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(54) **CaCO₃ in polyester for nonwoven and fibers**

(57) The present invention concerns a nonwoven fabric comprising at least one polymer comprising a polyester and at least one filler comprising calcium carbonate. The present invention further relates to a process of

producing such a nonwoven fabric as well as to the use of calcium carbonate as filler in a nonwoven fabric comprising at least one polymer comprising a polyester.

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Description

[0001] The invention relates to a nonwoven fabric, a process for preparing a nonwoven fabric, articles containing said nonwoven fabric, and the use of said nonwoven fabric as well as to the use of fibers for the manufacture of nonwoven fabrics and the use of calcium carbonate as fillers for nonwoven fabrics.

[0002] Nonwoven fabrics are sheets or web structures made by bonding together fibers or filaments. They can be flat or bulky and, depending upon the process by which they are produced and the materials used, can be tailored for a variety of applications. In contrast to other textiles such as woven fabrics or knitted fabrics, nonwoven fabrics need not to go through the preparatory stage of yarn spinning in order to be transformed into a web of a certain pattern. Depending on the strength of material needed for the specific use, it is possible to use a certain percentage of recycled fabrics in the nonwoven fabric. Conversely, some nonwoven fabrics can be recycled after use, given the proper treatment and facilities. Therefore, nonwoven fabrics may be the more ecological fabric for certain applications, especially in fields and industries where disposable or single use products are important such as hospitals, schools or nursing homes.

[0003] Today, nonwoven fabrics are mainly produced from thermoplastic polymers such as polypropylene, polyethylene, polyamides, or polyesters. The advantage of polyester fibers or filaments is their high crystallinity, high strength and high tenacity. Polyethylene terephthalate (PET) is the most widely used polyester class and is characterized by high modulus, low shrinkage, heat set stability, light fastness and chemical resistance account for the great versatility of PET. One major drawback of PET is its slow crystallization rate, which does not allow reasonable cycle times for manufacturing processes such as injection molding. Therefore nucleating agents such as talc are often added. However, these heterogeneous particles can act as stress concentrators, and thereby, may affect the mechanical properties of the polymer. Therefore, nucleated PET is often reinforced with glass fibers.

[0004] A talc filled PET is disclosed in the article of Sekelik et al. entitled "Oxygen barrier properties of crystallized and talc-filled poly(ethylene terephthalate)" published in Journal of Polymer Science: Part B: Polymer Physics, 1999, 37, 847 to 857. US 5,886,088 A is concerned with a PET resin composition comprising an inorganic nucleating agent. A method for producing a thermoplastic polymer material, which is filled with calcium carbonate is described in WO 2009/121085 A1. WO 2012/052778 A1 relates to tearable polymer films comprising a polyester and calcium carbonate or mica fillers. The spinning of PET fibers containing modified calcium carbonate was studied by Boonsri Kusktham and is described in the article entitled "Spinning of PET fibres mixed with calcium carbonate", which was published in the Asian Journal of Textile, 2011, 1(2), 106 to 113.

[0005] Extruded fibers and nonwoven webs containing titanium dioxide and at least one mineral filler are disclosed in US 6,797,377 B1. WO 2008/077156 A2 describes spunlaid fibers comprising a polymeric resin and one filler as well as nonwoven fabrics containing said fibers. Nonwovens of synthetic polymers with an improved binding composition are disclosed in EP 2 465 986 A1. WO 97/30199 relates to fibers or filaments suitable for the production of a nonwoven fabric, the fibers or filaments consisting essentially of a polyolefin and inorganic particles.

[0006] In view of the foregoing, improving the properties of polyester based nonwoven fabrics remains of interest to the skilled man.

[0007] It is an object of the present invention to provide a nonwoven fabric having an improved soft touch and a higher stiffness. It would also be desirable to provide a nonwoven fabric which can be tailored with respect to its hydrophobic or hydrophilic properties. It would also be desirable to provide a nonwoven fabric containing a reduced amount of polymer without affecting the quality of the nonwoven fabric significantly.

[0008] It also an object of the present invention to provide a process for producing a nonwoven fabric from a polyester based polymer composition, especially a PET composition, which allows short cycle times during melt processing. It is also desirable to provide a process for producing a nonwoven fabric which allows the use of recycled polyester, especially recycled PET.

[0009] The foregoing objects and other objects are solved by the subject-matter as defined herein in the independent claims.

[0010] According to one aspect of the present invention, a nonwoven fabric comprising at least one polymer comprising a polyester, and at least one filler comprising calcium carbonate is provided.

[0011] According to another aspect, the present invention provides a process for producing a nonwoven fabric comprising the steps of

- a) providing a mixture of at least one polymer comprising a polyester and at least one filler comprising calcium carbonate,
- b) forming the mixture into fibers, filaments and/or film-like filamentary structures, and
- c) forming a nonwoven fabric from the fibers, filaments and/or film-like filamentary structures.

[0012] According to still another aspect, the present invention provides an article comprising the inventive nonwoven fabric, wherein said article is selected from construction products, consumer apparel, industrial apparel, medical products,

home furnishings, protective products, packaging materials, cosmetic products, hygiene products, or filtration materials.

[0013] According to still another aspect, the present invention provides the use of calcium carbonate as filler in a nonwoven fabric comprising at least one polymer comprising a polyester.

[0014] According to still another aspect, the present invention provides the use of fibers for the manufacture of a non-woven fabric, wherein the fibers comprise at least one polymer comprising a polyester and at least one filler comprising calcium carbonate.

[0015] According to still another aspect, the present invention provides the use of the inventive nonwoven fabric in construction products, waterproofing, thermal insulation, soundproofing, roofing, consumer apparel, upholstery and clothing industries, industrial apparel, medical products, home furnishings, protective products, packaging materials, cosmetic products, hygiene products, or filtration materials.

[0016] Advantageous embodiments of the present invention are defined in the corresponding sub-claims.

[0017] According to one embodiment the polyester is selected from the group consisting of a polyglycolic acid, a polycaprolactone, a polyethylene adipate, a polyhydroxyalkanoate, a polyhydroxybutyrate, a polyethylene terephthalate, a polytrimethylene terephthalate, a polybutylene terephthalate, a polyethylene naphthalate, a polylactic acid, or a mixture thereof, or copolymers thereof, preferably the polyester is a polyethylene terephthalate. According to another embodiment the polyester has a number average molecular weight from 5000 to 100000 g/mol, preferably from 10000 to 50000 g/mol, and more preferably from 15000 to 20000 g/mol.

[0018] According to one embodiment the calcium carbonate is ground calcium carbonate, precipitated calcium carbonate, modified calcium carbonate, surface-treated calcium carbonate, or a mixture thereof, preferably surface-treated calcium carbonate. According to another embodiment the calcium carbonate has an average particle size d_{50} from 0.1 to 3 μm , preferably from 0.4 to 2.5 μm , more preferably from 1.0 to 2.3 μm , and most preferably from 1.2 to 1.8 μm . According to still another embodiment the calcium carbonate has an top cut particle size d_{98} from 1 to 10 μm , preferably from 5 to 8 μm , more preferably from 4 to 7 μm , and most preferably from 6 to 7 μm . According to still another embodiment the calcium carbonate is present in the nonwoven fabric in an amount from 0.1 to 50 wt.-%, preferably from 0.2 to 40 wt.-%, and more preferably from 1 to 35 wt.-%, based on the total weight of the nonwoven fabric.

[0019] According to one embodiment of the inventive process, in step b) the mixture is formed into fibers, preferably by an extrusion process, and more preferably by a melt blown process, a spunbond process, or a combination thereof. According to another embodiment of the inventive process, the nonwoven fabric is formed by collecting the fibers on a surface or carrier. According to still another embodiment of the inventive process, steps b) and c) are repeated two or more times to produce a multilayer nonwoven fabric, preferably a spunbonded-meltblown-spunbonded (SMS), a meltblown-spunbonded-meltblown (MSM), a spunbonded-meltblown-spunbonded-meltblown (SMSM), a meltblown-spunbonded-meltblown-spunbonded (MSMS), a spunbonded-meltblown-meltblown-spunbonded (SMMS), or a meltblown-spunbonded-spunbonded-meltblown (MSSM) nonwoven fabric.

[0020] It should be understood that for the purpose of the present invention, the following terms have the following meaning:

[0021] The term "degree of crystallinity" as used in the context of the present invention refers to the fraction of the ordered molecules in a polymer. The remaining fraction is designated as "amorphous". Polymers may crystallize upon cooling from the melt, mechanical stretching or solvent evaporation. Crystalline areas are generally more densely packed than amorphous areas and crystallization may affect optical, mechanical, thermal and chemical properties of the polymer. The degree of crystallinity is specified in percent and can be determined by differential scanning calorimetry (DSC).

[0022] "Ground calcium carbonate" (GCC) in the meaning of the present invention is a calcium carbonate obtained from natural sources, such as limestone, marble, calcite or chalk, and processed through a wet and/or dry treatment such as grinding, screening and/or fractionation, for example by a cyclone or classifier.

[0023] The term "intrinsic viscosity" as used in the context of the present invention is a measure of the capability of a polymer in solution to enhance the viscosity of the solution and is specified in dl/g.

[0024] "Modified calcium carbonate" (MCC) in the meaning of the present invention may feature a natural ground or precipitated calcium carbonate with an internal structure modification or a surface-reaction product, i.e. "surface-reacted calcium carbonate". A "surface-reacted calcium carbonate" is a material comprising calcium carbonate and insoluble, preferably at least partially crystalline, calcium salts of anions of acids on the surface. Preferably, the insoluble calcium salt extends from the surface of at least a part of the calcium carbonate. The calcium ions forming said at least partially crystalline calcium salt of said anion originate largely from the starting calcium carbonate material. MCCs are described, for example, in US 2012/0031576 A1, WO 2009/074492 A1, EP 2 264 109 A1, EP 2 070 991 A1, or 2 264 108 A1.

[0025] For the purpose of the present invention, the term "nonwoven fabric" refers to a flat, flexible, porous sheet structure that is produced by interlocking layers or networks of fibers, filaments, or film-like filamentary structures.

[0026] Throughout the present document, the "particle size" of a calcium carbonate filler is described by its distribution of particle sizes. The value d_x represents the diameter relative to which x % by weight of the particles have diameters less than d_x . This means that the d_{20} value is the particle size at which 20 wt.-% of all particles are smaller, and the d_{98} value is the particle size at which 98 wt.-% of all particles are smaller. The d_{98} value is also designated as "top cut". The

d_{50} value is thus the weight median particle size, i.e. 50 wt.-% of all grains are bigger or smaller than this particle size. For the purpose of the present invention the particle size is specified as weight median particle size d_{50} unless indicated otherwise. For determining the weight median particle size d_{50} value or the top cut particle size d_{98} value a Sedigraph 5100 or 5120 device from the company Micromeritics, USA, can be used.

[0027] As used herein the term "polymer" generally includes homopolymers and copolymers such as, for example, block, graft, random and alternating copolymers, as well as blends and modifications thereof.

[0028] "Precipitated calcium carbonate" (PCC) in the meaning of the present invention is a synthesized material, generally obtained by precipitation following a reaction of carbon dioxide and calcium hydroxide (hydrated lime) in an aqueous environment or by precipitation of a calcium- and a carbonate source in water. Additionally, precipitated calcium carbonate can also be the product of introducing calcium and carbonate salts, calcium chloride and sodium carbonate for example, in an aqueous environment. PCC may be vaterite, calcite or aragonite. PCCs are described, for example, in EP 2 447 213 A1, EP 2,524,898 A1, EP 2 371 766 A1, or unpublished European patent application no. 12 164 041.1.

[0029] In the meaning of the present invention, a "surface-treated calcium carbonate" is a ground, precipitated or modified calcium carbonate comprising a treatment or coating layer, e.g. a layer of fatty acids, surfactants, siloxanes, or polymers.

[0030] Where the term "comprising" is used in the present description and claims, it does not exclude other elements. For the purposes of the present invention, the term "consisting of" is considered to be a preferred embodiment of the term "comprising of". If hereinafter a group is defined to comprise at least a certain number of embodiments, this is also to be understood to disclose a group, which preferably consists only of these embodiments.

[0031] Where an indefinite or definite article is used when referring to a singular noun, e.g. "a", "an" or "the", this includes a plural of that noun unless something else is specifically stated.

[0032] Terms like "obtainable" or "definable" and "obtained" or "defined" are used interchangeably. This e.g. means that, unless the context clearly dictates otherwise, the term "obtained" does not mean to indicate that e.g. an embodiment must be obtained by e.g. the sequence of steps following the term "obtained" even though such a limited understanding is always included by the terms "obtained" or "defined" as a preferred embodiment.

[0033] The inventive nonwoven fabric comprises at least one polymer comprising a polyester and at least one filler comprising calcium carbonate. In the following details and preferred embodiments of the inventive product will be set out in more detail. It is to be understood that these technical details and embodiments also apply to the inventive process for producing said nonwoven fabric and the inventive use of the nonwoven fabric, fibers, compositions, and calcium carbonate.

The at least one polymer

[0034] The nonwoven fabric of the present invention comprises at least one polymer comprising a polyester.

[0035] Polyesters are a class of polymers which contain the ester functional group in their main chain and are generally obtained by a polycondensation reaction. Polyesters may include naturally occurring polymers such as cutin as well as synthetic polymers such as polycarbonate or poly butyrate. Depending on their structure polyesters may be biodegradable.

[0036] According to one embodiment, the polyester is selected from the group consisting of a polyglycolic acid, a polycaprolactone, a polyethylene adipate, a polyhydroxyalkanoate, a polyhydroxybutyrate, a polyethylene terephthalate, a polytrimethylene terephthalate, a polybutylene terephthalate, a polyethylene naphthalate, a polylactic acid, or a mixture thereof, or copolymers thereof. Any of these polymers may be in pure form, i.e. in form of a homopolymer, or may be modified by copolymerization and/or by adding one or more substituents to the main chain or side chains of the main chain.

[0037] According to one embodiment of the present invention, the at least one polymer consists of a polyester. The polyester may consist of only one specific type of polyester or a mixture of one or more types of polyesters.

[0038] The at least one polymer can be present in the nonwoven fabric in an amount of at least 40 wt.-%, preferably of at least 60 wt.-%, more preferably of at least 80 wt.-%, and most preferably of at least 90 wt.-%, based on the total weight of the nonwoven fabric. According to one embodiment, the at least one polymer is present in the nonwoven fabric in an amount from 50 to 99 wt.-%, preferably from 60 to 98 wt.-%, and more preferably from 65 to 95 wt.-%, based on the total weight of the nonwoven fabric.

[0039] According to a preferred embodiment of the present invention, the polyester is a polyethylene terephthalate.

[0040] Polyethylene terephthalate (PET) is a condensation polymer and may be industrially produced by condensating either terephthalic acid or dimethyl terephthalate with ethylene glycol.

[0041] PET may be polymerized by ester interchange employing the monomers diethyl terephthalate and ethylene glycol or direct esterification by employing the monomers terephthalic acid and ethylene glycol. Both ester interchange and direct esterification processes are combined with polycondensation steps either batch-wise or continuously. Batch-wise systems require two reaction vessels; one for esterification or ester interchange and one for polymerization. Continuous systems require at least three vessels; one for esterification or ester interchange, another for reducing excess

glycols, and still another for polymerization.

[0042] Alternatively, PET may be produced by solid-phase polycondensation. For example, in such a process a melt polycondensation is continued until the pre-polymer has an intrinsic viscosity of 1.0 to 1.4 dl/g, at which point the polymer is cast into a solid film. The pre-crystallization is carried out by heating, e.g. above 200°C, until the desirable molecular weight of the polymer is obtained.

[0043] According to one embodiment, PET is obtained from a continuous polymerization process, a batch-wise polymerization process or a solid phase polymerization process.

[0044] According to the present invention, the term "polyethylene terephthalate" comprises unmodified and modified polyethylene terephthalate. The polyethylene terephthalate may be a linear polymer, a branched polymer, or a cross-linked polymer. For example, if glycerol is allowed to react with a diacid or its anhydride each glycerol will generate a branch point. If internal coupling occurs, for example, by reaction of a hydroxyl group and an acid function from branches at the same or a different molecule, the polymer will become crosslinked. Optionally, the polyethylene terephthalate can be substituted, preferably with a C₁ to C₁₀ alkyl group, a hydroxyl, and/or an amine group. According to one embodiment, the polyethylene terephthalate is substituted with a methyl, ethyl, propyl, butyl, *tert.*-butyl, hydroxyl and/or amine group. The polyethylene terephthalate can also be modified by copolymerization, e.g. with cyclohexane dimethanol or isophthalic acid.

[0045] Depending on its processing and thermal history, PET may exist both as an amorphous and as a semi-crystalline polymer, i.e. as a polymer comprising crystalline and amorphous fractions. The semi-crystalline material can appear transparent or opaque and white depending on its crystal structure and particle size.

[0046] According to one embodiment, the polyethylene terephthalate is amorphous. According to another embodiment, the polyethylene terephthalate is semi-crystalline, preferably the polyethylene terephthalate has a degree of crystallinity of at least 20%, more preferably of at least 40%, and most preferably of at least 50%. According to still another embodiment, the polyethylene terephthalate has a degree of crystallinity from 10 to 80%, more preferably from 20 to 70%, and most preferably from 30 to 60%. The degree of crystallinity may be measured with differential scanning calorimetry (DSC).

[0047] According to one embodiment of the present invention, the polyethylene terephthalate has an intrinsic viscosity, IV, from 0.3 to 2.0 dl/g, preferably from 0.5 to 1.5 dl/g, and more preferably from 0.7 to 1.0 dl/g.

[0048] According to another embodiment of the present invention, the polyethylene terephthalate has a glass transition temperature, T_g, from 50 to 200°C, preferably from 60 to 180°C, and more preferably from 70 to 170°C.

[0049] According to one embodiment of the present invention, the polyethylene terephthalate has a number average molecular weight from 5000 to 100000 g/mol, preferably from 10000 to 50000 g/mol, and more preferably from 15000 to 20000 g/mol.

[0050] The polyethylene terephthalate may be a virgin polymer, a recycled polymer, or a mixture thereof. A recycled polyethylene terephthalate may be obtained from post consumed PET bottles, preform PET scrap, regrained PET, or reclaimed PET.

[0051] According to one embodiment, the polyethylene terephthalate includes 10 wt.-%, preferably 25 wt.-%, more preferably 50 wt.-%, and most preferably 75 wt.-% recycled PET, based on the total amount of polyethylene terephthalate.

[0052] According to one embodiment, the at least one polymer consists of a polyethylene terephthalate. The PET may consist of only one specific type of PET or a mixture of two or more types of PET.

[0053] According to one embodiment, the at least one polymer comprises further polymers, preferably polyolefines, polyamides, cellulose, polybenzimidazols, or mixtures thereof, or copolymers thereof. Examples for such polymers are polyhexamethylene diadipamide, polycaprolactam, aromatic or partially aromatic polyamides ("aramids"), nylon, polyphenylene sulfide (PPS), polyethylene, polypropylene, polybenzimidazols, or rayon.

[0054] According to one embodiment, the at least one polymer comprises at least 50 wt.-%, preferably at least 75 wt.-%, more preferably at least 90 wt.-%, and most preferably at least 95 wt.-% of a polyethylene terephthalate, based on the total amount of the at least one polymer.

The at least one filler

[0055] According to the present invention, the nonwoven fabric comprises at least one filler comprising a calcium carbonate. The at least one filler is dispersed within the at least one polymer.

[0056] The use of at least one filler comprising calcium carbonate in polyester-based nonwoven fabrics has certain advantages compared to conventional nonwoven fabrics. For example, the hydrophobic or hydrophilic properties of the nonwoven web can be adapted to the intended application by using an appropriate calcium carbonate filler. Furthermore, the use of calcium carbonate fillers allows for the reduction of polyesters in the production of nonwoven fabrics without affecting the quality of the nonwoven significantly. Moreover, the inventors surprisingly found that if calcium carbonate is added as filler to PET, the polymer exhibits a higher thermal conductivity, which leads to a faster cooling rate of the polymer. Furthermore, without being bound to any theory it is believed that calcium carbonate acts as nucleating agent for PET, and thus, increases the crystallization temperature of PET. As a result the crystallization rate is increased,

which, for example, allows shorter cycling times during melt processing. The inventors also found that nonwoven webs manufactured from PET including calcium carbonate fillers have an improved soft touch and a higher stiffness compared to nonwoven webs made from PET only.

[0057] According to one embodiment, the calcium carbonate is ground calcium carbonate, precipitated calcium carbonate, modified calcium carbonate, surface-treated calcium carbonate, or a mixture thereof. Preferably the calcium carbonate is surface-treated calcium carbonate.

[0058] Ground (or natural) calcium carbonate (GCC) is understood to be a naturally occurring form of calcium carbonate, mined from sedimentary rocks such as limestone or chalk, or from metamorphic marble rocks. Calcium carbonate is known to exist as three types of crystal polymorphs: calcite, aragonite and vaterite. Calcite, the most common crystal polymorph, is considered to be the most stable crystal form of calcium carbonate. Less common is aragonite, which has a discrete or clustered needle orthorhombic crystal structure. Vaterite is the rarest calcium carbonate polymorph and is generally unstable. Ground calcium carbonate is almost exclusively of the calcitic polymorph, which is said to be trigonal-rhombohedral and represents the most stable of the calcium carbonate polymorphs. The term "source" of the calcium carbonate in the meaning of the present application refers to the naturally occurring mineral material from which the calcium carbonate is obtained. The source of the calcium carbonate may comprise further naturally occurring components such as magnesium carbonate, alumino silicate etc.

[0059] According to one embodiment of the present invention the source of ground calcium carbonate (GCC) is selected from marble, chalk, calcite, dolomite, limestone, or mixtures thereof. Preferably, the source of ground calcium carbonate is selected from marble. According to one embodiment of the present invention the GCC is obtained by dry grinding.

[0060] "Precipitated calcium carbonate" (PCC) in the meaning of the present invention is a synthesized material, generally obtained by precipitation following reaction of carbon dioxide and lime in an aqueous environment or by precipitation of a calcium and carbonate ion source in water or by precipitation of calcium and carbonate ions, for example CaCl_2 and Na_2CO_3 , out of solution. Further possible ways of producing PCC are the lime soda process, or the Solvay process in which PCC is a by-product of ammonia production. Precipitated calcium carbonate exists in three primary crystalline forms: calcite, aragonite and vaterite, and there are many different polymorphs (crystal habits) for each of these crystalline forms. Calcite has a trigonal structure with typical crystal habits such as scalenohedral (S-PCC), rhombohedral (R-PCC), hexagonal prismatic, pinacoidal, colloidal (C-PCC), cubic, and prismatic (P-PCC). Aragonite is an orthorhombic structure with typical crystal habits of twinned hexagonal prismatic crystals, as well as a diverse assortment of thin elongated prismatic, curved bladed, steep pyramidal, chisel shaped crystals, branching tree, and coral or worm-like form. Vaterite belongs to the hexagonal crystal system. The obtained PCC slurry can be mechanically dewatered and dried.

[0061] According to one embodiment of the present invention, the calcium carbonate comprises one precipitated calcium carbonate. According to another embodiment of the present invention, the calcium carbonate comprises a mixture of two or more precipitated calcium carbonates selected from different crystalline forms and different polymorphs of precipitated calcium carbonate. For example, the at least one precipitated calcium carbonate may comprise one PCC selected from S-PCC and one PCC selected from R-PCC.

[0062] A modified calcium carbonate may feature a GCC or PCC with an internal structure modification or a surface-reacted GCC or PCC. A surface-reacted calcium carbonate may be prepared by providing a GCC or PCC in form of an aqueous suspension, and adding an acid to said suspension. Suitable acids are, for example, sulphuric acid, hydrochloric acid, phosphoric acid, citric acid, oxalic acid, or a mixture thereof. In a next step, the calcium carbonate is treated with gaseous carbon dioxide. If a strong acid such as sulphuric acid or hydrochloric acid is used for the acid treatment step, the carbon dioxide will form automatically *in situ*. Alternatively or additionally, the carbon dioxide can be supplied from an external source. Surface-reacted calcium carbonates are described, for example, in US 2012/0031576 A1, WO 2009/074492 A1, EP 2 264 109 A1, EP 2 070 991 A1, or EP 2 264 108 A1.

[0063] A surface-treated calcium carbonate may feature a GCC, PCC, or MCC comprising a treatment or coating layer on its surface. For example, the calcium carbonate may be treated or coated with a hydrophobising surface treatment agent such as, e.g., aliphatic carboxylic acids, salts or esters thereof, or a siloxane. Suitable aliphatic acids are, for example, C_5 to C_{28} fatty acids such as stearic acid, palmitic acid, myristic acid, lauric acid, or a mixture thereof. The calcium carbonate may also be treated or coated to become cationic or anionic with, for example, a polyacrylate or polydiallyldimethylammonium chloride (polyDADMAC). Surface-treated calcium carbonates are, for example, described in EP 2 159 258 A1.

[0064] According to one embodiment, the modified calcium carbonate is a surface-reacted calcium carbonate, preferably obtained from the reaction with sulphuric acid, hydrochloric acid, phosphoric acid, citric acid, oxalic acid, or a mixture thereof, and carbon dioxide.

[0065] According to another embodiment, the surface-treated calcium carbonate comprises a treatment layer or surface coating obtained from the treatment with fatty acids, their salts, their esters, or combinations thereof, preferably from the treatment with aliphatic C_5 to C_{28} fatty acids, their salts, their esters, or combinations thereof, and more preferably

from the treatment with ammonium stearate, calcium stearate, stearic acid, palmitic acid, myristic acid, lauric acid, or mixtures thereof.

[0066] According to one embodiment, the calcium carbonate has an average particle size d_{50} from 0.1 to 3 μm , preferably from 0.4 to 2.5 μm , more preferably from 1.0 to 2.3 μm , and most preferably from 1.2 to 1.8 μm . In addition or alternatively, the calcium carbonate has an top cut particle size d_{98} from 1 to 10 μm , preferably from 5 to 8 μm , more preferably from 4 to 7 μm , and most preferably from 6 to 7 μm .

[0067] The calcium carbonate can be present in the nonwoven fabric in an amount from 0.1 to 50 wt.-%, preferably from 0.2 to 40 wt.-%, and more preferably from 1.0 to 35 wt.-%, based on the total weight of the nonwoven fabric. According to another embodiment, the calcium carbonate is present in the nonwoven fabric in an amount from 0.5 to 20 wt.-%, from 1.0 to 10 wt.-%, from 5.0 to 40 wt.-%, from 7.5 to 30 wt.-%, or from 10 to 25 wt.-%, based on the total weight of the nonwoven fabric.

[0068] According to one embodiment, the calcium carbonate is dispersed within the at least one polymer and is present in an amount from 0.1 to 50 wt.-%, preferably from 0.2 to 40 wt.-%, and more preferably from 1 to 35 wt.-%, based on the total weight of the at least one polymer. According to another embodiment, the calcium carbonate is dispersed within the at least one polymer and is present in an amount from 0.5 to 20 wt.-%, from 1.0 to 10 wt.-%, from 5.0 to 40 wt.-%, from 7.5 to 30 wt.-%, or from 10 to 25 wt.-%, based on the total weight of the at least one polymer.

[0069] According to one embodiment, the at least one filler consists of calcium carbonate. The calcium carbonate may consist of only one specific type of calcium carbonate or a mixture of two or more types of calcium carbonates.

[0070] According to another embodiment, the at least one filler comprises further mineral pigments. Examples for further pigment particles comprise silica, alumina, titanium dioxide, clay, calcined clays, talc, kaolin, calcium sulphate, wollastonite, mica, bentonite, barium sulfate, gypsum, or zinc oxide.

[0071] According to one embodiment, the at least one filler comprises at least 50 wt.-%, preferably at least 75 wt.-%, more preferably at least 90 wt.-%, and most preferably at least 95 wt.-% calcium carbonate, based on the total amount of the at least one filler.

[0072] According to one embodiment, the at least one filler is present in the nonwoven fabric in an amount from 0.1 to 50 wt.-%, preferably from 0.2 to 40 wt.-%, and more preferably from 1 to 35 wt.-%, based on the total weight of the nonwoven fabric. According to another embodiment, the at least one filler is dispersed within the at least one polymer and is present in an amount from 1 to 50 wt.-%, preferably from 2 to 40 wt.-%, and more preferably from 5 to 35 wt.-%, based on the total weight of the at least one polymer.

[0073] According to one aspect of the present invention, the use of calcium carbonate as filler in a nonwoven fabric comprising at least one polymer comprising a polyester is provided. According to another aspect of the present invention, the use of calcium carbonate as filler in a nonwoven fabric is provided, wherein the filler is dispersed within at least one polymer comprising a polyester.

[0074] According to one preferred embodiment of the present invention, the use of calcium carbonate as filler in a nonwoven fabric comprising a polyethylene terephthalate is provided. According to another preferred embodiment of the present invention, the use of calcium carbonate as filler in a nonwoven fabric is provided, wherein the filler is dispersed within at least one polymer comprising a polyethylene terephthalate. Preferably, the calcium carbonate is a surface-treated calcium carbonate.

[0075] According to a further aspect of the present invention, the use of calcium carbonate as filler in a nonwoven fabric fiber, filament and/or film-like filamentary structure comprising at least one polymer comprising a polyester, preferably a polyethylene terephthalate, is provided. According to a further aspect of the present invention, the use of calcium carbonate as filler in a nonwoven fabric fiber, filament and/or film-like filamentary structure comprising at least one polymer comprising a polyester, preferably a polyethylene terephthalate, is provided, wherein the filler is dispersed within at least one polymer.

The nonwoven fabric

[0076] A nonwoven fabric is a flat, flexible, porous sheet structure that is produced by interlocking layers or networks of fibers, filaments and/or film-like filamentary structures.

[0077] According one aspect of the present invention a nonwoven fabric fiber, filament and/or film-like filamentary structure comprising at least one polymer comprising a polyester and at least one filler comprising calcium carbonate is provided.

[0078] According to one embodiment, the nonwoven fabric comprises at least one polymer comprising a polyester and at least one filler comprising calcium carbonate, wherein the at least one filler is dispersed within the at least one polymer. According to another embodiment the nonwoven fabric comprises the at least one polymer and the at least one filler in form of fibers, filaments and/or film-like filamentary structures, wherein the at least one filler is dispersed within the at least one polymer.

[0079] The fibers and/or filaments may have a diameter from 0.5 to 40 μm , preferably from 5 to 35 μm . Furthermore,

the fibers and/or filaments can have any cross-section shape, e.g., a circular, oval, rectangular, dumbbell-shaped, kidney-shaped, triangular, or irregular. The fibers and/or filaments can also be hollow and/or bi-component and/or tri-component fibers.

[0080] In addition to the at least one polymer and the at least one filler, the nonwoven fabric may comprise further additives, for example, waxes, optical brighteners, heat stabilizers, antioxidants, anti-static agents, anti-blocking agents, dyestuffs, pigments, luster improving agents, surfactants, natural oils, or synthetic oils. The nonwoven fabric may also comprise further inorganic fibers, preferably glass fibers, carbon fibers, or metal fibers. Alternatively or additionally, natural fibers such as cotton, linen, silk, or wool may be added. The nonwoven fabric may also be reinforced by reinforcement threads in form of a textile surface structure, preferably in form of a fabric, laying, knitted fabric, knitwear or nonwoven fabric.

[0081] According to one embodiment, the nonwoven fabric consists of the at least one polymer comprising a polyester and the at least one filler comprising calcium carbonate. According to another embodiment, the nonwoven fabric comprises at least one polymer comprising a polyethylene terephthalate and at least one filler comprising calcium carbonate. According to still another embodiment, the nonwoven fabric consists of a polyethylene terephthalate and calcium carbonate.

[0082] According to an exemplary embodiment, the nonwoven fabric comprises the at least one polymer in an amount from 50 to 99 wt.-%, and the at least one filler in an amount from 1 to 50 wt.-%, based on the total weight of the nonwoven fabric, preferably the at least one polymer in an amount from 60 to 98 wt.-%, and the at least one filler in an amount from 2 to 40 wt.-%, and more preferably the at least one polymer in an amount from 65 to 95 wt.-%, and the at least one filler in an amount from 5 to 35 wt.-%. According to another exemplary embodiment, the nonwoven fabric consists of 90 wt.-% of a polyester, preferably a polyethylene terephthalate, and 10 wt.-% calcium carbonate, preferably a ground calcium carbonate, based on the total weight of the nonwoven fabric. According to still another exemplary embodiment, the nonwoven fabric consists of 80 wt.-% of a polyester, preferably a polyethylene terephthalate, and 20 wt.-% calcium carbonate, preferably a ground calcium carbonate, based on the total weight of the nonwoven fabric.

[0083] According to one aspect of the present invention, a process for producing a nonwoven fabric is provided comprising the steps of

- a) providing a mixture of at least one polymer comprising a polyester and at least one filler comprising calcium carbonate,
- b) forming the mixture into fibers, filaments and/or film-like filamentary structures, and
- c) forming a nonwoven fabric from the fibers, filaments and/or film-like filamentary structures.

[0084] According to a preferred embodiment, the polyester is a polyethylene terephthalate and/or the calcium carbonate is surface-treated calcium carbonate.

[0085] The mixture of the at least one polymer comprising a polyethylene terephthalate and at the least one filler comprising calcium carbonate provided in process step a) can be prepared by any method known in the art. For example, the at least one polymer and the at least one filler may be dry blended, melt blended and optionally formed into granulates or pellets, or a masterbatch of the at least one polymer and the at least one filler may be premixed, optionally formed into granulates or pellets, and mixed with additional polymer or filler.

[0086] According to one embodiment, in step b) the mixture is formed into fibers, preferably by an extrusion process, and more preferably by a melt blown process, a spunbond process, or a combination thereof. However, any other suitable process known in the art for forming polymers into fibers may also be used.

[0087] Any melt blown process, spunbond process, or a combination thereof, known in the art may be employed to form the mixture of at least one polymer and at least one filler into fibers. For example, melt blown fibers may be produced by melting the mixture, extruding the mixture through a die or small orifices to form fibers, and attenuating the molten polymer fibers by hot air. Surrounding cool air can then be induced into the hot air stream for cooling and solidifying the fibers. In a spunbond process, the mixture can be melt-spun into fibers by pumping the molten mixture through a multitude of capillaries arranged in a uniform array of columns and rows. After extrusion, the fibers can be attenuated by high velocity air. The air creates a draw force on the fibers that draws them down to a desired denier. The spunbond process may have the advantage of giving nonwovens greater strength. A second component may be co-extruded in the spunbond process, which may provide extra properties or bonding capabilities.

[0088] Two typical spunbond processes are known in the art as the Lurgi process and the Reifenhäuser process. The Lurgi process is based on the extrusion of molten polymer through spinneret orifices followed by the newly formed extruded filaments being quenched with air and drawn by suction through Venturi tubes. Subsequent to formation, the filaments are disbursed on a conveyor belt to form a nonwoven web. The Reifenhäuser process differs from the Lurgi process in that the quenching area for the filaments is sealed, and the quenched air stream is accelerated, thus inducing more effective entrainment of the filaments into the air stream.

[0089] The fibers formed in process step b) may be drawn or elongated to induce molecular orientation and affect

crystallinity. This may result in a reduction in diameter and an improvement in physical properties.

[0090] According to one embodiment of the present invention, in step b) the mixture is formed into fibers by combining a melt blown process and a spunbond process.

[0091] By combining a meltblown and a spunbond process, a multilayer nonwoven fabric can be produced, for example, a nonwoven fabric comprising two outer layers of spunbond fabric and an inner layer of meltblown fabric, which is known in the art as spundbonded-meltblown-spunbonded (SMS) nonwoven fabric. Additionally either or both of these processes may be combined in any arrangement with a staple fiber carding process or bonded fabrics resulting from a nonwoven staple fiber carding process. In such described laminate fabrics, the layers are generally at least partially consolidated by one of the optional bonding methods described further below.

[0092] The nonwoven fabric produced by the inventive process can be a multilayered nonwoven fabric, preferably a spundbonded-meltblown-spunbonded (SMS), a meltblown-spunbonded-meltblown (MSM), a spundbonded-meltblown-spunbonded-meltblown (SMSM), a meltblown-spunbonded-meltblown-spunbonded (MSMS), a spundbonded-meltblown-meltblown-spunbonded (SMMS), or a meltblown-spunbonded-spunbonded-meltblown (MSSM) nonwoven fabric. Said nonwoven fabric may be compressed in order to ensure the cohesion of the layers, for example, by lamination.

[0093] According to one embodiment, steps b) and c) of the inventive process are repeated two or more times to produce a multilayer nonwoven fabric, preferably a spundbonded-meltblown-spunbonded (SMS), a meltblown-spunbonded-meltblown (MSM), a spundbonded-meltblown-spunbonded-meltblown (SMSM), a meltblown-spunbonded-meltblown-spunbonded (MSMS), a spundbonded-meltblown-meltblown-spunbonded (SMMS), or a meltblown-spunbonded-spunbonded-meltblown (MSSM) nonwoven fabric.

[0094] According to one embodiment, in step c) the nonwoven fabric is formed by collecting the fibers on a surface or carrier. For example, the fibers can be collected on a foraminous surface such as a moving screen or a forming wire. The fibers may be randomly deposited on the foraminous surface so as to form a sheet, which may be held on the surface by a vacuum force.

[0095] According to an optional embodiment of the inventive process, the obtained nonwoven fabric is subjected to a bonding step. Examples of bonding methods include thermal point bonding or calendering, ultrasonic bonding, hydroentanglement, needling and through-air bonding. Thermal point bonding or calendering is a commonly used method and involves passing nonwoven fabric to be bonded through a heated calender roll and an anvil roll. The calender roll is usually patterned in some way so that the entire fabric is not bonded across its entire surface. Various patterns can be used in the process of the present invention without affecting the mechanical properties of the web. For instance, the web can be bonded according to a ribbed knit pattern, a wire weave pattern, a diamond pattern, and the like. However, any other bonding method known in the art may also be used. Optionally, binding agents, adhesives, or other chemicals may be added during the binding step.

[0096] According to another optional embodiment of the inventive process, the obtained nonwoven fabric is subjected to a post-treatment step. Examples for post-treatment processes are direction orientation, creping, hydroentanglement, or embossing processes.

[0097] According to one aspect of the present invention the use of fibers for the manufacture of a non-woven fabric is provided, wherein the fibers comprise at least one polymer comprising a polyester and at least one filler comprising calcium carbonate. According to one preferred embodiment of the present invention the use of fibers for the manufacture of a non-woven fabric is provided, wherein the fibers comprise at least one polymer comprising a polyethylene terephthalate and at least one filler comprising calcium carbonate.

[0098] According to another aspect of the present invention the use of a polymer composition for the manufacture of a non-woven fabric is provided, wherein the polymer composition comprises at least one polymer comprising a polyester and at least one filler comprising calcium carbonate. According to another preferred embodiment of the present invention the use of a polymer composition for the manufacture of a non-woven fabric is provided, wherein the polymer composition comprises at least one polymer comprising a polyethylene terephthalate and at least one filler comprising calcium carbonate.

[0099] The nonwoven fabric of the present invention can be used in many different applications. According to one aspect of the present invention, the inventive nonwoven fabric is used in construction products, waterproofing, thermal insulation, soundproofing, roofing, consumer apparel, upholstery and clothing industries, industrial apparel, medical products, home furnishings, protective products, packaging materials, cosmetic products, hygiene products, or filtration materials. According to another aspect of the present invention, an article comprising the inventive nonwoven fabric is provided, wherein said article is selected from construction products, consumer apparel, industrial apparel, medical products, home furnishings, protective products, packaging materials, cosmetic products, hygiene products, or filtration materials.

[0100] Examples for construction products are house wrap, asphalt overlay, road and railroad beds, golf and tennis courts, wallcovering backings, acoustical wall coverings, roofing materials and tile underlayment, soil stabilizers and roadway underlayment, foundation stabilizers, erosion control products, canals construction, drainage systems, geomembranes protection and frost protection products, agriculture mulch, pond and canal water barriers, or sand infiltration

barriers for drainage tile. Other examples for construction products are fixations or reinforcements for earth fillings.

[0101] Examples for consumer apparel are interlinings, clothing and glove insulation, bra and shoulder paddings, handbag components, or shoe components. Examples for industrial apparel are tarps, tents, or transportation (lumber, steel) wrappings. Examples of medical products are protective clothing, face masks, isolation gowns, surgical gowns, surgical drapes and covers, surgical scrub suits, caps, sponges, dressings, wipes, orthopedic padding, bandages, tapes, dental bibs, oxygenators, dialyzers, filters for IV solutions or blood, or transdermal drug delivery components. Examples for home furnishings are pillows, cushions, paddings in quilts or comforters, dust covers, insulators, window treatments, blankets, drapery components, carpet backings, or carpets.

[0102] Examples for protective products are coated fabrics, reinforced plastic, protective clothing, lab coats, sorbents, or flame barriers. Examples of packaging materials are desiccant packing, sorbents packaging, gifts boxes, files boxes, various nonwoven bags, book covers, mailing envelopes, express envelopes, or courier bags. Examples of filtration materials are gasoline, oil and air filters, including filtration liquid cartridge and bag filters, vacuum bags, or laminates with non woven layers.

[0103] The scope and interest of the invention will be better understood based on the following examples which are intended to illustrate certain embodiments of the present invention and are non-limitative.

Examples

1. Measurement methods and materials

[0104] In the following, measurement methods and materials implemented in the examples are described.

Particle Size

[0105] The particle distribution of the calcium carbonate filler was measured using a Sedigraph 5120 from the company Micromeritics, USA. The method and the instruments are known to the skilled person and are commonly used to determine grain size of fillers and pigments. The measurement was carried out in an aqueous solution comprising 0.1 wt.-% $\text{Na}_4\text{P}_2\text{O}_7$. The samples were dispersed using a high speed stirrer and supersonics.

Intrinsic viscosity

[0106] The intrinsic viscosity was determined by a Schott AVS 370 system. The samples were dissolved in a 0.2 M NaCl solution, and subsequently, the pH was adjusted to 10 with NaOH. Measurements were performed at 25°C with a capillary type 0a and corrected using the Hagenbach correction.

Tensile test

[0107] The tensile test was carried out in accordance with ISO 527-3 using a 1 BA (1:2) testing sample at a speed of 50 mm/min. The properties that were determined via the tensile test are the yield stress, the break-strain, the break-stress, and the e-modulus of the polymer or polymer composition.

Charpy impact test

[0108] The charpy impact test was carried out in accordance with ISO 179-2:1997(E) using notched and unnotched testing samples having a size of $50 \times 6 \times 6$ mm.

Materials

[0109]

Polymer 1: Lighter S98 PET, commercially available from Equipolymers GmbH, Germany. Intrinsic viscosity: 0.85 ± 0.02 ; Tg: 78°C; T_m: 247°C; crystallinity: min. 50.

Polymer 2: Lighter C93 PET, commercially available from Equipolymers GmbH, Germany. Intrinsic viscosity: 0.80 ± 0.02 ; Tg: 78°C; T_m: 247°C; crystallinity: min. 50.

Filler: Omyafilm 707-OG (ground calcium carbonate), commercially available from Omya AG, Switzerland. Particle size d_{50} : 1.6 µm; top cut d_{98} : 6 µm.

2. Examples

Example 1

[0110] Testing samples containing polymer 1 only as well as a composition of 90 wt.-% polymer 1 and 10 wt.-% filler, based on the total weight of the composition, were prepared.

[0111] The mechanical properties of the testing samples were determined using the tensile test described above at a tension of 5 N with a 500 N tester. The results of the tensile test are shown in Table 1 below.

	Sample A (comparative)	Sample B (inventive)
Amount polymer (wt.-%)	100	90
Amount filler (wt.-%)	-	10
Thickness (μm)	206	205
Yield stress (N/mm^2)	55.9	58.8
Break-strain (%)	600	500
Break-stress (N/mm^2)	58.2	46.2
E-modulus (N/mm^2)	10 064	11 125
Table 1: Mechanical properties of samples A and B.		

[0112] The inventive sample B showed a higher yield stress and e-modulus compared to the comparative sample A, while the break-strain and break-stress of the inventive sample B was reduced. Thus, the inventive polymer composition (sample B) had a higher elasticity and softness compared to the pure PET polymer (sample A). This has a positive effect on the haptic properties of nonwoven fabrics produced from such a polymer composition, especially with respect to the softness of the material. For example, such a material is more pleasant to wear.

Example 2

[0113] Testing samples containing polymer 2 only as well as compositions of 90 wt.-% polymer 2 and 10 wt.-% filler, and 80 wt.-% polymer 2 and 20 wt.-% filler, based on the total weight of the composition, were prepared.

[0114] The mechanical properties of the testing samples were determined using the tensile test described above at a tension of 4 N with a 20 kN tester and the Charpy impact test. The results of the tensile test are shown in Table 2 below.

Table 2: Mechanical properties of samples C, D, and E.

	Sample C (comparative)	Sample D (inventive)	Sample E (inventive)
Amount polymer (wt.-%)	100	90	80
Amount filler (wt.-%)	-	10	20
Thickness (mm)	2.09	2.08	2.09
Yield stress (N/mm^2)	54.1	55.2	68.2
Break-strain (%)	830	578	242
Break-stress (N/mm^2)	~60	-50	-35
E-modulus (N/mm^2)	2280	2640	3070
Charpy (kJ/m^2) notched	2.9	1.6	1.0
Charpy (kJ/m^2) unnotched	150	72	62

[0115] The inventive samples D and E showed a higher yield stress and e-modulus compared to the comparative sample C, while the break-strain, the break-stress, and the impact resistance of the inventive samples C and D was reduced. Thus, the inventive polymer compositions (samples D and E) had a higher elasticity and softness compared to the pure PET polymer (sample C). This has a positive effect on the haptic properties of nonwoven fabrics produced

from such a polymer composition, especially with respect to the softness of the material. For example, such a material is more pleasant to wear.

Claims

1. A nonwoven fabric comprising
at least one polymer comprising a polyester, and
at least one filler comprising calcium carbonate.
2. The nonwoven fabric of claim 1, wherein the polyester is selected from the group consisting of a polyglycolic acid, a polycaprolactone, a polyethylene adipate, a polyhydroxyalkanoate, a polyhydroxybutyrate, a polyethylene terephthalate, a polytrimethylene terephthalate, a polybutylene terephthalate, a polyethylene naphthalate, a polylactic acid, or a mixture thereof, or copolymers thereof, preferably the polyester is a polyethylene terephthalate.
3. The nonwoven fabric of claim 1 or 2, wherein the polyester has a number average molecular weight from 5000 to 100000 g/mol, preferably from 10000 to 50000 g/mol, and more preferably from 15000 to 20000 g/mol.
4. The nonwoven fabric of any one of the foregoing claims, wherein the calcium carbonate is ground calcium carbonate, precipitated calcium carbonate, modified calcium carbonate, surface-treated calcium carbonate, or a mixture thereof, preferably surface-treated calcium carbonate.
5. The nonwoven fabric of any one of the foregoing claims, wherein the calcium carbonate has an average particle size d_{50} from 0.1 to 3 μm , preferably from 0.4 to 2.5 μm , more preferably from 1.0 to 2.3 μm , and most preferably from 1.2 to 1.8 μm .
6. The nonwoven fabric of any one of the foregoing claims, wherein the calcium carbonate has an top cut particle size d_{98} from 1 to 10 μm , preferably from 5 to 8 μm , more preferably from 4 to 7 μm , and most preferably from 6 to 7 μm .
7. The nonwoven fabric of any one of the foregoing claims, wherein the calcium carbonate is present in the nonwoven fabric in an amount from 0.1 to 50 wt.-%, preferably from 0.2 to 40 wt.-%, and more preferably from 1 to 35 wt.-%, based on the total weight of the nonwoven fabric.
8. A process for producing a nonwoven fabric comprising the steps of
 - a) providing a mixture of at least one polymer comprising a polyester and at least one filler comprising calcium carbonate,
 - b) forming the mixture into fibers, filaments and/or film-like filamentary structures, and
 - c) forming a nonwoven fabric from the fibers, filaments and/or film-like filamentary structures.
9. The process of claim 8, wherein in step b) the mixture is formed into fibers, preferably by an extrusion process, and more preferably by a melt blown process, a spunbond process, or a combination thereof.
10. The process of claim 9, wherein the nonwoven fabric is formed by collecting the fibers on a surface or carrier.
11. The process of any one of claims 8 to 10, wherein steps b) and c) are repeated two or more times to produce a multilayer nonwoven fabric, preferably a spundbonded-meltblown-spunbonded (SMS), a meltblown-spunbonded-meltblown (MSM), a spundbonded-meltblown-spunbonded-meltblown (SMSM), a meltblown-spunbonded-meltblown-spunbonded (MSMS), a spundbonded-meltblown-meltblown-spunbonded (SMMS), or a meltblown-spunbonded-spunbonded-meltblown (MSSM) nonwoven fabric.
12. Use of calcium carbonate as filler in a nonwoven fabric comprising at least one polymer comprising a polyester.
13. Use of fibers for the manufacture of a non-woven fabric, wherein the fibers comprise at least one polymer comprising a polyester and at least one filler comprising calcium carbonate.
14. Use of a nonwoven fabric according to any one of claims 1 to 7 in construction products, waterproofing, thermal insulation, soundproofing, roofing, consumer apparel, upholstery and clothing industries, industrial apparel, medical

products, home furnishings, protective products, packaging materials, cosmetic products, hygiene products, or filtration materials.

- 5 **15.** An article comprising the nonwoven fabric according to any one of claims 1 to 7, wherein said article is selected from construction products, consumer apparel, industrial apparel, medical products, home furnishings, protective products, packaging materials, cosmetic products, hygiene products, or filtration materials.

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