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(54) Bicomponent fibers with an exterior component comprising polypropylene

(57) The present invention relates to bicomponent fibers with improved bonding properties. In particular, the present invention relates to bicomponent fibers comprising an exterior component, which in turn comprises a polypropylene that has been degraded from a first melt flow index MFI_1 (measured according to ISO 1133, condition L, 230°C, 2.16 kg) to a second melt flow index MFI_2 (measured according to ISO 1133, condition L, 230°C, 2.16 kg), such that the degradation ratio MFI_1/MFI_2 is within a well-defined range and such that the second melt flow index MFI_2 is in the range from 50 dg/min to 300 dg/min. Further, the present invention relates to nonwovens, composites and laminates comprising said bicomponent fibers. The present invention also relates to a process for making such bicomponent fibers, nonwovens, composites and laminates.

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Description

Field of the invention

[0001] The present invention relates to bicomponent fibers with improved bonding properties. In particular, the present invention relates to bicomponent fibers comprising an exterior component, which in turn comprises a polypropylene that has been degraded from a first melt flow index MFI_1 (measured according to ISO 1133, condition L, 230°C, 2.16 kg) to a second melt flow index MFI_2 (measured according to ISO 1133, condition L, 230°C, 2.16 kg), such that the degradation ratio MFI_1/MFI_2 is within a well-defined range and such that the second melt flow index MFI_2 is in the range from 50 dg/min to 300 dg/min. Further, the present invention relates to nonwovens, composites and laminates comprising said bicomponent fibers. The present invention also relates to a process for making such bicomponent fibers, nonwovens, composites and laminates.

The technical problem and the prior art

[0002] Polypropylene is one of the most widely used synthetic polymers for fibers and nonwovens because it has good mechanical and chemical properties and can be easily processed. Mostly, the production of polypropylene fibers and nonwovens is done by a melt extrusion process, wherein molten polypropylene is extruded through a number of fine capillaries to form fibers or filaments, which can then be collected to form a nonwoven.

[0003] Depending upon the final application the polypropylene fibers and nonwovens need to have certain properties. For example fibers and nonwovens used in baby diapers should at the same time be strong, and also have a soft touch and good nonwoven forming properties, such as good thermal bonding behavior.

[0004] Frequently, it is not possible to produce fibers or nonwovens having all the desired properties with a single polypropylene and one has to revert to technically more demanding solutions, such as for example bicomponent fibers. Bicomponent fibers and nonwovens are made of an exterior component and an interior component with the interior component being largely covered by the exterior component. Such an arrangement allows producing fibers and nonwovens wherein the interior component provides the mechanical strength, and the exterior component provides the thermal bonding properties and/or the soft touch etc. This is exemplified by bicomponent fibers and nonwovens having a polypropylene as interior component and a polyethylene as exterior component.

[0005] However, fibers and nonwovens comprising polyethylene have the disadvantage that they are more difficult to produce because the processability of polyethylene in fiber spinning is not as good as that of polypropylene. In addition, in view of the requirements for recycling of consumer products, it is desired to have fibers and nonwovens that are monomaterial, i.e. that are made from polypropylene only.

[0006] The industry therefore has a need for bicomponent fibers and nonwovens that are easy to produce and have good properties.

[0007] It is therefore an object of the present invention to provide bicomponent fibers and nonwovens that can be easily produced.

[0008] It is a further object of the present invention to provide bicomponent fibers and nonwovens that have an exterior component comprising polypropylene, with the exterior component having good thermal bonding properties.

[0009] It is also an object of the present invention to provide bicomponent fibers and nonwovens with improved mechanical properties.

Brief description of the invention

[0010] We have now discovered that at least one of the above objectives can be met when the bicomponent fibers and nonwovens comprise an exterior component, which in turn comprises a polypropylene having specific properties.

[0011] The present invention therefore provides a bicomponent fiber comprising

(a) an exterior component covering at least 50 % of the surface of the bicomponent fibers, and
(b) an interior component comprising a thermoplastic polymer,

wherein the exterior component comprises a polypropylene, which has been degraded chemically or thermally from a first melt flow index MFI_1 (measured according to ISO 1133, condition L, 230°C, 2.16 kg) to a second melt flow index MFI_2 (measured according to ISO 1133, condition L, 230°C, 2.16 kg), such that the second melt flow index MFI_2 is in the range from 50 dg/min to 300 dg/min and such that the degradation ratio MFI_1/MFI_2 is at least 0.10 and at most 0.80..

[0012] The present invention further provides spunbond nonwovens, composites and laminates comprising such bicomponent fibers.

[0013] In addition, the present invention provides a process for the production of bicomponent fibers comprising the steps of

(a) polymerizing propylene and one or more optional comonomers with a polymerization catalyst to produce a polypropylene having a first melt flow index MFI_1 (measured according to ISO 1133, condition L, 230°C, 2.16 kg),
(b) thermally or chemically degrading the polypropylene obtained in step (a) to a second melt flow index MFI_2 (measured according to ISO 1133, condition L, 230°C, 2.16 kg),
(c) melting a polypropylene composition comprising the polypropylene obtained in step (b) in a first extruder to form a molten polypropylene composition,
(d) melting a thermoplastic polymer composition comprising a thermoplastic polymer in a second extruder to form a molten thermoplastic polymer composition,
(e) extruding the molten thermoplastic polymer composition from a number of fine, usually circular, capillaries of a spinneret,
(f) extruding the molten polypropylene composition of step (c) from a number of fine openings surrounding said capillaries of step (e), and
(g) combining the extrudates of steps (e) and (f) to form a single filament of an intermediate diameter, such that the extrudates of step (f) form an exterior component covering at least 50 % of the surface of the so-produced filament,

wherein the polypropylene obtained in step (b) has a second melt flow index MFI_2 (measured according to ISO 1133, condition L, 230°C, 2.16 kg) in the range from 50 dg/min to 300 dg/min and wherein the degradation ratio MFI_1/MFI_2 is at least 0.10 and at most 0.80.

[0014] Further, the present invention provides a process for the production of nonwovens, composites and laminates comprising the bicomponent fibers of the present invention.

Detailed description of the invention

[0015] For the purposes of the present invention the terms "fiber" and "filament" may be used interchangeably.

[0016] The bicomponent fibers of the present invention comprise an exterior component and an interior component. The exterior component covers at least 50 % of the surface of the bicomponent fibers. More preferably it covers at least 70 %, even more preferably at least 90 %, 95 %, 97 % or 99 % and most preferably 100 % of the surface.

[0017] Bicomponent fibers are known in many different configurations, such as for example side-by-side, sheath-core, islands-in-the-sea, pie or stripe configurations. Bicomponent fibers can be formed by co-extrusion of two different components into one fiber or filament. This is done by separately feeding the components to two extruders and combining the melts (or extrudates) into a single fiber or filament. The resulting fiber or filament has two different, essentially continuous polymer phases. Such fibers, their production as well as their forming a nonwoven, are well known to the skilled person and are for example described in F. Fourné, Synthetische Fasern, Carl Hanser Verlag, 1995, chapter 5.2 or in B.C. Goswami et al., Textile Yarns, John Wiley & Sons, 1977, p. 371 - 376.

EXTERIOR COMPONENT

[0018] The exterior component of said component fiber comprises a polypropylene. Preferably, the exterior component comprises at least 50 wt%, more preferably at least 70 wt% or 90 wt%, even more preferably at least 95 wt% or 97 wt% or 99 wt% of polypropylene relative to the total weight of the exterior component; it is most preferred that the exterior layer consists of polypropylene.

[0019] The polypropylene used in the exterior component may be produced by polymerizing propylene and one or more optional comonomers as defined below in the presence of a Ziegler-Natta catalyst system. Such catalyst systems are well known to the person skilled in the art. They comprise a titanium compound having at least one titanium-halogen bond and an internal electron donor, both on a suitable support (for example on a magnesium halide in active form), an organoaluminium compound (such as an aluminium alkyl), and an optional external donor (such as a silane or a diether compound).

[0020] The polymerization of propylene and one or more optional comonomers can be carried out in a slurry, bulk or gas phase process. In a slurry process the polymerization is carried out in a diluent, such as an inert hydrocarbon. In a bulk process the polymerization is carried out in liquid propylene as reactor medium.

[0021] For the purpose of the present invention the polypropylene recovered from the polymerization reactor is degraded either by thermal or by chemical treatment. Degradation by chemical treatment is preferred ("visbreaking"). For chemical degradation the molten polypropylene is mixed with a peroxide (for example with 2,5-dimethylhexane-2,5-di-tert-butylperoxide), leading to the generation of radicals, which in turn leads to a breakdown of the polypropylene polymer chains. Thus, the melt flow of the polypropylene increases and the molecular weight distribution narrows. Visbreaking of polypropylene is generally carried out at temperatures in the range from 200°C to 250°C. It can for example be done in the extruder in the granulation step of a polypropylene manufacturing plant or in the extruder feeding a fiber or nonwoven production line.

[0022] The degree to which a polypropylene has been degraded can be described by the degradation ratio MFI_1/MFI_2, which is the ratio between a first melt flow index MFI_1 (measured according to ISO 1133, condition L, 230°C, 2.16 kg) before degradation and a second melt flow index MFI_2 (measured according to ISO 1133, condition L, 230°C, 2.16 kg) after degradation. The polypropylene used in the exterior component of the present invention has a degradation ratio MFI_1/MFI_2 of at least 0.1, preferably at least 0.12, more preferably at least 0.14, even more preferably of at least 0.16, still even more preferably of at least 0.18, and most preferably at least 0.20. The polypropylenes used in the present invention have a degradation ratio MFI_1/MFI_2 of at most 0.8, more preferably of at most 0.7, even more preferably of at most 0.6, and most preferably of at most 0.5.

[0023] The second melt flow index MFI_2 (measured according to ISO 1133, condition L, 230°C, 2.16 kg) of the polypropylenes used in the exterior component is at least 50 dg/min, preferably at least 55 dg/min, and most preferably at least 60 dg/min. The second melt flow index MFI_2 of the polypropylenes used in the present invention is at most 300 dg/min, preferably at most 200 dg/min, more preferably at most 150 dg/min and most preferably at most 100 dg/min.

INTERIOR COMPONENT

[0024] The interior component of said bicomponent fiber comprises a thermoplastic polymer that adheres to polypropylene. Preferably said thermoplastic polymer is a polypropylene. Most preferably said thermoplastic polymer is a polypropylene that is different from the polypropylene comprised in the exterior component.

[0025] Preferably, the interior component comprises at least 50 wt%, more preferably at least 70 wt% or 90 wt%, even more preferably at least 95 wt% or 97 wt% or 99 wt% of said thermoplastic polymer relative to the total weight of the interior component; it is most preferred that the interior layer consists of said thermoplastic polymer.

[0026] The polypropylene suitable for use in the interior component has a melt flow index (measured according to ISO 1133, condition L, 230°C, 2.16 kg) in the range from 5 dg/min to 500 dg/min. When used for the production of fibers the polypropylene used in the interior component preferably has a melt flow index in the range from 5 dg/min 40 dg/min. When used in the spunbonding process the polypropylene used in the interior component preferably has a melt flow index of at least 10 dg/min, more preferably of at least 15 dg/min and most preferably of at least 20 dg/min; preferably the melt flow index is at most 300 dg/min, more preferably at most 200 dg/min, even more preferably at most 100 dg/min and most preferably at most 60 dg/min.

[0027] Preferably, the polypropylene suitable for use in the interior component has a molecular weight distribution (M_w/M_n) in the range from 2.0 to 8.0, more preferably in the range from 2.0 to 5.0. Such a polypropylene can for example be produced with a metallocene catalyst or with a Ziegler-Natta catalyst. When produced with a Ziegler-Natta catalyst it is preferred that the molecular weight distribution is reduced by thermal or chemical post-reactor treatment, for example by degradation with a peroxide ("visbreaking"). Molecular weights may be determined by size exclusion chromatography (SEC) as described in the examples.

[0028] The polypropylenes used in the present invention, irrespectively of whether used in the exterior or the interior component, can either be homopolymers or random copolymers of propylene with one or more comonomers. Homopolymers are preferred.

[0029] The comonomers can be ethylene or a C_4 - C_{20} α-olefin, such as for example butene-1, pentene-1, hexene-1, octene-1 or 4-methyl-pentene-1. The preferred random copolymer is a copolymer of propylene and ethylene. The random copolymers of the present invention comprise at least 0.1 wt%, preferably at least 0.2 wt% and most preferably at least 0.5 wt% of comonomer. Preferably they comprise at most 6.0 wt%, more preferably at most 5.0 wt% and most preferably at most 4.0 wt% of comonomer.

[0030] Preferably the polypropylenes used in the present invention, irrespectively of whether used in the exterior or the interior component, are predominantly isotactic polypropylenes, meaning that they are characterized by high isotacticity, for which the content of mmmm pentads is a measure. The content of mmmm pentads is at least 95.0 % and most preferably at least 96.0 wt%.

[0031] The isotacticity is determined by NMR analysis according to the method described by G.J. Ray et al. in Macromolecules, vol. 10, n° 4, 1977, p. 773-778.

[0032] The polypropylenes used in the present invention either in the exterior or the interior component may also contain additives such as, by way of example, antioxidants, light stabilizers, acid scavengers, lubricants, antistatic additives, and colorants. An overview of suitable additives is given for example in the Plastics Additives Handbook, 5th edition, ed. Hans Zweifel, Carl Hanser Verlag, 2001.

[0033] The bicomponent fibers as described above may be comprised in nonwovens, particularly in thermally bonded nonwovens or in spunbond nonwovens. It is preferred that such nonwovens comprise at least 50 wt%, preferably at least 70 wt% or 90 wt%, more preferably at least 95 wt% and most preferably that they consist of the bicomponent fibers of the present invention.

[0034] Surprisingly, the bicomponent fibers and nonwovens in accordance with the present invention are characterized by no or at most very little improvement in softness as had been expected from the use of the higher melt flow polypropylene as exterior component.

[0035] However, equally surprisingly it has been found that the nonwovens, especially the spunbond nonwovens, of the present invention show an increase of around 10 % in tenacity. It needs to be emphasized that the tenacity increase was observed in machine as well as in cross-machine direction when compared to nonwovens comprising fibers made from the polypropylene of the interior component only.

[0036] The present inventors have also been surprised that the increase in tenacity that was observed on the nonwovens, especially the spunbond nonwovens, of the present invention was not accompanied by a decrease in elongation but on the contrary by an increase in elongational properties. Thus, the present invention allows the production of nonwovens that at the same time have improved tenacity and elongation, and this in machine as well as cross-machine direction.

[0037] Nonwovens comprising the bicomponent fibers of the present invention may be used to form a composite of nonwoven layers or a laminate with film. A composite according to the present invention comprises a spunbond nonwoven layer (S) according to the present invention and/or a melt blown nonwoven layer (M). The composite can for example be of the SS, SSS, SMS, SMMSS or any other type. A laminate according to the present invention comprises a spunbond nonwoven layer (S) according to the present invention and a film layer (F) The laminate can be of the SF, SFS or any other type. Preferably, the film is a polyolefin film. The film of said laminate may be a breathable barrier film, thus resulting in a laminate with breathable properties.

[0038] The bicomponent fibers of the present invention as well as the nonwovens, composites and laminates comprising them are produced by methods well known to the person skilled in the art.

[0039] For the production of the bicomponent fibers of the present invention a polypropylene composition comprising the polypropylene as defined above for the exterior component is molten in a first extruder. Preferably, said polypropylene composition comprises at least 50 wt%, more preferably at least 70 wt% or 90 wt%, even more preferably at least 95 wt% or 97 wt% or 99 wt% of the polypropylene as defined above for the exterior component relative to the total weight of the exterior component; it is most preferred that the exterior layer consists of the polypropylene as defined above for the exterior component.

[0040] A thermoplastic polymer composition comprising a thermoplastic polymer as defined for the interior component is molten in a second extruder. Preferably said thermoplastic polymer composition comprises at least 50 wt%, more preferably at least 70 wt% or 90 wt%, even more preferably at least 95 wt% or 97 wt% or 99 wt% of said thermoplastic polymer as defined for the interior component relative to the total weight of the exterior component; it is most preferred that the interior layer consists of said thermoplastic polymer as defined for the interior component.

[0041] The molten thermoplastic polymer composition is then extruded from a number of fine, usually circular, capillaries of a spinneret. The molten polypropylene composition is extruded from a number of fine openings surrounding said capillaries. The extrudates from capillary and corresponding fine opening (Depending upon the type or bicomponent fiber to be produced it can also mean the extrudates from one or more capillaries and one or more surrounding fine opening that are intended to form a single filament.) are then combined to form a single, usually circular, filament of an intermediate diameter, whereby the extruded polypropylene composition forms the exterior component and the extruded thermoplastic polymer composition forms the interior component. In an optional step the intermediate diameter of the filaments is rapidly reduced to a final diameter (drawing step). In the drawing step the fibers can be drawn over heated rolls or in a heated oven to further reduce the intermediate diameter to a final diameter and increase the tenacity of the fibers. If no further drawing step is performed the intermediate diameter is the final diameter. The production of bicomponent fibers is for example described in F. Fourné, Synthetische Fasern, Carl Hanser Verlag, 1995, chapter 5.2 or in B.C. Goswami et al., Textile Yarns, John Wiley & Sons, 1977, p. 371 - 376.

[0042] The nonwovens comprising the bicomponent fibers of the present invention may be produced either by thermal bonding of the bicomponent fibers of the present invention or by the spunbonding process. Preferably, the nonwovens of the present invention are produced by the spunbonding process.

[0043] Stated in general terms, the nonwovens are produced by collecting the bicomponent fibers of the present invention on a support and subsequently bonding the collected fibers to form a bonded nonwoven.

[0044] For the production of thermally bonded nonwovens the bicomponent fibers of the present invention are cut into staple fibers having a length in the range from 5 to 30 mm. Said staple fibers are then carded, i.e. collected as a more or less continuous non-consolidated web on a support. In a final step the non-consolidated web is consolidated by thermal or chemical bonding, with thermal bonding being preferred.

[0045] For the spunbonding process fiber formation can be accomplished either by using one single spinneret with a large number of holes, generally several thousand, or by using several smaller spinnerets with a correspondingly smaller number of holes per spinneret. The combined extrudates with the polypropylene composition forming the exterior component and the thermoplastic polymer composition forming the interior component are quenched by a current of cold air. The diameter of the filaments is then rapidly reduced to a final diameter by a stream of high-pressure air. Air velocities in the drawdown step can be of several thousand meters per minute. After drawdown the filaments are collected on a support, for example a wire mesh belt, thus creating a first fabric, which may then be passed through compaction rolls and finally goes through a bonding step. Bonding of the fabric may be accomplished by thermobonding, hydroentanglement, needlepunching, or chemical bonding.

[0046] In comparison to the production of the well known bicomponent fibers having a polypropylene as interior component and a polyethylene as exterior component the fibers of the present invention proved very easy to process. No problems were encountered in the production of the nonwovens, especially the spunbond nonwovens, comprising the bicomponent fibers of the present invention.

[0047] In addition the bicomponent fibers and nonwovens of the present invention proved to also have the advantage of being more easily produced that fibers and nonwovens made from a commercial polypropylene of melt flow index 25 dg/min (measured according to ISO 1133, condition L, 230°C, 2.16 kg) and of narrow molecular weight distribution. Without wishing to be bound by theory it is believed that this is due to the higher melt flow index of the polypropylene used in the exterior component of the bicomponent fibers and nonwovens of the present invention. Interestingly, the higher melt flow index of the polypropylene in the exterior component does not lead to a loss in mechanical properties of the bicomponent nonwovens of the present invention when comprised of fibers having comparable titer but rather to an increase in both, tenacity and elongational properties in both directions, machine and cross-machine direction.

[0048] One or more nonwovens in accordance with the present invention may be applied to one or more other nonwovens, which may but need not be in accordance with the present invention, to form a composite as described above. Preferably the one or more other nonwovens are thermally bonded nonwovens, spunbond nonwovens or melt blown nonwovens. Spunbond nonwovens are most preferred.

[0049] One of more nonwovens in accordance with the present invention may be laminated to a film to form a laminate. The film preferably is a polyolefin film. The film may be a breathable barrier film, thus resulting in a laminate with breathable properties.

[0050] The fibers, nonwovens, composites and laminates of the present invention may be used in hygiene articles, such as baby diapers, adult incontinence products, female hygiene products, and wipes, or in products for the construction industry or for agriculture, or for medical drapes and gowns, protective garments, lab coats etc.

Examples

TEST METHODS

[0051] The melt flow index was measured according to norm ISO 1133, condition L, using a weight of 2.16 kg and a temperature of 230°C.

[0052] Molecular weights are determined by Size Exclusion Chromatography (SEC) at high temperature (145°C). A 10 mg PP sample is dissolved at 160°C in 10ml of TCB (technical grade) for 1 hour. The analytical conditions for the Alliance GPCV 2000 from WATERS are :

- Volume : +/- 400μl
- Injector temperature : 140°C
- Column and detector: 145°C
- Column set: 2 Shodex AT-806MS and 1 Styragel HT6E
- Flow rate 1ml/min
- Detector: Refractive index
- Calibration : Narrow standards of polystyrene
- Calculation : Based on Mark-Houwink relation ($\log(M_{PP}) = \log(M_{PS}) - 0.25323$)

[0053] The isotacticity (mmmm %) is determined by NMR analysis according to the method described by G.J. Ray et al. in Macromolecules, vol. 10, n° 4, 1977, p. 773-778. It is performed on the dried product resulting of the extraction by boiling heptane of the xylene insoluble PP fraction.

[0054] Tensile strength and elongation of the nonwovens were measured according to ISO 9073-3:1989.

POLYPROPYLENES

[0055] Nonwovens were produced using a polypropylene homopolymer, denoted as PP1, and a commercial polypropylene homopolymer, denoted as PP2. An overview of their properties is given in table 1.

Table 1

		PP1	PP2
Degradation ratio MFI_1/MFI_2		0.2	0.08
Final MFI	dg/min	60	25
M_n	kDa	33	46
M_w	kDa	152	189
M_z	kDa	431	452
MWD = M_w/M_n		4.6	4.1

SPUNBOND NONWOVEN

[0056] Polypropylenes PP1 and PP2 were used to produce the following spunbond nonwovens

Example 1	- Bicomponent nonwoven with PP1 as exterior component and PP2 as interior component wherein the exterior layer comprised 30 wt% of the total weight of the fibers
Comparative example 1	- Nonwoven made from PP2

[0057] The spunbond nonwovens were produced on a 1.1 m wide Reicofil 4 line with a single beam having about 6800 holes per meter length, the holes having a diameter of 0.6 mm.. The nonwoven had a fabric weight of 12 g/m^2. The nonwoven were thermally bonded using an embossed roll. Further processing conditions are given in table 2. The bonding roll temperature reported in table 2 is the bonding temperature at which the highest values for elongation were obtained. Properties of the nonwoven obtained under these conditions are shown in table 3.

Table 2

		Ex. 1		Comp. ex. 1
Belt speed	m/min	300		300
Throughput	Kg/h/m	220		220
Extruder temperature				
- Exterior component	°C	240		250
- Interior component	°C	250		n.a.
Melt temperature at the die				
- Exterior component	°C	247		256
- Interior component	°C	249		249
Cabin pressure	Pa	8000		8000
Nip pressure	N/mm	80		80
Calender temperature (set point) for max. elongation	°C	152		155

Table 4

		Ex. 1		Comp. ex. 1
Filament titer	den	1.25		1.16

(continued)

		Ex. 1		Comp. ex. 1
Tensile strength @ max MD	N/5cm	34.0		31.5
Tensile strength @ max CD	N/5cm	18.0		17.1
Elongation MD	%	81		68
Elongation CD	%	72		71

[0058] The results clearly demonstrate the advantages of the present invention:

- Because the polypropylene of the exterior component has a higher melt flow index than the current commercial polypropylene spunbond grades (as exemplified by PP2) the extruder temperature of the respective extruder could be lowered. This leads to a reduction in energy consumption but also to less thermal degradation of the polypropylene.
- The combination of polypropylene PP1 of higher melt flow index as exterior component and polypropylene PP2 of lower melt flow index as interior component allowed to improve the strength of the nonwoven in machine direction as well as in cross-machine direction.
- At the same time as the nonwoven strength could be increased the bicomponent nonwovens of the present invention allowed increasing the elongational properties, which is quite surprising as the elongation normally decreases when strength increases and vice versa.

[0059] Thus, the results show that the fibers and nonwovens in accordance with the present invention have improved properties in comparison to the fibers and nonwovens of the prior art. The present invention further allows the production of bicomponent fibers and nonwovens based on polypropylene only, without having to revert to the use of polyethylene in the exterior component, thus facilitating the production of such bicomponent fibers and nonwovens.

Claims

1. Bicomponent fiber comprising

(a) an exterior component covering at least 50 % of the surface of the bicomponent fiber, and
(b) an interior component comprising a thermoplastic polymer,

wherein the exterior component comprises a polypropylene, which has been degraded chemically or thermally from a first melt flow index MFI_1 (measured according to ISO 1133, condition L, 230°C, 2.16 kg) to a second melt flow index MFI_2 (measured according to ISO 1133, condition L, 230°C, 2.16 kg), such that the second melt flow index MFI_2 is in the range from 50 dg/min to 300 dg/min and such that the degradation ratio MFI_1/MFI_2 is at least 0.10 and at most 0.80.

2. Bicomponent fiber according to claim 1, wherein the exterior component comprises said polypropylene in at least 50 wt% relative to the total weight of the exterior component.

3. Bicomponent fiber according to claim 1 or claim 2, wherein the thermoplastic polymer of the interior component is a polypropylene.

4. Bicomponent fiber according to claim 1 or claim 2, wherein the thermoplastic polymer of the interior component is a polypropylene different from the polypropylene of the exterior component.

5. Nonwoven comprising the bicomponent fiber of any of claims 1 to 4.

6. Composite and laminate comprising the nonwoven of claim 5.

7. Process for the production of bicomponent fibers comprising the steps of

(a) polymerizing propylene and one or more optional comonomers with a polymerization catalyst to produce a polypropylene having a first melt flow index MFI_1 (measured according to ISO 1133, condition L, 230°C, 2.16kg),

(b) thermally or chemically degrading the polypropylene obtained in step (a) to a second melt flow index MFI_2 (measured according to ISO 1133, condition L, 230°C, 2.16 kg),
(c) melting a polypropylene composition comprising the polypropylene obtained in step (b) in a first extruder to form a molten polypropylene composition,
(d) melting a thermoplastic polymer composition comprising a thermoplastic polymer in a second extruder to form a molten thermoplastic polymer composition,
(e) extruding the molten thermoplastic polymer composition from a number of fine, usually circular, capillaries of a spinneret,
(f) extruding the molten polypropylene composition of step (c) from a number of fine openings surrounding said capillaries of step (e), and
(g) combining the extrudates of steps (e) and (f) to form a single filament of an intermediate diameter, such that the extrudates of step (f) form an exterior component covering at least 50 % of the surface of the so-produced filament,

wherein the polypropylene obtained in step (b) has a second melt flow index MFI_2 (measured according to ISO 1133, condition L, 230°C, 2.16 kg) in the range from 50 dg/min to 300 dg/min and wherein the degradation ratio MFI_1/MFI_2 is at least 0.10 and at most 0.80.

8. Process according to claim 7, wherein the polypropylene in step (a) is produced by a Ziegler-Natta polymerization catalyst.

9. Process according to claim 7 or claim 8, wherein the thermoplastic polymer of step (d) is a polypropylene.

10. Process according to any of claims 7 to 9, wherein the process further comprises the step of

(h) rapidly reducing the intermediate diameter of the filaments extruded in the previous step to a final diameter.

11. Process according to any of claims 7 to 10, wherein the process further comprises the step of

(i) collecting the filaments obtained in step (g) or (h) on a support, and
(k) subsequently bonding the collected filaments to form a bonded nonwoven.

12. Process according to any of claims 7 to 11, further comprising the step of

(I-1) laminating a film to the bonded nonwoven obtained in step (k) to form a laminate

13. Process according to any of claims 7 to 11, further comprising the step of

(1-2) applying a spunbond and/or a meltblown nonwoven to the bonded nonwoven obtained in step (k).

14. Process according to any of claims 7 to 13, wherein the bonded nonwoven is a spunbond nonwoven.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 08 16 1327

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 00/40789 A (KIMBERLY CLARK CO [US]) 13 July 2000 (2000-07-13) * the whole document * -----	1-14	INV. D01F8/06 D01D5/30
X	US 5 281 378 A (KOZULLA RANDALL E [US]) 25 January 1994 (1994-01-25) * the whole document * -----	1-14	
X	WO 99/06617 A (FIBERVISIONS INC [US]) 11 February 1999 (1999-02-11) * the whole document * -----	1-14	
X	WO 00/63471 A (MONTELL TECHNOLOGY COMPANY BV [NL]; SARTORI FRANCO [IT]; BRACA GIANCAR) 26 October 2000 (2000-10-26) * the whole document * -----	1-14	
			TECHNICAL FIELDS SEARCHED (IPC)
			D01F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	29 September 2008	Barker, Stephan

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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....
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 08 16 1327

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29-09-2008

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 0040789 A	13-07-2000	AU 2721100 A	24-07-2000
		US 6583076 B1	24-06-2003
US 5281378 A	25-01-1994	NONE	
WO 9906617 A	11-02-1999	AU 8661398 A	22-02-1999
		CN 1272895 A	08-11-2000
		EP 1000185 A1	17-05-2000
		JP 2001512189 T	21-08-2001
		US 5948334 A	07-09-1999
WO 0063471 A	26-10-2000	AT 288507 T	15-02-2005
		AU 771652 B2	01-04-2004
		AU 4290700 A	02-11-2000
		BR 0006094 A	20-03-2001
		CA 2334893 A1	26-10-2000
		CN 1313915 A	19-09-2001
		CZ 20010178 A3	15-08-2001
		DE 60017852 D1	10-03-2005
		DE 60017852 T2	30-03-2006
		ES 2235855 T3	16-07-2005
		HU 0103284 A2	28-12-2001
		ID 27644 A	19-04-2001
		JP 2002542403 T	10-12-2002
		MX PA00012502 A	09-04-2002
		NO 20006389 A	12-02-2001
		PL 345220 A1	03-12-2001
		RU 2224830 C2	27-02-2004
		TR 200003709 T1	21-06-2001
		US 6657033 B1	02-12-2003

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

Non-patent literature cited in the description

- **F. Fourné.** Synthetische Fasern. Carl Hanser Verlag, 1995 **[0017] [0041]**
- **B.C. Goswami et al.** Textile Yarns. John Wiley & Sons, 1977, 371-376 **[0017] [0041]**
- **G.J. Ray et al.** *Macromolecules,* 1977, vol. 10 (4), 773-778 **[0031] [0053]**
- Plastics Additives Handbook. Carl Hanser Verlag, 2001 **[0032]**