case less than or equal to 40 g/10 minutes. Such an advantageous selection of the components according to the criterion of their MFIs has a positive effect, surprisingly enough, in a similar way to the selection according to the invention of the components based on their melting points.

[0028] In this case, the MFI is measured according to ISO 1133 with a test load of 2.16 kg and a test temperature of 230° C. The MFI in this case is also referred to as a melt-flow index or else as a melt-mass-flow rate (MFR). The determination is made according to ISO 1133 by the material being melted in a heating cylinder and being pressed by means of the test load through a defined die. The MFI is a measurement of the viscosity of the melts of the respective polymer-containing components. The viscosity in turn is associated with the degree of polymerization, which corresponds to the mean number of monomer units in each molecule of a polymer.

[0029] The positive influence of the advantageous differences between the MFIs essentially relates to the specific tearing force and the specific nail tear resistance. These two characteristic values of a spunbond fabric produced from the fibers can be improved by the advantageously selected MFIs. In this case, even a simultaneous increase of the two characteristic values is possible, but in any case, one of the two characteristic values can be improved without the other characteristic value deteriorating. This also has a positive effect on the haptic properties. Thus, the specific tearing force can be increased without softness and the so-called "textile grip" being negatively influenced. In this case, textile grip is defined as a pleasant feeling upon contact.

[0030] Preferably, the proportion by weight of the component with the higher MFI in the bi-component fiber is at most 50%, more preferably at most 25%, even more preferably at most 10%, and in particular at most 5%. In this case, the

bi-component fiber is especially preferably a core-sheath fiber, whereby the component with the higher MFI forms the sheath.

[0031] Preferably, the first component has an additive for influencing or improving properties.

[0032] Preferably, the proportion by weight of the additive of the first component in the second component is at most 66.6%, more preferably at most 50%, and in particular at most 33.3% of the proportion by weight of the additive in the first component. It is also possible that the additive is present only in the first component.

[0033] The advantage of the concentration of the additives in the first component lies in the fact that it has been shown that the amount of the required additive in the second component can be less than in the usual equal distribution of the additive in the two components, when the same or an improved action of the additive is to be produced.

[0034] Additives in this sense are defined as admixtures that are added to the polymer in the respective component in order to modify and thus to improve the properties of the resulting fiber or of the spunbond fabric obtained from the fiber.

[0035] Advantageously, the first component and the second component in the fiber are arranged in such a way that in the cross-section of the fiber, the first component surrounds the second component.

[0036] Preferably, the proportion by weight of the first component in the bi-component fiber is at most 50%, more preferably at most 25%, even more preferably at most 10%, and in particular at most 5%. In this case, the bi-component fiber is especially preferably a core-sheath fiber, whereby the first component forms the sheath.

[0037] The additives that are added at low concentrations to the polymers in principle represent a contamination of the polymer with respect to the fiber production. In the case of contaminations, in principle there is always the risk that because of these contaminations, the behavior of the components in the production of fibers changes. Therefore, an unequal distribution of the additives in the components of the bi-component fiber first involves the risk, from the standpoint of one skilled in the art, that the quality of the bi-component fiber or the stability of the production process deteriorates. Moreover, from the standpoint of one skilled in the art, the point is not usually that an additive is concentrated in a specific zone of the fiber. This is due to the small thickness of the fibers in question. As is the case with dyes or pigments, even in additives, it likewise makes no obvious sense from the standpoint of one skilled in the art to concentrate the latter in a specific zone of the fiber. Thus, for example, in the case of a flame retardant, in any case the entire fiber is to be affected by the combustion processes. Also, UV irradiation will penetrate the entire fiber. Surprisingly enough, it has nevertheless been shown that in some cases, even especially advantageous results can be achieved when the additive is not only reduced in the one component but rather is completely omitted. One advantage of the concentration of the additives in the first component is in any case the cost savings because of the smaller amount of additive required.

[0038] Advantageously, the additive is a primary or secondary antioxidant, a UV absorber, a UV stabilizer, a flame retardant, an antistatic agent, a lubricating agent, a metal deactivator, a hydrophilizing agent, a hydrophobizing agent,

an anti-fogging additive, and/or a biocide. In this case, the following families of substances and mixtures thereof are especially preferred:

[0039] Sterically inhibited phenols, aromatic secondary or tertiary amines, aminophenols, aromatic nitro or nitroso compounds as primary antioxidants.

[0040] Organic phosphites or phosphonates, thioethers, thioalcohols, thioesters, sulfides and sulfur-containing organic acids, dithiocarbamates, thiodipropionates, aminopyrazoles, metal-containing chelates, mercaptobenzimidazoles as secondary antioxidants.

[0041] Hydroxybenzophenones, cinnamates, oxalanilides, salicylates, 1,3 benzenediol-monobenzoates, benzotriazoles, triazines, benzophenones, as well as UV-absorbing pigments such as titanium dioxide or carbon black as a UV absorber.

[0042] Metal-containing complexes of organic sulfur compounds or phosphorus compounds, sterically hinderd amines (HALS) as UV stabilizers.

[0043] Metal hydroxides, borates, organic bromine- or chlorine-containing compounds, organic phosphorus compounds, antimony trioxide, melamine, melamine cyanurate, expanded graphite or other intumescence systems as flame retardants.

[0044] Quaternary ammonium salts, alkyl sulfonates, alkyl sulfates, alkyl phosphates, dithiocarbamates, alkaline(-earth) metal carboxylates, polyethylene glycols, as well as their esters and ethers, fatty acid esters, ethoxylates, mono- and diglycerides, and ethanolamines as antistatic agents.

[0045] Fatty alcohols, esters of fatty alcohols, fatty acids, fatty acid esters, dicarboxylic acid esters, fatty acid amides, metal salts of fatty acids, polyolefin waxes, natural or synthetic paraffins, and their derivatives, fluoropolymers and fluoroligomers, anti-blocking agents such as silicic acids, silicones, silicates, calcium carbonate, etc., as lubricating agents.

[0046] Amides of mono- and dicarboxylic acids, and their derivatives, cyclic amides, hydrazones, and bishydrazones, hydrazides, hydrazines, melamine and its derivatives, benzotriazoles, aminotriazoles, sterically inhibited phenols in connection with complexing metal compounds, benzyl phosphonates, pyridithiols, thiobisphenol esters as metal deactivators.

[0047] Polyglycols, ethoxylates, fluoropolymers and fluoroligomers, montan waxes, in particular stearates, as hydrophilizing, hydrophobizing, or anti-fogging agents.

[0048] 10,10'-Oxybisphenoxarsine (OBPA), N-(trihalomethylthiol)phthalimide, tributyltin oxide, zinc dimethyl dithiocarbamate, diphenylantimony-2-ethyl hexanoate, copper-8-hydroxyquinoline, isothiazolone, silver and silver salts as biocides.

[0049] For example, when executing a burning test according to EN 13501-1, it can be noted that in the above-mentioned distribution of the additive in the components, a smaller amount of the additive overall, in this example a flame retardant, is sufficient to provide a positive test result than when the flame retardant is uniformly distributed in the fiber. In this test, within fractions of a second, the entire fiber is enveloped by the flame, so the advantageous effect cannot readily be attributed to a kind of shielding action of the sheath area of the fiber.

[0050] Advantageously, the first polymer and/or the second polymer is/are a polyolefin or a polyolefin-copolymer, preferably a polymer and/or copolymer of ethylene, propylene, butylene, hexene or octene, and/or a mixture and/or a blend thereof It has been shown that these polymers are especially well suited to produce therefrom the bi-component fibers according to the invention. In this connection, a copolymer is defined as a polymer that was produced from at least two different types of monomers, whereby the proportion by weight of the monomer, which is decisive for the naming of the copolymer, is at least 50%.

[0051] Preferably, the bi-component fiber is a core-sheath fiber, whereby the proportion by weight of the core is 50% to 98%, preferably 60% to 95%, especially preferably 70% to 95%, and quite especially preferably 80% to 90%. It has been shown that the advantages of the bi-component fiber according to the invention, when the latter is a core-sheath fiber, occur particularly in the case of these advantageous proportions by weight of the core.

[0052] If the bi-component fiber is a side-by-side fiber, segmented-pie fiber or islands-in-the-sea fiber, the mass ratio of the two components lies in the range of 10:90 up to 90:10, preferably in the range of 70:30 up to 30:70, and especially preferably in the range of 60:40 up to 40:60. In the case of these fiber types, it has been shown that the advantages of the bi-component fibers according to the invention can be achieved especially readily for the cited component ratios.

[0053] In the case of another preferred embodiment, the bi-component fiber is a multilobal fiber, in particular a tetralobal or trilobal fiber. As a function of their cross-sectional geometry, these fibers offer a higher specific surface area than comparable fibers with circular cross-sections. In connection with the latter, the advantages of the fibers according to the invention can be used especially efficiently, in particular when the different properties of the components, which are to be optimized by the bi-component fibers according to the invention, are properties that relate to the surface area of the fibers.

[0054] Advantageously, the diameter of the bi-component fiber is between 1 μm and 50 μm, preferably between 5 μm and 30 μm, and especially preferably between 8 μm and 20 μm. It has been shown that especially in the case of fiber diameters that lie in these advantageous ranges, the combination of two components in a bi-component fiber results particularly in synergistic effects.

[0055] In addition, the invention relates to a spunbond fabric with bi-component fibers according to the invention. Two properties that play a special role in spunbond fabrics are the specific tearing force of the spunbond fabric as well as the specific nail tear resistance of the spunbond fabric. In this case, a desirable high specific tearing force is achieved by fibers with high strength.

[0056] In this sense, good connectivity is defined as the movability of the fibers in the spunbond fabric being able to be set defined as much as possible in the connecting of the fibers during the production of a spunbond fabric. The targeted setting of the movability of fibers in the non-woven fabric, which depends on the strength of the connecting of the fibers among themselves, is the requirement for the production of a spunbond fabric with high specific tensile strength and at the same time high specific nail tear resistance.

[0057] In practice, the problem may exist that suitable fibers with high strength have a poor connectivity and fibers with a good connectivity have only a low level of strength. Therefore, especially in the case of the production of a spunbond fabric, which is to have both a high specific tearing force and a high specific nail tear resistance, the use of a bi-com-

ponent fiber is useful. In this case, the bi-component fibers according to the invention are particularly suitable to make possible a high specific tearing force and a high specific nail tear resistance of a spunbond fabric, since especially the bi-component fibers according to the invention can be optimized with respect to a combination of good connectivity and high strength.

[0058] Such a non-woven fabric produced from the fibers according to the invention is suitable for numerous applications, for example in medicine, in the field of hygiene, in the automobile industry, in the field of clothing, in home and industrial textiles, as well as in particular in the construction industry and in agriculture. In addition, possible applications comprise the use in filters and membranes, battery separators and as support non-woven fabrics for laminates and as carriers for coatings of all types.

[0059] Advantageously, the weight per unit of area of the spunbond fabric is between 1 g/m^2 and 300 g/m^2, preferably between 5 g/m^2 and 200 g/m^2, and especially preferably between 8 g/m^2 and 200 g/m^2. It has been shown that in the case of weights per unit of area, which lie in these advantageous ranges, the use of a bi-component fiber with high strength and at the same time good connectivity according to the invention particularly results in a combination that consists of high specific tearing force and at the same time high specific nail tear resistance of the non-woven fabric produced from these fibers.

[0060] Advantageously, the specific tearing force of the spunbond fabric is at least 1.8 N/g·5 cm in the machine direction and/or at least 1.3 N/g·5 cm in the transverse direction, preferably 2.0 N/g·5 cm in the machine direction and/or at least 1.5 N/g·5 cm in the transverse direction, preferably at least 2.2 N/g·5 cm in the machine direction, and/or at least 2.0 N/g·5 cm in the transverse direction, and especially preferably at least 2.4 N/g·5 cm in the machine direction, and/or at least 1.9 N/g·5 cm in the transverse direction. In this case, machine direction refers to the direction in which the spunbond fabric has been transported during its production in the machine, i.e., routinely the longitudinal direction of a spunbond fabric web. Transverse direction refers to the direction that lies at a right angle to the latter, in which the spunbond fabric expands in a flat manner, i.e., routinely the width of a spunbond fabric web. In this case, the specific tearing force is measured according to EN 12311-1.

[0061] It has been shown that achieving these advantageous minimum values for the specific tearing force of the spunbond fabric should be the goal in any case when bi-component fibers according to the invention are used for the production of the spunbond fabric. The bi-component fibers according to the invention allow these advantageous minimum values to be achieved for the specific tearing force without the specific nail tear resistance dropping disproportionately thereby.

[0062] Advantageously, the specific nail tear resistance of the spunbond fabric is at least 1.0 N/g in the machine direction and/or at least 1.2 N/g in the transverse direction, preferably at least 1.4 N/g in the machine direction and/or at least 1.5 N/g in the transverse direction, preferably at least 1.6 N/g in the machine direction, and/or at least 2.16 N/g·cm in the transverse direction, and especially preferably at least 1.8 N/g in the machine direction, and/or at least 2.1 N/g in the transverse direction.

[0063] The specific nail tear resistance is in this case the maximum force that occurs when tearing a strip of non-woven fabric when the strip of non-woven fabric already has

given damage, namely a nail thrust through the non-woven fabric. The specific nail tear resistance is measured according to EN 12310-1. It has been shown that the above-mentioned minimum values for the specific nail tear resistance of the spunbond fabric can be sought without the specific tearing force of the spunbond fabric dropping disproportionately, when bi-component fibers according to the invention are optimized accordingly with respect to their connectivity and strength. In particular, in this case, it is also possible to produce a combination of the above-mentioned specific advantageous nail tear resistance and the previously-mentioned, advantageous specific minimum tearing forces.

[0064] The combination of these two advantageous minimum parameters results in a spunbond fabric, which is suitable for a host of applications with respect to its mechanical properties. Such a spunbond fabric can be readily used, for example, in the construction field, where frequently a fastening of the spunbond fabric webs by nailing, stapling, or screwing must be possible. In this case, the spunbond fabric must not tear away or tear off when it is fastened to, for example, a roof. Also, use of these advantageous spunbond fabrics as geotextiles is readily possible. Geotextiles must in any case have a high tolerance for selective damage, as can be caused by, for example, sharp stones.

[0065] In practice, a high specific nail-tear-out strength often accompanies a good surface feel. The softness and the textile grip of such spunbond fabrics therefore also open up applications, e.g., applications in the field of hygiene or medicine. The cause of the good surface feel is the high movability of individual fibers, which routinely accompanies the occurrence of high nail tear resistance. In practice, fibers that behave in this manner routinely also have haptic properties that are perceived as soft and comfortable. The fiber segment movability makes it possible for fibers to "gather" in or around the nail during the movement of the nail through the non-woven fabric by avoiding the nail as it moves through the non-woven fabric and not immediately tearing. This leads to a zone of increased fiber density, i.e., a zone of increased strength, around the nail.

[0066] It is understood that the invention is also extended to threads or objects produced therefrom, which have one or a large number of bi-component fibers of the above-mentioned type. In particular, the invention also relates to a spunbond fabric that is produced from bi-component fibers according to the invention. A spunbond fabric according to the invention is a structure, in particular a textile pattern, made from bi-component fibers according to the invention, in particular continuous fibers that have been joined in any way to form a non-woven fabric and have been connected with one another in any way.

[0067] The invention also relates to a method for the production of bi-component fibers according to the invention and a method for the production of a spunbond fabric from the bi-component fibers according to the invention.

[0068] Advantageously, in this case, the two components of the bi-component fiber are melted separately. The polymer melts thus produced form the starting material for the fibers. It is advantageous to combine the melt flows thus produced only once they are in a spinning plate. In such a spinning plate, the melt flows are extruded by spinning nozzles to form bi-component fibers. Advantageously, in this case, the spinning nozzles have a hole diameter of 0.1 mm to 10 mm, preferably a hole diameter of 0.2 mm to 5 mm, and especially preferably a hole diameter of 0.5 mm to 3 mm. Spinning

nozzles, whose hole diameter lies in the above-mentioned preferred ranges, have proven especially suitable for the production of bi-component fibers.

[0069] It is advantageous to stretch the extruded fibers mechanically after their extrusion. Preferably, in this case, the fibers are drawn off over galettes. Galettes are special rollers that are used in the production of synthetic threads and fibers and serve in the transporting and/or stretching and/or heat treatment of the fibers or threads.

[0070] Advantageously, in this case, the cooling rate of the fibers can be regulated by the temperature of the galettes. By the defined cooling rate, in particular during the stretching of the fibers, their mechanical properties can be further improved.

[0071] In a likewise advantageous way, a stretching of the fibers by an air flow guided along the fiber is also possible. Preferably, in this case, the cooling rate of the fibers is regulated by the temperature of the air flow and/or the amount of air.

[0072] For the production of a spunbond fabric, it is advantageous to swirl the fibers, which in this connection are also referred to as filaments, after they are cooled and stretched. The fibers thus acquire a random arrangement. In this case, parts of the fibers are reoriented from the machine direction into the transverse direction, so that an overall more isotropic non-woven fabric can be obtained. Then, the fibers can be placed on a filter belt.

[0073] The layer of fibers thus produced can then be preferably thermally solidified. During solidification, the individual fibers are connected to one another, by which the actual non-woven fabric is produced. The thermal solidification can in this case be carried out by flowing through with hot air or water vapor; in an especially advantageous way, it is carried out by calendering. Calendering is defined as solidification with use of hot or heated rollers. In an advantageous way, the calendering can be carried out with a smooth roller and a sculptured roller. In this case, the sculptured roller is preferably configured in such a way that a proportional pressing surface of at least 5% and at most 25%, preferably at least 8% and at most 20%, and especially preferably at least 12% and at most 20%, is produced because of the engraving of the rollers. As a result, the connecting of the fibers among themselves and thus the mobility of the fibers can be specifically influenced.

[0074] The temperature of the rollers in this case is preferably at most 70° C., preferably at most 50° C. less than the temperature of the melting point of the component with the lower melting point. A good connecting of the fibers is ensured by these minimum temperatures of the rollers. In this case, the pressing pressure of the rollers in the roll gap is advantageously 10 N/mm to 250 N/mm, preferably 25 N/mm to 200 N/mm, and especially preferably 50 N/mm to 150 N/mm. In particular, in combination with the above-mentioned advantageous temperatures, it is useful to set the pressing pressure within the above-mentioned advantageous ranges. It has been shown that the connections between the fibers that are produced when using these parameter combinations result in a spunbond fabric with good mechanical properties when the bi-component fibers according to the invention are used.

[0075] As an alternative, the solidification of the fiber layer can also be carried out mechanically. In this case, the non-woven fabric, for example, can be needled or solidified by means of water jets. Another possible advantageous alterna-

tive is the chemical solidification of the fiber layer. In this case, a binder is applied to the fiber layer, for example by impregnation or spraying. This binder is hardened, by which the fibers are connected to the spunbond fabric. The hardening of the binder can take place by, for example, tempering, photo-induced or moisture-induced cross-linking, cooling, evaporation of a solvent, or similar measures.

[0076] It is expressly pointed out that the features indicated in the above-mentioned separate paragraphs in each case can be combined in combination with the basic ideas of this invention without features from others of the above-mentioned paragraphs being absolutely necessary for implementing the invention.

[0077] In addition, it is expressly pointed out that all intervals mentioned above and listed below contain all intermediate intervals and also individual values contained therein, and these intermediate intervals and individual values can be regarded as essential to the invention even when these intermediate intervals or individual values are not actually indicated in detail.

[0078] Other features, advantages and possible applications of this invention follow from the subsequent description of embodiments based on the drawing and the drawing itself. In this case, all features that are described and/or depicted graphically form the subject of this invention by themselves or in any combination, regardless of how they are combined in the claims or how they are referenced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0079] FIG. 1 is a cross-sectional view of an embodiment of a bi-component fiber according to the invention as a core-sheath fiber,

[0080] FIG. 2 is a cross-sectional view of an embodiment of a bi-component fiber according to the invention as a core-sheath fiber with a thin sheath,

[0081] FIG. 3 is a cross-sectional view of another embodiment of a bi-component fiber according to the invention as a core-sheath fiber with an eccentrically arranged core,

[0082] FIG. 4 is a cross-sectional view of another embodiment of a trilobal bi-component fiber according to the invention as a core-sheath fiber,

[0083] FIG. 5 is a cross-sectional view of another embodiment of a bi-component fiber according to the invention as a side-by-side fiber,

[0084] FIG. 6 is a cross-sectional view of another embodiment of a bi-component fiber according to the invention as a side-by-side fiber with a small proportion of the second component,

[0085] FIG. 7 is cross-sectional views at various spots along another embodiment of a bi-component fiber as a mixed type that consists of core-sheath fibers and side-by-side fibers,

[0086] FIG. 8 is a cross-sectional view of another embodiment of a bi-component fiber according to the invention as a side-by-side fiber,

[0087] FIG. 9 shows cross-sections at various spots along another embodiment of a bi-component fiber according to the invention as a mixed type of a side-by-side fiber and a core-sheath fiber,

[0088] FIG. 10 is a cross-sectional view of another embodiment of a trilobal bi-component fiber according to the invention as a side-by-side fiber,

[0089] FIG. 11 is a cross-sectional view of another embodiment of a trilobal bi-component fiber according to the invention as a side-by-side fiber,

[0090] FIG. 12 is a cross-sectional view of another embodiment of a trilobal bi-component fiber according to the invention as a side-by-side fiber with an alternative arrangement of the components,

[0091] FIG. 13 is a cross-sectional view of another embodiment of a tetralobal bi-component fiber according to the invention as a side-by-side fiber with a component arrangement similar to the fiber depicted in FIG. 12,

[0092] FIG. 14 is a cross-sectional view of another embodiment of a bi-component fiber according to the invention as a segmented-pie fiber,

[0093] FIG. 15 is a cross-sectional view of another embodiment of a bi-component fiber according to the invention as an island-in-the-sea fiber,

[0094] FIG. 16 is a cross-sectional view of another embodiment of a bi-component fiber according to the invention with a strip-like arrangement of the components, and

[0095] FIG. 17 shows a portion of a spunbond fabric according to the invention by way of example.

DETAILED DESCRIPTION OF THE INVENTION

[0096] FIGS. 1 to 16 show cross-sectional views of bi-component fibers 1 according to the invention by way of example. The depicted bi-component fibers 1, in each case, have a first component 2 and a second component 3. In the core-sheath fibers depicted in FIGS. 1 and 4, in this case, the first component 2 surrounds the second component 3 and thus forms the outer surface of the fiber. In this case, the bi-component fibers 1 depicted in FIGS. 1 to 3 have an at least approximately circular or round geometry in cross-section. The bi-component fiber depicted in FIG. 4 shows, however, a trilobal cross-section. Such trilobal cross-sections, like other multilobal cross-sections as well, have the effect that the fiber has a larger outer surface in relation to its mass than is the case with fibers with a circular cross section. In the case of "core-sheath fibers," in which the proportion of the components forming the sheath is very small, for example approximately 2%, but certainly even in "core-sheath fibers" with a higher sheath proportion, it may occur that the sheath has defects. This means that the sheath does not completely surround the core but rather is broken at several spots, so that the core at these spots also forms the outer surface of the fiber. Also, such fibers are "core-sheath fibers." In particular, in the case of such fibers, the component that forms the broken sheath constitutes the outer surface of the fiber in terms of this invention.

[0097] FIGS. 5, 6, 8 and 10 to 13 show bi-component fibers that are embodied as side-by-side fibers. These side-by-side fibers are characterized in that both the first component 2 and the second component 3 form a portion of the outer surface of the bi-component fiber 1. Also, in the case of side-by-side fibers, circular or at least approximately circular cross-sections, as they are depicted in FIGS. 5, 6 and 8, are also possible, such as multilobal cross sections, as they are depicted in FIGS. 10 to 13. Depending on which fiber properties or nonwoven fabric properties are to be achieved, the first component 2 and the second component 3 can be combined with one another in different ratios and in different spatial arrangements. Thus, for example, as is shown in FIG. 8, a component—the second component 3 in the example that is shown—can be arranged so that it forms only a small proportion of the outer surface of the bi-component fiber 1

relative to its proportion by weight. Also, as is depicted in FIGS. 12 and 13, a component, the first component 2 in the examples shown, can be arranged at especially exposed spots of the bi-component fiber 1 in the case of a multilobal bi-component fiber 1. In FIGS. 12 and 13, the first component 2 is arranged at the tips of the multilobal cross-section of the bi-component fiber 1.

[0098] The bi-component fiber 1 that is depicted in FIG. 14 is embodied as a segmented-pie fiber. In this respect, this fiber structure exhibits a similarity to the side-by-side fiber structures to the extent that both the first component 2 and the second component 3 form a portion of the outer surface of the bi-component fiber 1. The same applies to the bi-component fiber 1 mentioned there for the structure depicted in FIG. 16, in which the first component 2 and the second component 3 alternate in cross-section in a layer structure. In contrast to the "classical" side-by-side structures, the structures shown in FIGS. 14 and 16 have in common the fact, however, that in each case they have a host of areas that are formed from the first component 2 or the second component 3.

[0099] However, the bi-component fiber 1 shown in FIG. 15 with its islands-in-the-sea structure can be regarded as a variation on a core-sheath fiber, in which a host of cores from the second component 3 are present. The individual cores from the second component 3 are surrounded by a common sheath that consists of the first component 2.

[0100] In addition, mixed forms between core-sheath fibers and side-by-side fibers are possible, as they are depicted by way of example in FIGS. 7 and 9. The bi-component fiber 1 depicted in FIG. 7 has partial cross-sections along the fibers in which the first component 2 surrounds the second component 3 similar to a core-sheath fiber and forms by itself the outer surface of the bi-component fiber 1. At other spots along the fiber, the second component 3 also forms a portion of the outer surface of the bi-component fiber 1. The first component 2 does not completely surround the second component 3 in cross-section. This also applies for the bi-component fiber 1 depicted in FIG. 9; the latter has only one other alternative geometry in comparison to the bi-component fiber 1 depicted in FIG. 7. Also, in terms of this application, such mixed forms are also referred to as core-sheath fibers as long as the first component forms more than 50% of the outer surface of the fiber.

[0101] In FIG. 17, it is shown how a host of bi-component fibers 1, by way of example, form a spunbond fabric 4. In this case, the spunbond fabric forms a web with a transverse direction X, a thickness direction Y, and a longitudinal direction Z, which is also referred to as the machine direction.

[0102] The specific tearing forces of the spunbond fabric 4 according to the following examples were measured according to the standard EN 12311-1, the specific nail tear resistance according to standard EN 12310-1. The MFIs were measured according to ISO 1133 (2.16 kg at 230° C.). The bi-component fibers 1 are core-sheath fibers in the following examples, with a sheath that comprises the first component 2 and a core that formed of the second component 3.

[0103] A spunbond fabric 4, by way of example, was produced from bi-component fibers 1, which were thermally solidified by means of a calender. The weight per unit of area of the spunbond fabric 4 that is produced is 70 g/m^2. The bi-component fibers 1 have polypropylene, which has been polymerized with a metallocene catalyst, in the sheath as a first polymer, and polypropylene, which has been polymerized with a Ziegler-Natta catalyst and subjected to a subse-

quent visbreaking treatment, in the core as a second polymer. The proportion by weight of the core in the bi-component fiber **1** is 90%. The specific tearing forces of the spunbond fabric **4** that are achieved are 2.90 N/g·5 cm in the machine direction Z and 2.25 N/g·5 cm in the transverse direction X. The specific nail tear resistances are 1.59 N/g in the machine direction Z and 1.90 N/g in the transverse direction X.

[0104] Another spunbond fabric **4**, by way of example, was produced from bi-component fibers **1**, which were also thermally solidified by means of a calender. The weight per unit of area of the spunbond fabric **4** that was produced is 70 g/m^2. The bi-component fibers **1** have polypropylene, which has been polymerized with a metallocene catalyst, in the sheath as a first polymer and polypropylene, which has been polymerized with a Ziegler-Natta catalyst and subjected to a subsequent visbreaking treatment, in the core as a second polymer. The proportion by weight of the core in the bi-component fiber **1** is 70%. The specific tearing forces of the spunbond fabric **4** that are achieved are 2.80 N/g·5 cm in the machine direction Z and 2.06 N/g·5 cm in the transverse direction X. The specific nail tear resistances are 1.52 N/g in the machine direction Z and 1.90 N/g in the transverse direction X.

[0105] Another spunbond fabric **4**, by way of example, was produced from bi-component fibers **1**, which were also thermally solidified by means of a calender. The weight per unit of area of the spunbond fabric **4** that was produced is 70 g/m^2. The bi-component fibers **1** have polypropylene, which has been polymerized with a metallocene catalyst, in the sheath as a first polymer, and polypropylene, which has been polymerized with a Ziegler-Natta catalyst and subjected to a subsequent visbreaking treatment, in the core as a second polymer. The proportion by weight of the core in the bi-component fiber **1** is 70%. The specific tearing forces of the spunbond fabric **4** that are reached are 2.28 N/g·5 cm in the machine direction Z and 1.71 N/g·5 cm in the transverse direction X. The specific nail tear resistances are 1.54 N/g in the machine direction Z and 1.85 N/g in the transverse direction X.

[0106] Another spunbond fabric **4**, by way of example, was produced from bi-component fibers **1**, which were also thermally solidified by means of a calender. The weight per unit of area of the spunbond fabric **4** that was produced is 70 g/m^2. The bi-component fibers **1** have polypropylene, which has been polymerized with a metallocene catalyst, in the sheath as a first polymer, and polypropylene, which has been polymerized with a Ziegler-Natta catalyst and subjected to a subsequent visbreaking treatment, in the core as a second polymer. The proportion by weight of the core in the bi-component fiber **1** is 85%. The specific tearing forces of the spunbond fabric **4** that are reached are 2.42 N/g·5 cm in the machine direction Z and 1.68 N/g·5 cm in the transverse direction X. The specific nail tear resistances are 1.70 N/g in the machine direction Z and 1.99 N/g in the transverse direction X.

What is claimed is:

1. Bicomponent fiber for the production of spunbond fabrics, with a first component and a second component, whereby the first component has a first polymer as an integral part and the second component has a second polymer as an integral part,

characterized in that

the polymer of one of the two components has been polymerized with a metallocene catalyst and in that the polymer of the other component has been polymerized with a Ziegler-Natta catalyst and subjected to a subsequent visbreaking treatment.

2. Bicomponent fiber according to claim **1**, characterized in that the difference between the melting points of the first component and the second component is less than or equal to 8° C.

3. Bicomponent fiber according to claim **1**, characterized in that the difference between the melting points of the first component and the second component is at most 6° C.

4. Bicomponent fiber according to claim **1**, characterized in that the difference between the melting points of the first component and the second component is between 1° C. to 8° C.

5. Bicomponent fiber according to claim **1**, characterized in that the difference between the melting points of the first component and the second component is between 1° C. to 6° C.

6. Bicomponent fiber according to claim **1**, characterized in that the component whose polymer has been polymerized with a metallocene catalyst forms an outer surface of the bicomponent fiber viewed in a cross-sectional direction of the fiber.

7. Bicomponent fiber according to claim **1**, characterized in that the component whose polymer has been polymerized with a metallocene catalyst completely surrounds the component whose polymer has been polymerized with a Ziegler-Natta catalyst.

8. Bicomponent fiber according to claim **1**, characterized in that the difference between melt-flow indices of the first component and the second component is less than or equal to 25 g/10 minutes.

9. Bicomponent fiber according to claim **1**, characterized in that the difference between melt-flow indices of the first component and the second component is less than or equal to 20 g/10 minutes.

10. Bicomponent fiber according to claim **1**, characterized in that the difference between melt-flow indices of the first component and the second component is 15 g/10 minutes.

11. Bicomponent fiber according to claim **1**, characterized in that melt-flow indices of the first component and the second component in each case are less than or equal to 50 g/10 minutes.

12. Bicomponent fiber according to claim **1**, characterized in that the melt-flow indices of the first component and the second component in each case are less than or equal to 40 g/10 minutes.

13. Bicomponent fiber according to claim **1**, characterized in that the first component has an additive, wherein the second component has a proportion by weight of the additive that is less than that in the first component.

14. Bicomponent fiber according to claim **1**, characterized in that the first component has an additive, wherein the second component has a proportion by weight of the additive that is at most 33.3% of the proportion by weight of the additive in the first component.

15. Bicomponent fiber according to claim **13**, characterized in that the additive is selected from the group of a primary antioxidant, a secondary antioxidant, a UV absorber, a UV stabilizer, a flame retardant, an antistatic agent, a lubricating agent, a metal deactivator, a hydrophilizing agent, a hydrophobizing agent, an anti-fogging additive, a biocide, and mixtures thereof

16. Bicomponent fiber according to claim **13**, characterized in that the additive is selected from the group of:

sterically inhibited phenols, aromatic secondary or tertiary amines, aminophenols, aromatic nitro compounds or

nitroso compounds, organic phosphites or phosphonates, thioethers, thioalcohols, thioesters, sulfides and sulfur-containing organic acids, dithiocarbamates, thiodipropionates, aminopyrazoles, metal-containing chelates, mercaptobenzimidazoles, hydroxybenzophenones, cinnamates, oxalanilides, salicylates, resorcinol, monobenzoates, benzotriazoles, triazines, benzophenones, titanium dioxide, carbon black, metal-containing complexes of organic sulfur compounds or phosphorus compounds, sterically hindered amines (HALS), metal hydroxides, borates, organic bromine-containing compounds or chlorine-containing compounds, organic phosphorus compounds, antimony trioxide, melamine, melamine cyanurate, expanded graphite or other intumescence systems, quaternary ammonium salts, alkyl sulfonates, alkyl sulfates, alkyl phosphates, dithiocarbamates, alkaline(-earth) metal carboxylates, polyethylene glycols, as well as their esters and ethers, ethoxylates, mono- and diglycerides, fatty alcohols, esters of fatty alcohols, fatty acids, fatty acid esters, dicarboxylic acid esters, fatty acid amides, metal salts of fatty acids, polyolefin waxes, natural or synthetic paraffins, and their derivatives, fluoropolymers and fluoroligomers, anti-blocking agents such as silicic acids, silicones, silicates, calcium carbonate, amides of monocarboxylic acids and dicarboxylic acids and their derivatives, cyclic amides, hydrazones, and bishydrazones, hydrazides, hydrazines, melamine and its derivatives, benzotriazoles, aminotriazoles, sterically inhibited phenols in connection with complexing metal compounds, benzyl phosphonates, pyridithiols, thiobisphenol esters, polyglycols, ethoxylates, fluoropolymers and fluoroligomers, montan waxes, in particular stearates, 10,10'-oxybisphenoxarsine (OBPA), N-(trihalo-methylthiol)phthalimide, tributyltin oxide, zinc dimethyl dithiocarbamate, diphenylantimony-2-ethyl hexanoate, copper-8-hydroxyquinoline, isothiazolones, silver and silver salts as biocides, and mixtures of the above-mentioned substances.

17. Bicomponent fiber according to claim **1**, characterized in that the first polymer is selected from the group of polyolefins, polyolefin-copolymers, ethylene polymers, ethylene-copolymers, propylene, butylene, hexene, octene, mixtures of the above-mentioned substances, and blends of the above-mentioned substances.

18. Bicomponent fiber according to claim **1**, characterized in that the second polymer is selected from the group of polyolefins, polyolefin-copolymers, ethylene polymers, ethylene-copolymers, propylene, butylene, hexene, octene, mixtures of the above-mentioned substances, and blends of the above-mentioned substances.

19. Bicomponent fiber according to claim **1**, characterized in that the proportion by weight of the component whose polymer has been polymerized with a metallocene catalyst is at most 50% in the bicomponent fiber.

20. Spunbond fabric with at least one bicomponent fiber with a first component and a second component, whereby the first component has a first polymer as an integral part and the second component has a second polymer as an integral part, the polymer of one of the two components having been polymerized with a metallocene catalyst and the polymer of the other component having been polymerized with a Ziegler-Natta catalyst and subjected to a subsequent visbreaking treatment.

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