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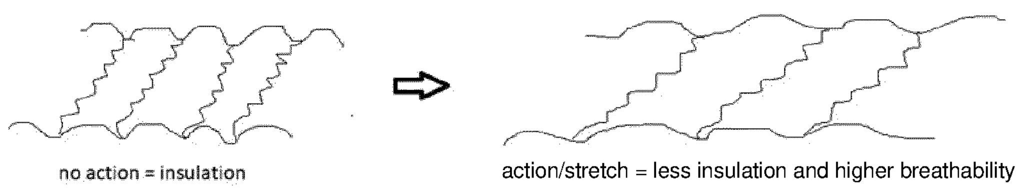
(54) ELASTIC NONWOVEN FABRIC AND METHOD OF MAKING THE SAME

(57) The present invention relates to a nonwoven fabric having a special structure which gives it elastic properties, to a process for its production and to its use for thermal and/or acoustic insulation and for the production of textile articles, in particular for thermally insulating clothing.

Fig. 2



EP 4 036 296 A1

Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a nonwoven fabric having a special structure which gives it elastic properties, to a process for its production and to its use for thermal and/or acoustic insulation and for the production of textile articles, in particular for thermally insulating clothing.

[0002] High demands are placed on nonwovens for thermal insulation in the textile sector, e.g. for sports and outdoor clothing. The desired property profile is complex and, in addition to pure insulation quality, includes requirements for high wear comfort, care and other material properties. These include high thermal insulation, good moisture management, i.e. the ability to absorb perspiration from the skin and release it into the environment, good drying properties and good insulating properties even when soaked, good washability and resistance to fiber migration, high wearing comfort, good haptic properties (softness), etc. The demand for nonwovens is particularly high. In particular, there is a need for nonwovens for wadding that have two actually contradictory properties: high thermal insulation, especially when the wearer is not active, and good air permeability, high breathability and the ability to remove excess heat when the wearer is active.

[0003] Currently, there is still a great demand for nonwovens for thermal and acoustic insulation that also meet ecological requirements for the use of sustainable materials. These include the elimination of fossil mineral oil as a basic material for the fibers used or at least a high degree of recycling, an ecologically acceptable manufacturing process and/or the biodegradability/compostability of the fibers.

[0004] EP 0390579 A1 describes a lightweight, insulating, stitch-bond nonwoven fabric and a method for its manufacture. According to this, a nonwoven fiber layer is stitched under tension with a plurality of needles using an elastic thread, the tension is released after stitching, and the nonwoven fabric thus stitch-bond is subjected to a shrinkage treatment at a temperature in a range of 50 to 100 °C. In this way, the bonded fiber layer is drawn together or crimped and the specific volume of the textile fabric is increased. In this process, shrinkage is produced mainly in the longitudinal direction of the nonwoven fabric, i.e. in the machine direction (md).

[0005] EP 0695382 A1 describes a process for the production of a gathered nonwoven fabric, in which the fiber layer is made dimensionally stable and wash-resistant by overstitching the gathered fiber layer with inelastic yarn. The result is a nonwoven fabric which has rows of corrugations or bulges and which has an extensibility in the longitudinal and transverse direction of at most 20 %.

[0006] EP 0303497 A2 describes a layer of substantially nonbonded fibers which is multi-needle stitched with elastic thread to form a nonwoven fabric. This causes contraction and drawing together of the nonwoven fabric surface, wherein the nonwoven fabric area after release of the tension force is not greater than 40 % of the initial area of the fiber layer.

[0007] The oject of the present invention is to provide a nonwoven fabric for thermal and acoustic insulation and wadding based thereon, which has good application properties and, in particular, good clothing physiological properties, especially for use in sports and outdoor clothing.

[0008] Surprisingly, it has now been found that this object is solved when, for the production of the nonwoven fabric, a nonwoven fiber material is subjected to a special stitch binding and a subsequent shrinkage treatment. The resulting nonwoven fabrics have a three-dimensional structure that gives them a combination of advantageous properties.

SUMMARY OF THE INVENTION

[0009] A first object of the invention is to provide a process for the production of a nonwoven fabric comprising the steps of

i) providing a nonwoven material,

ii) subjecting the nonwoven material to binding by incorporating a yarn by knitting with a plurality of needles to form parallel rows of zig-zag stitches arranged substantially in the longitudinal direction (md), wherein at least one yarn capable of thermal shrinkage is used for knitting,

iii) subjecting the bonded nonwoven material obtained in step ii) to a thermal shrinkage treatment at a temperature of at least 100 °C.

[0010] In a preferred embodiment, a Raschel process is used for the knitting in step ii).

[0011] Another object of the invention is a nonwoven fabric obtainable by a process as previously and hereinafter defined.

[0012] Another object of the invention is a nonwoven fabric comprising a nonwoven fibrous material bonded by incorporating a yarn capable of thermal shrinkage by knitting with a plurality of needles and having parallel rows of zig-zag stitches and rows of corrugations arranged substantially in the longitudinal direction (md), the crests and troughs of the corrugations being arranged substantially parallelly to the longitudinal direction (cmd) of the nonwoven fabric.

[0013] Another object of the invention is a thermally insulating wadding comprising or consisting of a nonwoven fabric as previously and hereinafter defined or obtainable by a process as previously and hereinafter defined.

[0014] Another object of the invention is a textile article comprising a nonwoven fabric as previously and hereinafter defined or obtainable by a process as previously and hereinafter defined, or comprising a thermally insulating wadding as previously and hereinafter defined.

[0015] Another object of the invention is the use of a nonwoven fabric as previously and hereinafter defined, or obtainable by a process as previously and hereinafter defined, or a thermally insulating wadding as previously and hereinafter defined, for the production of a textile article.

[0016] Another object of the invention is the use of a nonwoven fabric as previously and hereinafter defined or obtainable by a process as previously and hereinafter defined, or a thermally insulating wadding as previously and hereinafter defined, for thermal and/or acoustic insulation

DESCRIPTION OF THE INVENTION

[0017] The nonwoven fabrics according to the invention are particularly suitable for use in wadding for textile articles, such as sports and outdoor clothing. The nonwoven fabrics according to the invention are also suitable overall for thermal and/or acoustic insulation, e.g. of buildings, vehicles, technical installations and household devices.

[0018] The nonwoven fabrics according to the invention are sheet-like textile fabrics which have an essentially two-dimensional, planar extension (also referred to as the x,y plane) and a smaller thickness (in the direction of the z-axis orthogonal to the x,y plane = material thickness). The x-axis indicates the direction of greatest expansion or longitudinal direction and the y-axis, which is orthogonal to it, indicates the transverse direction. Due to the manufacturing process, nonwoven fabrics in the longitudinal direction as the direction of material flow through the machine used for production (i.e. in the direction of the x-axis, also described as roll direction, machine direction or md) often have different material properties than in the cross direction (i.e. in the direction of the y-axis, also described as counter roll direction, cross machine direction or cmd).

[0019] The nonwoven fabrics according to the invention have an advantageous three-dimensional structure, which is achieved by the production process according to the invention, especially the combination of a zig-zag stitch binding with a yarn capable of thermal shrinkage and a subsequent shrinkage treatment. This results in elastic extensibility in all spatial directions, especially in the transverse direction (cmd). In the context of the invention, the specification of extensibility specifies the ability of the nonwoven fabric to change its shape when a force is applied. The extensibility indicates how far the nonwoven fabric can be extended in a certain direction without tearing. The nonwoven fabrics of the invention are generally elastic, i.e. reversibly deformable. When the applied force is removed, the nonwoven fabric returns to its original shape. Preferably, the nonwoven fabrics according to the invention show a permanent change in length after elongation which is at most 15 %, preferably at most 10 %, in particular at most 5 %, especially at most 2 % of the maximum change in length during elongation.

[0020] The nonwoven fabrics according to the invention have a regular corrugated structure, with the corrugation crests and troughs arranged substantially parallelly to the longitudinal direction (cmd) of the nonwoven fabric.

[0021] With respect to the x-axis, all points on a straight line parallel to the x-axis have the same thickness. All points on a straight line, parallel to the y-axis, have variable thicknesses, corresponding to crests and troughs.

[0022] The nonwoven fabrics according to the invention have the following advantages:

- The nonwoven fabrics according to the invention have a three-dimensional nonwoven structure (corrugated structure), which gives them advantageous mechanical properties and application properties. In particular, they have elasticity, i.e. the ability to be reversibly stretchable. Especially in the transverse direction to the machine direction, the nonwoven fabrics according to the invention have a significantly higher extensibility than known stitch-bond nonwoven fabrics.
- The nonwoven fabrics according to the invention are suitable for waddings characterized by adaptive thermoregulative insulation. In other words, the wadding has an advantageous combination of warming properties as a result of good thermal insulation and the ability to transport away excess heat. The special structure makes it particularly suitable for use in sports and outdoor clothing, e.g. for cycling, running and skiing. When the wearer is active, the nonwoven fabric expands and excess heat can be removed by means of the "pump effect" induced by the movement. When the wearer is active, the nonwoven fabric is thin, highly permeable to air and has high breathability. In rest phases, when movement stops, the nonwoven fabric contracts, becomes more voluminous and the air trapped in the structure acts as an air cushion, again increasing the insulating effect.
- The wadding based on the nonwoven fabrics according to the invention is characterized by good thermal resistance values R_{ct} in the dry state.

- The nonwoven fabrics can be made partly or entirely from recycled fibers and/or biodegradable fibers. The wadding according to the invention can be used to comply with the OEKO-TEX standard.
- The nonwoven fabrics according to the invention have very low basis weights.
- The nonwoven fabrics according to the invention are resistant to washing and wearing and resistant to fiber migration. They are suitable for the sports, outdoor and fashion market, especially as interlinings for jackets, vests, pants, sweaters, hoodies, etc.

Step i)

[0023] In step i) of the process according to the invention, a nonwoven material is provided. For this purpose, a fiber composition can be subjected to a conventional process for producing a fiber web (nonwoven formation process) and, if necessary, to one or more subsequent steps for nonwoven fabric production. Suitable processes for the production of nonwovens and nonwoven fabrics are known to those skilled in the art and are described, for example, in H. Fuchs, W. Albrecht, Vliesstoffe, 2nd ed. 2012, p. 121 ff, Wiley-VCH. These include, for example, dry processes, wet processes, extrusion processes and solvent processes. For example, to produce the nonwoven fibrous material in step i), a fiber composition may be provided and subjected to a dry-laying process to produce a fiber web. The production of dry laid nonwovens can in principle be carried out by a carding process or by an aerodynamic process. After the carding process, a fiber web is formed by means of card, whereby the nonwoven can be laid in various ways. In parallelly laid nonwovens, the carded fibers are laid parallelly in machine direction, which usually results in different properties in machine direction (md) and in cross direction (cmd) of the fiber nonwoven material. In the case of crosslaid nonwovens, the fiber web, which is initially oriented in the machine direction, is doubled several times and in a crosswise manner with the aid of a crosslapper, as a result of which the properties of the nonwoven material in machine direction (md) and in the cross direction (cmd) are generally aligned. In aerodynamic processes, nonwovens are formed with the aid of air. For this purpose, fibers are conveyed to a rapidly rotating roll with the aid of an air stream, separated and laid down randomly to form a nonwoven fabric by the centrifugal force with an additional air stream.

[0024] For the production of the nonwoven material in step i), fiber webs can be stacked in several layers to form a nonwoven.

[0025] Furthermore, the properties can be modified, e.g. by stretching the nonwoven. To prepare the nonwoven material, a nonwoven can be subjected to thickness calibration and/or prebonding. The usual calendering processes, for example, are suitable for this purpose. Furthermore, the nonwoven material provided in step i) may be a nonwoven material for the production of which a nonwoven has been subjected to mechanical, thermal and/or chemical nonwoven bonding. In a particular embodiment, in step i) of the process according to the invention, a nonwoven material is provided which comprises a nonwoven material bonded with a binder or which consists of a nonwoven material bonded with a binder The nonwoven material preferably has a mass per unit area in the range from 10 g/m^2 to 200 g/m^2, particularly preferably from 20 g/m^2 to 150 g/m^2.

[0026] The nonwoven material preferably has a width (extension in the y-direction) of 50 mm to 2500 mm, particularly preferably 900 mm to 2000 mm.

[0027] In a preferred embodiment, the nonwoven material provided in step i) is coiled onto a roll. It can thus be fed to the binding in step ii) by knitting or stitching.

[0028] The nonwoven material provided in step i) may comprise fibers and fiber blends in general, as used in the production of nonwovens and nonwoven fabrics. Typically, the nonwoven material comprises fibers selected from natural fibers, man-made fibers of natural polymers, man-made fibers of synthetic polymers, and mixtures thereof.

[0029] Suitable natural fibers are selected from plant based fibers, animal fibers and blends thereof. Plant based fibers include, for example, cotton, linen (flax), jute, sisal, coir, hemp, bamboo, etc. Animal fibers include, for example, wool, silk and animal hair, e.g. alpaca, llama, camel, angora, mohair, cashmere, etc.

[0030] Suitable natural fibers are also those usually employed in paper pulps.

[0031] The nonwoven material provided in step i) may comprise further fibers comprising or consisting of at least one natural polymer. Preferably, the natural polymers are selected from chitin, chitosan, plant proteins, keratin and mixtures thereof.

[0032] The nonwoven material provided in step i) may further comprise man-made cellulose fibers (industrially produced cellulose fibers). A distinction is made between non-derivatized cellulose fibers and derivatized cellulose fibers. Non-derivatized cellulose fibers, also referred to as cellulose regenerated fibers, are obtained when the solid cellulose, which is in the form of cellulose pulp, is first dissolved and then subjected to fiber formation with re-solidification. In one particular embodiment, cellulose regenerated fibers are produced by a direct solvent process using a tertiary amine oxide as solvent. Preferably, N-methyl-morpholine-N-oxide (NMMO) is used as solvent. Cellulose regenerated fibers produced in this way are given the generic name Lyocell by BISFA (The International Bureau for the Standardisation of Man Made Fibres). Lyocell fibers are offered in a wide range of finenesses by the company Lenzing AG under the brand name Tencel®.

[0033] The nonwoven material provided in step i) may further comprise fibers selected from polyester fibers, polyamide fibers, polyurethane fibers, polyolefine fibers, polyacrylic ester fibers, polyacrylonitrile fibers, preoxidized polyacrylonitrile fibers (PAN), carbon fibers, polyvinyl alcohol fibers, polypropylene sulfide fibers (PPS), polyaramide fibers, polyamide imide fibers, thermoplastic starch fibers, man-made cellulose fibers, e.g. viscose, lyocell, cellulosic natural fibers, fibers of natural polymers different therefrom, polyesteramide fibers, glass fibers and mixtures thereof.

[0034] Preferably, the fibers used in step i) comprise fibers of synthetic polymers, in particular fibers of polyesters, especially polyethylene terephthalate, polyethylene naphthalate and polybutylene terephthalate, natural fibers, in particular fibers of wool, cotton or silk, mixtures thereof and/or mixtures with other fibers.

[0035] Preferably, the fibers used in step i) comprise at least one polyester or consist of at least one polyester. Preferably, the polyesters are selected from aliphatic polyesters, aliphatic-aromatic copolyesters and mixtures thereof.

[0036] Preferably, the aliphatic polyesters are selected from polylactic acid (PLA), poly(ethylene succinate) (PES), poly(butylene succinate) (PBS), poly(ethylene adipate) (PEA), poly(butylene succinate-co-butylene adipate) (PBSA), polyhydroxyacetic acid (PGA), poly(butylene succinate-co-butylene sebacate) (PBsu-co-BSe), poly(butylene succinate-co-butylene adipate) (PBSu-co-bad), poly(tetramethylene succinate) (PTMS), polycaprolactone (PCL), polypropriolactone (PPL), poly(3-hydroxybutyrate) (PHB), poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV), and mixtures thereof.

[0037] Preferred polyesters are also aliphatic-aromatic copolyesters (AAC), i.e. polyesters containing at least one aromatic dicarboxylic acid, at least one aliphatic diol and at least one further aliphatic component incorporated. Said other aliphatic component is preferably selected from aliphatic dicarboxylic acids, hydroxycarboxylic acids, lactones and mixtures thereof. In contrast to polyesters of at least one aromatic dicarboxylic acid and at least one aliphatic diol, such as polyethylene terephthalate (PET) or polybutylene terephthalate (PBT), the aliphatic-aromatic copolyesters (AAC) are generally biodegradable and/or compostable. Preferably, the aliphatic-aromatic copolyesters (AAC) are selected from copolyesters of 1,4-butanediol, terephthalic acid and adipic acid (BTA), copolyesters of 1,4-butanediol, terephthalic acid and succinic acid, copolyesters of 1,4-butanediol, terephthalic acid, isophthalic acid, succinic acid and lactic acid (PB-STIL). Mixtures (blends) of aliphatic-aromatic polyesters, such as polyethylene terephthalate (PET), polybutylene terephthalate (PBT), polyethylene isophthalate (PEIP), glycol-modified polyethylene terephthalate (PETG) with at least one of the previously mentioned aliphatic polyesters are also suitable. PETG is obtained by esterification of terephthalic acid with ethylene glycol and 1,4-cyclohexanedimethanol (CHDM).

[0038] Preferably, the fibers used in step i) comprise polyester fibers or consist of polyester fibers, in particular they comprise recycled polyester fibers or consist of recycled polyester fibers.

[0039] Furthermore, the fibers used in step i) preferably comprise at least one polyamide or consist of at least one polyamide.

[0040] Preferably, the polyamide fibers are selected from aliphatic polyamines. In particular the aliphatic polyamide is selected from PA 6, PA 6.6, PA 11, PA 12, PA 46, PA 66, PA 666, PA 69, PA 610, PA 612, PA 96, PA 99, PA 910, PA 912, PA 1212, copolymers and mixtures thereof, especially PA 6, PA 6.6 and mixtures thereof.

[0041] Furthermore, the fibers used in step i) preferably comprise at least one polypropylene or consist of at least one polypropylene.

[0042] In a particular embodiment, fibers obtained from a polymer blend are used in step i).

[0043] Further preferably, the fibers used in step i) comprise at least one polyesteramide or consist of at least one polyesteramide.

[0044] In a particular embodiment, the fibers used in step i) comprise at least one multicomponent fiber. Suitable multicomponent fibers comprise at least two polymer components. Suitable polymers are selected from the polymer components of the aforementioned man-made cellulose fibers, the polymer components of fibers different therefrom, and combinations thereof. Preferred are multicomponent fibers consisting of two polymer components (bicomponent fibers). Suitable types of bicomponent fibers are sheath/core fibers, side-by-side fibers, islands-in-the-sea fibers and pie piece fibers.

[0045] A preferred bicomponent fiber contains two polymer components selected from two different polyesters. Particularly preferred are the two different polyesters selected from polylactic acid (PLA), poly(ethylene succinate) (PES), poly(butylene succinate) (PBS), poly(ethylene adipate) (PEA), poly(butylene succinate-co-butylene adipate) (PBSA), polyhydroxyacetic acid (PGA), poly(butylene succinate-co-butylene sebacate) (PBsu-co-BSe), poly(butylene succinate-co-butylene adipate) (PBSu-co-bad), poly(tetramethylene succinate) (PTMS), polycaprolactone (PCL), polypropriolactone (PPL), poly(3-hydroxybutyrate) (PHB), poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV), and mixtures thereof. A special bicomponent fiber is a PLA/PBS bicomponent fiber, more specifically a PLA/PBS sheath/core bicomponent fiber, even more specifically a PLA/PBS sheath/core bicomponent fiber with PBS sheath and PLA core. Another special bicomponent fiber is a PTT (polytrimethylene terephthalate) / PET (polyethylene terephthalate) fiber.

[0046] Also preferred bicomponent fibers contain at least one polymer component selected from the polyester as defined above and at least one polymer component selected from polyamides. Suitable polyamides are aliphatic polyamines. In particular the aliphatic polyamide is selected from PA 6, PA 6.6, PA 11, PA 12, PA 46, PA 66, PA 666,

PA 69, PA 610, PA 612, PA 96, PA 99, PA 910, PA 912, PA 1212, copolymers and mixtures thereof.

[0047] The fibers used can be characterized by their fineness, i.e. the weight in relation to a certain length. The so-called fineness of the fibers is given in dtex (1 dtex = 0.1 tex or 1 gram per 10000 meters).

[0048] Preferably, the nonwoven fiber material provided in step i) comprises fibers having a fineness in the range of 0.5 to 10 dtex or consists of fibers having a fineness in the range of 0.5 to 10 dtex. Preferably, the nonwoven fiber material provided in step i) comprises fibers having a fineness in the range of 0.5 to 6.6 dtex or consists of fibers having a fineness in the range of 0.5 to 6.6 dtex.

[0049] Preferably, the nonwoven material provided in step i) comprises synthetic fibers having a fineness in the range of 0.5 to 6.6 dtex or consists of synthetic fibers having a fineness in the range of 0.5 to 6.6 dtex.

[0050] Preferably, the nonwoven material provided in step i) comprises synthetic fibers selceted from staple fibers having a fiber length in the range of 10 mm to 70 mm, more preferably 30 mm to 65 mm.

Step ii)

[0051] In step ii) of the process according to the invention, the nonwoven material provided in step i) is subjected to binding by incorporating a yarn by means of knitting with a plurality of needles, forming parallel rows of zig-zag stitches.

[0052] Preferably, a warp knitting process is used for the knitting in step ii), preferably a stitch knitting process or Raschel process. Equipment known under the designations Maliwatt, Kunit, Malinit, etc. can be used. A Raschel process is particularly preferred. These warpknitting technologies have in common that they can insert a yarn in a zig-zag pattern into a nonwoven. The binding is defined by means of needle offset of the needle bars, e.g. tricot, satin, velvet. Preferred is a binding of the tricot open type, tricot closed type, satin open type, satin closed type or velvet closed type. Especially preferred is a binding of the velvet closed type.

[0053] Preferably, in step ii), the parallel rows of stitches have a row spacing in the range of 1 to 7 rows per centimeter, more preferably in the range of 2 to 4 rows per centimeter.

[0054] Preferably, the stitch spacing in each row is in a range of 1 to 4 stitches per centimeter, more preferably in a range of 2 to 3 stitches per centimeter.

[0055] Suitable thermo shrinkable yarns used in step ii) are e.g. based on polyesters, polyamides, viskose, Lyocell, wool, etc.

[0056] Preferably, the thermo shrinkable yarn used in step ii) comprises at least one polyester or consists of at least one polyester, in particular selected from polyethylene terephthalate, polypropylene terephthalate, polybutylene terephthalate, polylactic acid and copolyester and mixtures thereof.

[0057] In particular, the at least one yarn used in step ii) is selected from yarns containing polyethylene terephthalate fibers or consisting of polyethylene terephthalate fibers. Preferably, the at least one yarn used in step ii) is selected from multifilament yarns, preferably multifilament yarns comprising 20 to 150 filaments, in particular multifilament yarns comprising 25 to 120 filaments.

[0058] Preferably, the at least one yarn has a thermal shrinkage at 200 °C, determined according to DIN EN 14621:2006-03 of from 5.0 % to 15.0 %, preferably from 7.0 % to 10.0 %.

[0059] Preferably, the at least one yarn has a maximum tensile elongation, determined according to DIN EN ISO 2062:2010-04, of 10.0 % to 50.0 %, preferably of 17.0 % to 27.0 %.

[0060] Preferably, the at least one yarn has a crimp, determined according to DIN 53830-4:1981-05, of from 35.0 % to 55.0 %, particularly preferably from 41.0 % to 51.0 %.

[0061] The yarns may be subjected to a mechanical pre-treatment e.g. by texturing in particular by crimping.

Step iii)

[0062] In step iii) of the process according to the invention, the bonded nonwoven material obtained in step ii) is subjected to a thermal shrinkage treatment at a temperature of at least 100 °C.

[0063] Preferably, the bonded nonwoven material is subjected to a thermal shrinkage treatment at a temperature in the range from 120 to 250 °C, particularly preferably from 140 to 220 °C.

[0064] The duration of the thermal treatment is preferably from 10 seconds to 120 minutes, more preferably from 30 seconds to 60 minutes, in particular from 1 minute to 60 minutes.

[0065] The thermal treatment can be carried out inline with the production of the bonded nonwoven fiber material or separately from it. The heating of the bonded nonwoven fiber material can preferably be carried out by means of hot air, by bringing it into contact with a heated surface, by means of steam or a combination thereof. Usually, a skilled person is familiar with these processes.

[0066] In a first embodiment, the bonded nonwoven material is passed through an oven for thermal shrinkage treatment. The temperature is, for example, in a range from 120 to 220 °C at a web speed of 1 to 30 m/min, preferably 2 to 25 m/min. The residence time in the oven is preferably in the range from 30 seconds to 30 minutes.

[0067] In another embodiment, the bond nonwoven material is treated with steam for thermal shrinkage treatment. The treatment time is preferably 30 seconds to 30 minutes.

[0068] In a further embodiment, the bond nonwoven fiber material is brought into contact with at least one heating roll for thermal shrinkage treatment. This process is preferably suitable for inline thermal shrinkage treatment following the binding of the nonwoven material in step ii).

Nonwoven fabric

[0069] A further object of the invention is the nonwoven fabric obtainable by the process according to the invention.

[0070] The thermoshrink results in a three-dimensional nonwoven structure in the sense of a regular corrugated structure. The thickness of the nonwoven according to DIN EN ISO 9073-2 (extension in z-axis, i.e. the amplitude of the corrugation) is preferably in a range from 1.2 to 10 mm, particularly preferably from 1.5 mm to 8 mm, especially from 2 mm to 5 mm.

[0071] Preferably, the nonwoven fabric according to the invention has a basis weight in the range of 20 to 200 g/m^2.

[0072] Preferably, the nonwoven fabric according to the invention has an extensibility in the transverse direction (cmd) in the range of 90 to 120 %.

[0073] Preferably, the nonwoven fabric according to the invention has an extensibility in the machine direction (md) in the range of 20 to 60 %, determined according to DIN EN 29073-3:1992-08.

[0074] Preferably, the nonwoven fabric according to the invention has rows of corrugations arranged essentially in the transverse direction (cmd). The material thickness in the region of the crests of the corrugations (in the direction of the z-axis) is preferably in a range from 2 to 7 mm. The material thickness in the area of the corrugation troughs is preferably in a range of 0.2 to 2.0 mm.

Wadding

[0075] The nonwoven fabric according to the invention is advantageously suitable for the production of waddings (linings) which can be used as a thermally insulating material in various textile articles.

[0076] Thus, another object of the invention is a thermally insulating wadding comprising or consisting of a nonwoven fabric as previously defined.

[0077] In a preferred embodiment, the wadding according to the invention comprises at least one binder. In a suitable embodiment, the treatment with a binder can be carried out during and/or after the provision of the nonwoven fiber material in step i). For this purpose, the web can be sprayed or impregnated with at least one binder after it has been deposited from the card. The treatment with a binder can also be carried out after step ii), i.e. after the knitted binding. As a rule, the treatment with a binder is carried out before the thermal treatment in step iii).

[0078] The thermal insulating wadding according to the invention preferably comprises the at least one binder in an amount of from 1 to 30 % by weight, preferably from 2 to 25 % by weight, based on the total weight of the wadding.

[0079] The binder used to produce the wadding according to the invention is preferably selected from binders of the acrylate, styrene acrylate, ethylene vinyl acetate, butadiene acrylate, SBR, NBR and/or polyurethane type.

[0080] As described previously, the wadding according to the invention is characterized by very good thermal insulation and moisture management.

[0081] To modify their properties, e.g. to reduce or avoid fiber loss, the wadding according to the invention can be subjected to at least one further treatment by a chemical process and/or physical (mechanical and/or thermal) process. Preferably, this treatment is selected from spray application of a binder material, addition of thermoplastic binders to the fiber blend, sandwich structuring of the wadding, treatment with a textile additive to modify the hydrophilic/hydrophobic properties, and combinations thereof.

[0082] The bonding of nonwovens with the aid of binders is a special type of thermal treatment process. The melting or softening of the binder fibers produces predominantly dot-like bindings. For the purposes of the invention, the term binder fibers refers to thermoplastic synthetic fibers which, compared with other fibers present in the fiber blend, either can be melted at all or have a melting point at least 1 °C lower than that of the other thermoplastic fibers present in the fiber blend. Preferably, the binder fibers have a melting point at least 5 °C, and more preferably at least 10 °C, lower than the other fibers contained in the fiber blend. This ensures good selective thermal bonding. Homogeneous binder fibers, bicomponent binder fibers or mixtures thereof can be used for bonding the nonwoven. Bicomponent binding fibers consist of two different polymers, the melting point of one polymer preferably being at least 5 °C, and more preferably at least 10 °C, higher than that of a second polymer also present in the fibers. These polymers are preferably present as a core/sheath structure, with the material of the core having the higher melting point and the material of the sheath having the lower melting point. Also suitable are "side by side" fibers or "sea-island type" fibers. Bicomponent binder fibers with a core/sheath structure are preferred. These include, for example, bicomponent fibers in which the sheath is made of polyethylene and the core of polypropylene.

[0083] Sandwich-structured means that the wadding comprises at least two nonwoven layers. Preferably, the sandwich-structured nonwoven material can consist of 2, 3, 4, 5 or 6 layers. A nonwoven material composed of layers can also be considered a nonwoven composite. The individual layers may have the same structure, or two layers may differ in each case in at least one physical and/or chemical property. This includes, for example, the type of fibers, in the case of fiber blends, their composition, the fineness of the fibers, etc. The layers can be bond by conventional methods, e.g. needling, sewing, bonding, laminating, etc.

[0084] To modify its properties, the wadding according to the invention can be subjected to a treatment with a textile additive to modify the hydrophilic/hydrophobic properties.

Textile article

[0085] The textile article is preferably selected among clothing articles. These specifically include outerwear, functional sportswear, outdoor clothing, lightweight sports jackets, walking jackets, ski jackets, ski pants, children's clothing, work-wear, uniforms, footwear and gloves. Further, the textile articles may be sleeping bags.

[0086] Another object of the invention is to use a nonwoven fabric as previously defined or obtainable by a process as previously defined or a thermal insulating padding as previously defined for thermal and/or acoustic insulation.

[0087] The nonwovens and waddings according to the invention are advantageously suited for thermal insulation, for example for insulation systems for use in the construction industry, e.g. for insulating ceilings, roofs, floors, walls and other building surfaces. They are also suitable for insulating various building materials, such as pipes, roller shutter boxes and window profiles, technical equipment, such as heating systems, or household devices.

[0088] The nonwovens and waddings according to the invention are also advantageously suited for acoustic insulation, e.g. of buildings, automobiles, technical equipment, household devices, etc. The acoustic insulation can be based on sound proofing or acoustic treatment.

[0089] Sound insulation impedes the propagation of sound by placing an obstacle in the path of the propagating sound wave front, the surface of which is such that sound waves are reflected particularly well. Sound insulation serves to acoustically isolate rooms from unwanted noise from neighbouring rooms or from outside.

[0090] Sound attenuation or sound absorption reduces the sound energy by partially converting it into another form of energy (e.g. heat) or by absorbing it. This leads to a specific change in the sound of the room, less reverberation and better room acoustics. In building technology, the principle of sound damping is often used to reduce noise, whereby the sound waves come into contact with structured and/or porous surfaces.

[0091] EP 3375602 A1 describes sound-absorbing textile composites comprising a) an open-pored carrier layer comprising coarse staple fibers with a linear density of 3 to 17 dtex and fine staple fibers with a linear density of 0.3 to 2.9 dtex, and b) a flow layer arranged on the carrier layer and comprising a microporous foam layer. These composites are used specifically for sound absorption in automotive applications. Reference is made here to the acoustic insulation options described in this document.

[0092] Preferred embodiments are the followings:

1. A process for the production of a nonwoven fabric comprising the steps of

    i) providing a nonwoven material,

    ii) subjecting the nonwoven material to binding by incorporating a yarn by knitting with a plurality of needles to form parallel rows of zig-zag stitches arranged substantially in the longitudinal direction (md), wherein at least one yarn capable of thermal shrinkage is used for knitting,

    iii) subjecting the bonded nonwoven material obtained in step ii) to a thermal shrinkage treatment at a temperature of at least 100°C.

2. The process according to embodiment 1, wherein the nonwoven material provided in step i) has a mass per unit area in a range from 10 g/m^2 to 200 g/m^2, preferably a mass per unit area in a range from 20 g/m^2 to 150 g/m^2.

3. The process according to embodiment 1 or 2, wherein the nonwoven material provided in step i) comprises fibers selected from natural fibers, man-made fibers of natural polymers, man-made fibers of synthetic polymers and mixtures thereof.

4. The process according to any one of the embodiments 1, 2 or 3, wherein the nonwoven material provided in step i) comprises fibers of synthetic polymers, in particular fibers of polyesters, especially polyethylene terephthalate, polyethylene naphthalate and polybutylene terephthalate, natural fibers, in particular fibers of wool, cotton or silk,

mixtures thereof and/or mixtures with other fibers, in particular the nonwoven material provided in step i) comprises polyester fibers or consists of polyester fibers, preferably comprises recycled polyester fibers or consists of recycled polyester fibers.

5. The process according to any one of the embodiments 1, 2, 3, or 4, wherein the nonwoven material provided in step i) comprises fibers having a fineness in the range from 0.5 to 10 dtex or consists of fibers having a fineness in the range from 0.5 to 10 dtex.

6. The process according to any one of the embodiments 1, 2, 3, 4 or 5, wherein in step ii) the parallel rows of stitches have a row spacing in the range from 1 to 7 rows per centimeter, preferably in the range from 2 to 4 rows per centimeter.

7. The process according to any one of embodiments 1, 2, 3, 4, 5 or 6, wherein in step ii) the stitch spacing in each row is in a range from 1 to 4 stitches per centimeter, preferably in a range from 2 to 3 stitches per centimeter.

8. The process according to any one of the embodiments 1, 2, 3, 4, 5, 6 or 7, a warp knitting process, preferably a stitch knitting process or Raschel process, in particular a Raschel process, is used for knitting in step ii).

9. The process according to any one of the embodiments 1, 2, 3, 4, 5, 6, 7 or 8, wherein the nonwoven material is provided in step ii) with a zig-zag binding of the tricot open type, tricot closed type, satin open type, satin closed type or velvet closed type, preferably the nonwoven material is provided in step ii) with a zig-zag binding of the velvet closed type.

10. The process according to any one of the embodiments 1, 2, 3, 4, 5, 6, 7, 8 or 9, wherein the at least one yarn used in step ii) is selected from yarns comprising or consisting of polyester fibers, preferably yarns comprising or consisting of polyethylene terephthalate fibers.

11. The process according to any one of the embodiments 1, 2, 3, 4, 5, 6, 7, 8, 9 or 10, wherein the at least one yarn used in step ii) is selected from multifilament yarns, preferably multifilament yarns comprising 20 to 150 filaments, in particular multifilament yarns comprising 25 to 120 filaments.

12. The process according to any one of the embodiments 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 or 11, wherein the at least one yarn has a thermal shrinkage at 200°C, determined according to DIN 14621, of from 5.0 % to 15.0 %, preferably from 7.0 % to 10.0 %.

13. The process according to any one of the embodiments 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 or 12, wherein the at least one yarn has a maximum tensile elongation, determined according to DIN EN ISO 2062:2010-04, of from 10.0 to 50.0 %, preferably from 17.0 to 27.0 %.

14. A process according to any one of the embodiments 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 or 13, wherein the at least one yarn has a crimp, determined according to DIN 53830-4:1981-05, of from 41.0 % to 51.0 %.

15. The process according to any one of the embodiments 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 or 14, wherein in step iii) the bonded nonwoven material obtained in step ii) is subjected to a thermal shrinkage treatment at a temperature of from 120 to 250°C, preferably from 140 to 220°C.

16. A nonwoven fabric obtainable by a process as defined in any one of the embodiments 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 or 15.

17. A nonwoven fabric comprising a nonwoven fibrous material bond by incorporating a yarn capable of thermal shrinkage by knitting with a plurality of needles and having parallel rows of zig-zag stitches and rows of corrugations arranged substantially in the longitudinal direction (md), the crests and troughs of the corrugations being arranged substantially parallelly to the longitudinal direction (cmd) of the nonwoven fabric.

18. The nonwoven fabric according to the embodiments 16 or 17, having a basis weight in the range of 20 to 200 g/m^2.

19. The nonwoven fabric according to any one of the embodiments 16, 17 or 18, which has an extensibility in the transverse direction (cmd) in the range of 90 to 120 %.

20. The nonwoven fabric accrding to any one of the embodiments 16, 17, 18 or 19, which has an extensibility in the machine direction (md) ranging from 20 to 60 %.

21. The nonwoven fabric according to any one of the embodiments 16, 17, 18, 19 or 20, which forms rows of corrugations arranged substantially in the transverse direction (cmd), wherein the material thickness in the region of the corrugation crests is in a range from 2 to 7 mm and in the region of the corrugation troughs is in a range from 0.2 to 2 mm.

22. A thermally insulating wadding comprising or consisting of a nonwoven fabric as defined in any one of the embodiments 16, 17, 18, 19, 20 or 21 or obtainable by a process as defined in anyone of embodiments 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 or 15.

23. The thermally insulating wadding according to the embodiment 22, comprising at least one binder, preferably in an amount of from 1 to 30 % by weight, preferably from 2 to 25 % by weight, based on the total weight of the wadding.

24. The thermally insulating wadding according to the embodiments 22 or 23, comprising binder fibers, preferably in an amount of from 15 % to 40 % by weight based on the total weight of the wadding.

25. The thermally insulating wadding of the embodiment 23, wherein the binder is selected from acrylate, styrene acrylate, ethylene vinyl acetate, butadiene acrylate, SBR, NBR and/or polyurethane type binders.

26. A textile article comprising a nonwoven fabric as defined in any one of the embodiments 16, 17, 18, 19, 20 or 21 or obtainable by a process as defined in any one of the embodiments 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 or 15, or comprising a thermally insulating wadding as defined in any one of the embodiments 22, 23, 24 or 25.

27. Use of a nonwoven fabric as defined in any one of embodiments 16, 17, 18, 19, 20 or 21, or obtainable by a process as defined in any one of embodiments 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 or 15, or a thermally insulating wadding as defined in any one of the embodiments 22, 23, 24 or 25, for the production of a textile article.

28. Use according to embodiment 27, wherein said textile article is selected from clothing articles, in particular outerwear, functional sportswear, outdoor clothing, lightweight sports jackets, walking jackets, ski jackets, ski pants, children's clothing, workwear, uniforms, gloves and sleeping bags.

29. Use of a nonwoven fabric as defined in any one embodiments 16, 17, 18, 19, 20 or 21 or obtainable by a process as defined in any one of embodiments 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 or 15, or a thermally insulating wadding as defined in any one of the embodiments 22, 23, 24 or 25, for thermal and/or acoustic insulation.

DESCRIPTION OF THE DRAWINGS

[0093] Figure 1 depicts a nonwoven fabric according to the invention having a regular corrugated structure, with the corrugation crests and troughs arranged substantially in cross machine direction (cmd) of the nonwoven fabric. Shown is a structure in a rest phase, i.e. a phase wherein the wearer is not in action. The nonwoven fabric contracts, becomes voluminous and the air trapped in the structure acts as an air cushion, increasing the thermal insulating effect.

[0094] Figure 2 depicts the change in the structure of the nonwoven fabric when the wearer is active. The nonwoven fabric expands and excess heat can be removed by means of the "pump effect" induced by the movement.

[0095] Figure 3 is a side view showing the crests and troughs of the corrugations of the nonwoven fabric.

EXAMPLES

Example 1

[0096] For manufacturing a nonwoven according to the invention, a wadding based on a carded recycled polyester fibre blend was employed, which, based on the total weight, contained 40 % fibres with a fineness of 1.7 dtex and a cut length of 38 millimetres and 60 % fibres with a fineness of 3.3 dtex and a cut length of 64 millimetres. Binding is performed by means of a spray binder being applied on both sides. Curing of the binder and consolidation are effected in an oven using hot air. The binder accounts for 35 % of the total weight of the wadding.

[0097] The weight per unit area at the end of the nonwoven process is 45 g/m^2 with a roll width at the winder of 190 cm.

[0098] The nonwoven is fed into a Raschel machine (Kettenwirkmaschine RS 2-V, Karl Mayer Textilmaschinenfabrik, DE-Obertshausen) as a roll material having a width of 190 cm.

[0099] Trevira PET filament yarns, consisting of 35 filaments, are incorporated into the nonwoven by a lateral offset of the needle bar and reinforce the nonwoven with a velvet closed binding.

[0100] A stitch length of 0.33 cm (3 stitches / cm) with a division of 4.5 needles / 25 mm is obtained. This corresponds to a quantity of 4 % filament yarn per square meter. The filament yarn is processed under tension.

[0101] The velocity of the machine is 4 m / min, corresponding to 1200 strokes per minute. The nonwoven, having a total width of 185 cm, is pulled off and wound up and afterwards led through a steamer at 15 m / min and treated with 500 kg steam per hour. The total width of the resulting fiber-enforced nonwoven is 155 cm.

Example 2

[0102] For manufacturing a nonwoven according to the invention, a wadding based on a carded recycled polyester fiber blend was employed, which, based on the total weight, contained 95 % polyester fibres and 5 % polyamide fibers. Binding is performed by means of a spray binder being applied on both sides. Curing of the binder and consolidation is effected in an oven using hot air. The binder accounts for 35 % of the total weight of the wadding.

[0103] The weight per unit area after winding is 50 g/m^2 with a roll width at the winder of 150 cm.

[0104] The nonwoven is fed into a Raschel machine (Kettenwirkmaschine Raschel Gauge: E18, Karl Mayer Textilmaschinenfabrik, DE-Obertshausen) as a roll material having a width of 150 cm.

[0105] Trevira PET filament yarns, consisting of 35 filaments, are incorporated into the nonwoven by a lateral offset of the needle bar and reinforce the nonwoven with a velvet closed binding.

[0106] A stitch length of 0.33 cm (3 stitches / cm) with a division of 4.5 needles / 25 mm is obtained. This corresponds to a quantity of 4 % filament yarn per square meter. The filament yarn is processed under tension.

[0107] The velocity of the machine is 4 m / min, corresponding to 1200 strokes per minute. The nonwoven, having a total width of 145 cm, is pulled off and wound up and afterwards led through a steamer at 15 m / min and treated with 500 kg steam per hour. The total width of the resulting fiber-enforced nonwoven is 130 cm.

Example 3

[0108] For manufacturing a nonwoven according to the invention, a wadding based on a carded recycled polyester fiber blend was employed, which, based on the total weight, contained 100 % polyester fibres. Binding is performed by means of a spray binder being applied on both sides. Curing of the binder and consolidation is effected in an oven using hot air. The binder accounts for 23 % of the total weight of the wadding.

[0109] The weight per unit area after winding is 70 g/m^2 with a roll width at the winder of 150 cm.

[0110] The nonwoven is fed into a Raschel machine (Kettenwirkmaschine Raschel Gauge: E18, Karl Mayer Textilmaschinenfabrik, DE-Obertshausen) as a roll material having a width of 150 cm.

[0111] Trevira PET filament yarns, consisting of 35 filaments, are incorporated into the nonwoven by a lateral offset of the needle bar and reinforce the nonwoven with a velvet closed binding.

[0112] A stitch length of 0.5 cm (2 stitches / cm) with a division of 4.5 needles / 25 mm is obtained. This corresponds to a quantity of 1.5 % filament yarn per square meter. The filament yarn is processed under tension.

[0113] The velocity of the machine is 4 m / min, corresponding to 1200 strokes per minute. The nonwoven, having a total width of 145 cm, is pulled off and wound up and afterwards led through a steamer at 15 m / min and treated with 500 kg steam per hour. The total width of the resulting fiber-enforced nonwoven is 130 cm.

Example 4

[0114] For manufacturing a nonwoven according to the invention, a wadding based on a carded recycled polyester fiber blend was employed, which, based on the total weight, contained 100 % polyester fibres. Binding is performed by means of a spray binder being applied on both sides. Curing of the binder and consolidation is effected in an oven using hot air. The binder accounts for 23 % of the total weight of the wadding.

[0115] The weight per unit area after winding is 40 g/m^2 with a roll width at the winder of 190 cm.

[0116] The nonwoven is fed into a Raschel machine (Kettenwirkmaschine Raschel Gauge: E9, Karl Mayer Textilmaschinenfabrik, DE-Obertshausen) as a roll material having a width of 190 cm.

[0117] PET filament yarns, consisting of 35 filaments, are incorporated into the nonwoven by a lateral offset of the needle bar and reinforce the nonwoven with a velvet closed binding.

[0118] A stitch length of 0.33 cm (3 stitches / cm) with a division of 4.5 needles / 25 mm is obtained. This corresponds to a quantity of 4 % filament yarn per square meter. The filament yarn is processed under tension.

[0119] The velocity of the machine is 1,8 m / min, corresponding to 400 strokes per minute. The nonwoven, having a total width of 185 cm, is pulled off via heating rollers and wound up. The total width of the resulting fiber-enforced nonwoven is 155 cm.

Test methods

[0120]

I) Measurement of thermal resistance R_{ct} [m^2K/W] (thermal insulation) of a moist filling material according to DIN EN ISO 11092:2014-12[A] (Textiles - Physiological effects - Measurement of thermal and water vapour resistance under steady-state conditions (sweating guarded-hotplate test))

For the insulating effect of thermal insulating filling materials, it is decisive to what extent they retain their thermal insulating effect even if they have become damp, e.g. due to heavy perspiration of the wearer. Textiles whose thermal insulation drops sharply in this case are perceived as unpleasantly cold.

Test device: thermoregulation model of the human skin

Test climate: T_a = 20 °C, φ_a = relative humidity of 65 %

II) Measurement of resistance to water vapour permeability R_{et} [m^2Pa/W] of a filling material according to DIN EN ISO 11092:2014-12[A], Short-term water vapour absorption capacity F_i [g/m^2], buffering capacity of water vapour ("humidity compensation number" F_d) and the drying time of the sweat from the textile.

The R_{et} value (RET = Resistance to Evaporating Heat Transfer) defines, how much resistance the fabric offers to the passage of water vapour. The lower the RET value of a garment, the more breathable it is.

Test device: thermoregulation model of the human skin

Test climate: T_a = 35 °C, φ_a = relative humidity of 40 %

III) Determination of mass per unit area is performed according to DIN EN 29073-1:1992-08.
IV) Determination of thickness (overall, corrugation crest, corrugation trough) is performed according to DIN EN ISO 9073-2:1997-02.
V) Determination of tensile strength and elongation is performed according to DIN EN 29073-3:1992-08.

Results:

[0121]

example no.	Mass per unit area [g/m^2]	Thickness Cor. crest [mm]	Thickness Cor. trough [mm]	TS MD [N]	TS CMD [N]	EN CMD [%]	Module at 10 N [%]	Force at 15% [N]	Force at 25% [N]	R_{ct} [m^{2}K/W]	Ret [m^{2}K/W] stretched 10 %	Ret [Pa*m^2/W]	Ret [Pa*m^2/W] stretched 10 %
basic nonwoven	45	5.6 (overall)			10	44.2	44.7	0.6	1.8	-		-	
1	60	4.0	1	33.8	45	114	73.4	0.3	0.6	0.086	0.0710	5.27	4.70
2	65	3.0	1	31	40	70	70.2	0.3	0.7	0.0756	0.0614	7.50	6.65
3	80	2.6	1	41	32	54	30.0	1.5	5	-		-	-
4	40	2.0	1	21.3	10	60	64	1.5	2.8	-	-	-	-
MD = machine direction, CMD = cross machine direction TS = tensile strength, EN = elongation													

Claims

1. A process for the production of a nonwoven fabric comprising the steps of

   i) providing a nonwoven material,
   ii) subjecting the nonwoven material to binding by incorporating a yarn by knitting with a plurality of needles to form parallel rows of zig-zag stitches arranged substantially in the longitudinal direction (md), wherein at least one yarn capable of thermal shrinkage is used for knitting,
   iii) subjecting the bonded nonwoven material obtained in step ii) to a thermal shrinkage treatment at a temperature of at least 100°C.

2. The process according to claim 1, wherein the nonwoven material provided in step i) has a mass per unit area in a range from 10 g/m^2 to 200 g/m^2, preferably a mass per unit area in a range from 20 g/m^2 to 150 g/m^2.

3. The process according to claim 1 or 2, wherein the nonwoven material provided in step i) comprises fibers selected from natural fibers, man-made fibers of natural polymers, man-made fibers of synthetic polymers and mixtures thereof.

4. The process according to any one of the preceding claims, wherein the nonwoven material provided in step i) comprises fibers of synthetic polymers, in particular fibers of polyesters, especially polyethylene terephthalate, polyethylene naphthalate and polybutylene terephthalate, natural fibers, in particular fibers of wool, cotton or silk, mixtures thereof and/or mixtures with other fibers, in particular the nonwoven material provided in step i) comprises polyester fibers or consists of polyester fibers, preferably comprises recycled polyester fibers or consists of recycled polyester fibers.

5. The process according to any one of the preceding claims, wherein the nonwoven material provided in step i) comprises fibers having a fineness in the range from 0.5 to 10 dtex or consists of fibers having a fineness in the range from 0.5 to 10 dtex.

6. The process according to any one of the preceding claims, wherein in step ii) the parallel rows of stitches have a row spacing in the range from 1 to 7 rows per centimeter, preferably in the range from 2 to 4 rows per centimeter.

7. The process according to any one of the preceding claims, wherein in step ii) the stitch spacing in each row is in a range from 1 to 4 stitches per centimeter, preferably in a range from 2 to 3 stitches per centimeter.

8. The process according to any one of the preceding claims, a warp knitting process, preferably a stitch knitting process or Raschel process, in particular a Raschel process, is used for knitting in step ii).

9. The process according to any one of the preceding claims, wherein the nonwoven material is provided in step ii) with a zig-zag binding of the tricot open type, tricot closed type, satin open type, satin closed type or velvet closed type, preferably the nonwoven material is provided in step ii) with a zig-zag binding of the velvet closed type.

10. The process according to any one of the preceding claims, wherein the at least one yarn used in step ii) is selected from yarns comprising or consisting of polyester fibers, preferably yarns comprising or consisting of polyethylene terephthalate fibers, in particular the at least one yarn is selected from multifilament yarns, especiallymultifilament yarns comprising 20 to 150 filaments, more especiallymultifilament yarns comprising 25 to 120 filaments.

11. The process according to any one of the preceding claims, wherein the at least one yarn has one or more of the following properties:

   - has a thermal shrinkage at 200°C, determined according to DIN 14621, of from 5.0 % to 15.0 %, preferably from 7.0 % to 10.0 %;
   - has a maximum tensile elongation, determined according to DIN EN ISO 2062:2010-04, of from 10.0 to 50.0 %, preferably from 17.0 to 27.0 %;
   - has a crimp, determined according to DIN 53830-4:1981-05, of from 41.0 % to 51.0 %.

12. A nonwoven fabric obtainable by a process as defined in any one of claims 1 to 11.

13. A nonwoven fabric comprising a nonwoven fibrous material bond by incorporating a yarn capable of thermal shrinkage by knitting with a plurality of needles and having parallel rows of zig-zag stitches and rows of corrugations arranged substantially in the longitudinal direction (md), the crests and troughs of the corrugations being arranged substantially parallelly to the longitudinal direction (cmd) of the nonwoven fabric.

14. The nonwoven fabric according to claim 12 or 13, has one or more of the following properties:

- has a basis weight in the range of 20 to 200 g/m^2;
- has an extensibility in the transverse direction (cmd) in the range of 90 to 120 %;
- has an extensibility in the machine direction (md) ranging from 20 to 60 %;
- forms rows of corrugations arranged substantially in the transverse direction (cmd), wherein the material thickness in the region of the corrugation crests is in a range from 2 to 7 mm and in the region of the corrugation troughs is in a range from 0.2 to 2 mm.

15. A thermally insulating wadding comprising or consisting of a nonwoven fabric as defined in any one of claims 12 to 14 or obtainable by a process as defined in any one of claims 1 to 11.

16. The thermally insulating wadding according to claim 15, comprising at least one binder, preferably in an amount of from 1 to 30 % by weight, preferably from 2 to 25 % by weight, based on the total weight of the wadding and/or binder fibers, preferably in an amount of from 15 % to 40 % by weight based on the total weight of the wadding.

17. A textile article comprising a nonwoven fabric as defined in any one of claims 12 to 14 or obtainable by a process as defined in any one of claims 1 to 11, or comprising a thermally insulating wadding as defined in any one of claims 15 to 16.

18. Use of a nonwoven fabric as defined in any one of claims 12 to 14, or obtainable by a process as defined in any one of claims 1 to 11, or a thermally insulating wadding as defined in any one of claims 15 to 16, for the production of a textile article or thermal and/or acoustic insulation, preferably wherein said textile article is selected from clothing articles, in particular outerwear, functional sportswear, outdoor clothing, lightweight sports jackets, walking jackets, ski jackets, ski pants, children's clothing, workwear, uniforms, gloves and sleeping bags.

Fig. 1

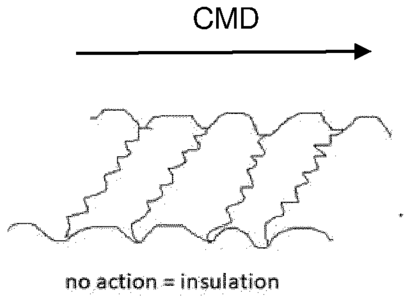


Fig. 2

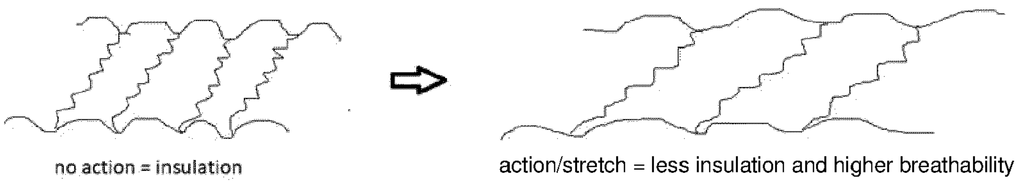
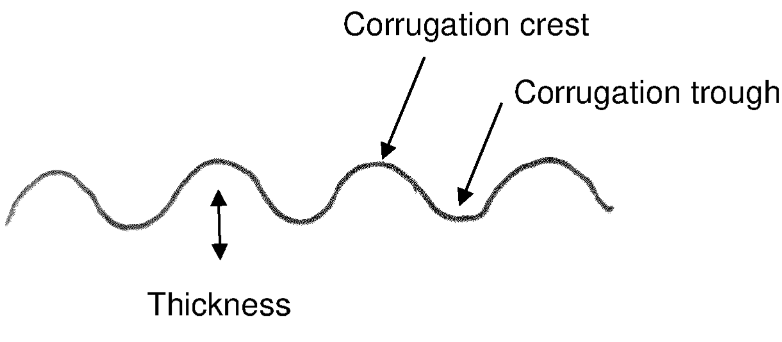


Fig. 3



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EUROPEAN SEARCH REPORT

Application Number
EP 22 15 3194

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 2004/092476 A2 (XYMID LLC [US]; TSIARKEZOS STEPHEN H [US]; ZAFIROGLU DIMITRI P [US]) 28 October 2004 (2004-10-28) * figures 3a-4b; examples *	1-18	INV. D04H1/52 D04H1/50 A41D31/06
X	WO 2005/091836 A2 (SWZ LLC [US]; ZAFIROGLU DIMITRI P [US]) 6 October 2005 (2005-10-06) * example 1 *	1-18	
X,D	EP 0 390 579 A1 (DU PONT [US]) 3 October 1990 (1990-10-03) * page 4, lines 15-18; claims 1, 5, 6 *	1-18	
X	WO 2019/200294 A1 (AMTEX INNOVATIONS LLC [US]) 17 October 2019 (2019-10-17)	12-18	
A	* paragraph [0039]; examples *	1-11	
A,D	EP 0 695 382 A1 (DU PONT [US]) 7 February 1996 (1996-02-07) * example I *	1-18	

TECHNICAL FIELDS SEARCHED (IPC)

D04H
A41D

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	14 June 2022	Saunders, Thomas

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
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