TRANSLATION

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Nonwoven fabric with embossed mesh pattern

Description

Technical field

The invention relates to a nonwoven fabric having an embossed mesh pattern. The invention further relates to a method for producing such a nonwoven fabric and to the use thereof as a wiping cloth for domestic use and commercial application, and/or as a wiping material in a mop.

Prior art

Textile fabrics in the form of nonwoven fabrics are widely used as wipes and are used as wiping material in wiping mops.

In order to achieve a higher durability, the fibres in such nonwoven fabrics are generally either thermally bonded by melting of present thermoplastic fibres or by adhesion or bonding of the fibres by surface applied or incorporated chemical binders.

In order to further increase the binding characteristics and improve the mechanical properties, a thermal model is described, for example, in JP 60-194160, wherein the compression is achieved by means of heated rollers. This full-surface compression however results in thin, less flexible, paper-like and low-absorbing flat structures.

As described in EP 1 322 806 B1, wet baby care wipes can also be provided with partial embossing to increase the strength of the material, which, however, leads to an increase in the bending moment and thus to an undesirable rigidity of the wipes in the known methods and patterns. In order to nevertheless obtain moist disposable wipes which meet the requirements for softness, volume, absorption and mechanical strength it is proposed in the present document to set a distance of at least half of the nominal fibre length between discrete (individual discontinuous) embossed regions. In addition, the embossed region should be between 4% and 8% of the total area.

Flexibility and strength according to the state of the art described are opposite properties of thermally compressed (calandered) nonwoven fabrics. For the application as multiple-use wipes or wiping material in mops according to the prior art, compromises of softness and strength achievable by embossing are not acceptable, so that by contrast to moist single-use wipes they have not been able to advance in this field to date.

Against this background it is the object of the invention to propose a nonwoven which fulfills the high requirements regarding softness, flexibility and durability. In addition, the nonwoven shall have adequate absorption properties and in particular enable the manufacture of wipes and wiping materials with the aforementioned properties for mops.

Summary of the invention

In accordance with the present invention the aforementioned object is achieved by the features of patent claim 1.

It has been recognised that, in the case of a specific arrangement and dimensioning of embossed grooves in relation to the fibre length, both the durability of a nonwoven fabric and its softness and flexibility can be increased and that thereby the absorption capacity of the nonwoven fabric is not significantly reduced by the embossed grooves being introduced.

Details of the invention

The present invention relates to a nonwoven fabric comprising framework fibres and an at least partially fused thermoplastic material, in particular at least partially fused thermoplastic binding fibres, wherein at least the framework fibres are staple fibres, wherein the nonwoven fabric has a thermally embossed mesh pattern consisting of a plurality of intersecting embossed grooves, between which is arranged a plurality of embossed elevations, wherein the equivalent diameter of the embossed elevations is less than 50% of the fibre length of the framework fibres, wherein the ratio of the width of the embossed grooves to the thickness of the nonwoven in the region of the embossed elevations is less than or equal to 4/5, and wherein the ratio of the width of the embossed grooves to the thickness of the nonwoven in the region of the embossed grooves is 0.5 to 2.

A further substantial aspect of the nonwoven fabric according to the invention is the presence of a thermally embossed mesh pattern of a plurality of intersecting embossed grooves. In this mesh pattern, a plurality of embossed elevations is arranged between the embossed grooves. In the region of the embossed grooves, the nonwoven material is compressed in relation to the embossed elevations and the thermoplastic material is at least partially fused, as a result of which the embossed structure is stabilised. The mesh pattern also has a positive effect on the stability and durability of the nonwoven fabric

as a whole. The pattern can be formed over the entire surface or only on part regions of the nonwoven fabric. In a preferred embodiment of the invention, the mesh pattern is arranged over at least 60%, more preferred 70% to 100% and much more preferred 80% to 100% of the surface of the nonwoven fabric.

A further essential aspect of the nonwoven fabric according to the invention is that the embossed grooves are arranged and dimensioned in such a way that the equivalent diameter of the embossed elevations is smaller than 50% of the fibre length of the framework fibres.

The term "equivalent diameter of the embossed elevations" as used herein means the diameter of the smallest circle which circumscribes the entire embossed elevation (that is to say can be drawn around and/or enclose the latter). Circumscribing of the symbol means that at least two points of the embossed elevation touch the circle tangentially and no section of the embossed elevation intersects the circle to the outside. Of course, no real circle has to be drawn or marked on the nonwoven. For the purposes of the present invention, equivalent symbol diameters were determined as shown below in the paragraph regarding the test methods.

A further essential aspect of the nonwoven fabric according to the invention is that the ratio of the width of the embossed grooves to the thickness of the nonwoven within the region of the embossed elevations is less than or equal to 4/5 and the ratio of the width

of the embossed grooves to the thickness of the nonwoven fabric in the region of the embossed grooves is between 0.5 and 2.

The width of the embossed grooves is defined as the distance between two inflection points W of the transitions of an embossed groove into the adjoining embossed elevations. For the purposes of the present invention, the width of embossed grooves was determined as described below in the paragraph regarding the test methods. Furthermore, the thickness of the nonwoven fabric in the region of the embossed elevations was measured according to DIN EN ISO 9073-2: 1997, and the thickness of the nonwoven material in the region of the embossed grooves as described below in the paragraph regarding the test methods.

It has been found that in the case of these special arrangements and dimensioning of the embossed grooves in coordination with the fibre length of the framework fibres, a very good profile of properties of high strength and abrasion resistance and high absorption capacity and flexibility of the nonwoven fabric is achieved, which is advantageous for use as a wiping cloth and/or wiping material in a wiping mop.

In particular, the special arrangement and dimensioning of the embossed grooves in relation to the fibre length enables a high proportion of multiple consolidation, for example, framework fibres which are arranged at least at two different points in the bonding region of the embossed grooves. The durability and strength of the nonwoven fabric can thereby be improved and a low fibre loss can be achieved during use and washing of the nonwoven fabric. In addition, the nonwoven fabric according to the invention is surprisingly characterised by high flexibility or low bending moment, which gives the nonwoven fabric a high conformability and, associated therewith, imparts a pleasant hand feel to the user. Furthermore, the specific mesh pattern results in good cleaning performance properties, even for coarser dirt particles, to be achieved by the nonwoven fabric.

Without wishing to be bound to the theory, it is assumed that in the specific arrangement and dimensioning of the embossed grooves and fibre lengths according to the present invention - although the individual framework fibres are strongly bonded in a threedimensional structure by the thermoplastic material in the embossed grooves, and thus restricted in terms of their mutual position and mobility - the embossed grooves

are still just so far apart that the embossed areas can serve as joints to some extent, thereby increasing the flexibility of the nonwoven fabric.

As a result of this effect, the tendency that an embossing process usually dramatically increases the bending moment of the materials, is overcompensated. Nevertheless, due to the intensive bonding of the framework fibres, high resistance, strength and dimensional stability are achieved during use and washing.

In practical tests, it has been found to be particularly advantageous if the equivalent diameter of the embossed elevations is 5% to 50%, more preferred 5% to 40%, more preferred 7% to 40%, and most preferred 8% to 30% of the fibre length of the frameworking fibres.

Furthermore, it has been found to be particularly advantageous if the ratio of the width of the embossed grooves to the thickness of the nonwoven in the region of the embossed elevations is 4/5 to 1/5, more preferred of 4/5 to 1/3 and more preferred 2/3 to 1/3.

Furthermore, it has proven to be particularly favourable, if the ratio of the width of the embossed grooves to the thickness of the nonwoven in the region of the embossed grooves is from 0.5 to 1.5 and in particular 0.75 to 1.25.

The proportion of the surface of the embossed elevations in relation to the total surface of the nonwoven can be adjusted in dependence of the desired properties of the nonwoven. In principle, by increasing the proportion of the surface of the embossed elevations in relation to the total surface of the nonwoven fabric, the fluffy nature and absorbency of the nonwoven fabric can be increased. Against this background it has proven to be advantageous for the total surface of the embossed elevations to be adjusted to more than 50%, preferred from 55% to 85%, more preferred from 60% to 80%, based on the total surface area of the nonwoven.
In the event that the mesh pattern is only limited to part regions of the nonwoven fabric, for the sake of determining the proportion of the surface with the embossed elevations, only the part region provided with the mesh pattern is viewed as the total surface of the nonwoven fabric.

In this case, the proportion of the surface of the embossed elevations in relation to the total surface of the nonwoven fabric can be determined by colouring the embossed elevations and subsequent optical evaluation, as shown below in the paragraph regarding the test methods.

By increasing the proportion of the surface of the embossed grooves relative to the total surface of the nonwoven fabric, again the resistance, strength and dimensional stability of the nonwoven can be increased. Against this background, the proportion of the surface of the embossed grooves in relation to the total surface of the nonwoven fabric is preferred to be more than 15%, for example from 15% to 45%, even more preferred from 20% to 40%. In the event that the mesh pattern is present only on part regions of the nonwoven fabric, only the part region provided with the mesh pattern is regarded as the total surface of the nonwoven fabric for the determination of the proportion of the surface of the embossed grooves.

The proportion of the surface of the embossed grooves on the total surface of the nonwoven fabric can likewise be determined by means of colouring the embossed

elevations and optical evaluation as described below in the paragraph relating to the test method.

According to the invention, the non-woven material contains an at least partially fused thermoplastic material, in particular thermoplastic binding fibres. As a result, the framework fibres can be bonded in the nonwoven fabric. The thermoplastic material can comprise thermoplastic binding particles, in particular binding powders, and/or binding fibres. According to the invention, binding fibres are preferred since they can be processed particularly easily and can be distributed homogeneously in the nonwoven fabric.

In order to enable simple melting of the thermoplastic material during the production of the nonwoven fabric, the melting point of the thermoplastic material is advantageously at least 30° C, for example from 30°C to 150°C, more preferred at least 40°C, for example from 40°C to 150°C and much more preferred at least 45° C, for example from 45°C to 130°C below the melting point or decomposition point of the framework fibres.

As explained above, through the at least partially fused thermoplastic material, a stabilisation of the embossed mesh pattern and of the nonwoven fabric as a whole can be achieved. The fusing of this material during the production of the nonwoven material can be carried out in a simple manner, for example by the use of heated embossing rollers.

Particularly preferred, at least partially fused thermoplastic materials according to the invention contain polyolefin, in particular polypropylene and/or polyethylene, and also polyester, polyamide, polylactide, and/or mixtures and copolymers thereof.

In order to obtain a sufficient stabilisation of the mesh pattern and of the nonwoven fabric as a whole, it has been found expedient to add the proportion of the at least partially fused thermoplastic material to at least 5 wt.. %, preferred 5 wt. % to 30 wt.-%, more preferred 15 wt.-% to 25 wt.-% based on the total weight of the nonwoven fabric. An adjustment to more than 30% is disadvantageous since in this case the flexibility of the nonwoven is restricted in an undesirable manner.

As a further component, the nonwoven fabric contains framework fibres. In accordance with their function, these are preferably either not fused or, at least in comparison to the at least partially fused thermoplastic material, are significantly less fused.
In a preferred embodiment of the invention, the framework fibres are selected from non-thermoplastic materials, for example natural fibres, preferably cellulose fibres, in particular viscose or cotton fibres and/or mixtures thereof.

However, the use of thermoplastic fibres as framework fibres is also conceivable, provided that the melting point thereof is at a sufficient distance from the melting point of the at least partially fused thermoplastic material. For this purpose, in particular polyester, polyamide, polylactide fibres and/or mixtures thereof are suitable.

According to the invention, the use of mixtures of non-thermoplastic and thermoplastic fibres as framework fibres is particularly preferred, since this allows a particularly good profile of properties to be achieved for use as a wiping cloth and/or wiping material in a wiping mop.

According to the invention, the framework fibres are staple fibres. In contrast to filaments which at least theoretically have an unlimited length, staple fibres have defined lengths. The average length of the framework fibres is preferred to be 15 mm to 85 mm, more preferred 20 mm to 60 mm, much more preferred 25 mm to 55 mm. It has been found that, by means of the combination of the aforementioned fibre lengths and the specific mesh pattern it is possible to achieve double fibre binding and nevertheless sufficiently unbonded fibre surface and free fibre ends to achieve high cleaning performance of the nonwoven fabric.

The mean titre of the framework fibres is preferred to be between 0.1 dtex and 2.6 dtex, more preferred from 0.3 dtex to 2.4 dtex, much more preferred from 0.6 dtex to 2.2 dtex. If a mixture of fibres of different titres is present, fibre titres greater than 6.7 dtex are not taken into account when determining the mean titre. It has been found that fibres having the aforementioned titres achieve a higher cleaning performance and also a good hand feel.

The weight per unit area of the nonwoven fabric is preferably in the range between 50 g/m² and 300 g/m², more preferred from 100 g/m² to 250 g/m², in particular of 120 g/m² to 220 g/m² . It has been found that, in the case of the aforementioned surface weights, on the one hand, due to a sufficiently available volume, a high absorption capacity and, on the other hand, a satisfactory and pleasant flexibility of the nonwoven can be achieved.

The volume weight of the region of the nonwoven fabric compressed by the embossed grooves can be calculated from the thickness of the nonwoven material in the region of the embossed grooves and from the weight per unit area of the nonwoven fabric and is preferably less than 0.0005 g/mm3, even more preferred from 0.00015 g/mm3 to 0.00045 g/mm3.

In the region of the embossed elevations, the nonwoven has a lower density than in the region of the embossed grooves and is therefore more voluminous and absorbent than in the region of the embossed grooves.

The volume weight of the region of the nonwoven fabric, which is not compressed by the embossed grooves can be determined from the thickness of the nonwoven material in the region of embossed elevations and the weight per unit area of the nonwoven fabric and is preferred to be less than 0.00015 g/mm3, more preferred to be between 0.00008 /mm3 to 0.0012 g/mm3.

As explained above, the nonwoven fabric according to the invention has a surprisingly low bending moment at least in one direction. This bending moment is preferably less than the bending moment of a nonwoven fabric of the same construction without embossed grooves.

The bending moment of a nonwoven fabric according to the invention in at least one direction, is preferably less than 90%, more preferred between 70% and 90%, in particular between 75% and 85% of a nonwoven of the same construction without embossing.

As explained above, the non-woven material via the at least partially fused thermoplastic material can be present as thermally bonded. In this case, the partially fused thermoplastic material is present at least in the regions of the embossed grooves.

In a preferred embodiment, the at least partially fused thermoplastic material is additionally also present in the regions of the embossed elevations, which makes further stabilisation of the nonwoven fabric possible. The formation of the at least partially fused regions can, as explained above, be effected by the embossing operation. However, it can also be advantageous to carry out an additional thermal bonding in which the thermoplastic material at least partially fuses.

In addition to thermal bonding, the nonwoven can also have a binding agent for bonding, wherein advantageously at least a part of the fibres present is bonded with a binding agent . In this case a binding agent can be used which is traditionally used for chemical consolidation of textile materials, wherein the binding agent is preferably selected from the group consisting of an aqueous copolymer dispersion of vinyl acetate and ethylene.

It is also conceivable that the non-woven material is additionally also consolidated by needling.

The shape of the embossed grooves can be linear or non-linear, for example of a wave-shaped or zigzag-shaped design provided as long as a mesh pattern is created.

It is also conceivable for the embossed grooves to be arranged intermittently, for example, in the form of dashed and/or dotted grooves. This can have an advantageous effect on the absorption capacity of the nonwoven fabric.

In an advantageous embodiment of the invention, the mesh pattern is represented as a diamond pattern, honeycomb pattern, fish scale pattern, waffle pattern, linen pattern and/or butterfly pattern.

According to the invention, the fish scale pattern shown by way of example in Figs. 2 and 4 to 6 is preferred. The mesh pattern is preferably oriented such that the embossed grooves run diagonally to the machine running direction. In this way, the strength values can be homogenised (measured as maximum traction force) in the longitudinal and transverse directions.

The special configuration of the nonwoven fabric according to the invention facilitates the creation of a homogeneous profile of properties. The MD/CD ratio of the maximum traction force is preferred to be more than 0.65, for example from 0.65 to 0.95, more preferred from 0.75 to 0.95. Under these conditions, the nonwoven fabric according to the invention exhibits a homogeneous strength profile, which proves to be advantageous in its application.

The nonwoven fabric can be constructed in one or more layers. Preferably, it is constructed in one layer. Here, the embossed mesh pattern can be created in one process step on both sides of the nonwoven fabric. Furthermore, delamination is made more difficult.

The nonwoven fabric according to the invention is outstandingly suitable as a wiping cloth for the domestic and/or the commercial sector and/or as a wiping material in a mop.

The nonwoven fabric according to the invention can be produced, for example, by a method comprising the following process steps:

- provision of a fibrous web comprising staple fibres as framework fibres and a thermoplastic material, in particular thermoplastic binding fibres;

- consolidating of the fibrous web by means of needling, binding agents and/or thermal loading;
- thermal embossing of a mesh pattern with at least partial fusing of the thermoplastic material, wherein the mesh pattern
  - has a plurality of intersecting embossed grooves, between which a plurality of embossed elevations are arranged,
  - the equivalent diameter of the embossed elevations is smaller than 50% of the fibre length of the framework fibres,
  - the ratio of the width of the embossed grooves to the thickness of the nonwoven in the region of the embossed elevations is less than or equal to 4/5,
  - the ratio of the width of the embossed grooves to the thickness of the nonwoven fabric in the region of the embossed grooves is from 0.5 to 2.

The thermal embossing can be carried out in a simple manner, for example by the use of heated embossing rollers.

According to the invention, the bonding is undertaken at least by means of needling and optionally additionally by means of binding agents and/or thermal loading, for example with a calander or a furnace. It is advantageous in the needling that it can bring about a reorientation of the fibres in the nonwoven fabric and thus allows a further adjustment of the property profile of the nonwoven fabric.

In this case, the specific mesh pattern can be obtained by suitable selection of the embossing webs on the embossing rollers.

Brief description of the drawing

The drawing shows in

FIG. 1 a schematic view of a detail from the cross section of a nonwoven fabric according to the invention;

FIG. 2 the schematic representation of the top view of a nonwoven fabric according to the invention and the enlarged view of a section thereof;

FIG. 3 a CT image of a detail from the cross section of a nonwoven fabric according to the invention;

FIG. 4 a CT image of a detail from the top view of a nonwoven fabric according to the invention;

FIG. 5 an REM image of a detail from the top view of a nonwoven fabric according to the invention;

FIG. 6 a further CT image of a detail from the top view of a nonwoven material according to the invention.

Description of the figures

FIG. 1 shows the schematic view of a detail from the cross section of a nonwoven fabric 1 according to the invention with an embossed groove 2, which has a width 3. In the region of the embossed groove 2, the nonwoven 1 has a thickness 4. Two embossed elevations 5 and 5′ adjoin the embossed groove 2 to the left and right. In the region of the embossed elevations 5 and 5' the nonwoven 1 has a thickness 6 in each case.

FIG. 2 shows the schematic view of the top view of a nonwoven fabric 1 according to the invention comprising a plurality of embossed elevations 5. By way of example, the smallest circle is represented on an embossed elevation 5, which circumscribes the entire embossed elevation 5. The diameter of this circle is the equivalent diameter 7 of the same embossed elevation 5.

FIG. 3 shows a CT image of a detail from the cross section of a nonwoven fabric 1 according to the invention.

FIG. 4 shows a CT image of a detail from the top view of a nonwoven fabric 1 according to the invention.

FIG. 5 shows an REM image in 50-fold magnification of a detail of the top view of a nonwoven fabric 1 according to the invention.

FIG. 6 shows a further CT image of a detail from the top view of a nonwoven fabric 1 according to the invention. Here, as an example, the embossed elevation 5 shows the smallest circle, which circumscribes the entire embossed elevation 5. The diameter of this circle is the equivalent diameter 7 of this embossed elevation 5.

Test methods

In principle, care must be taken when selecting the areas used for the test methods to ensure that representative sections with the prevailing pattern are selected in each case.

Equivalent diameter of the embossed elevations

The equivalent diameter of the embossed elevations is determined as follows: a computer-tomographic image of the top view of the nonwoven fabric with the entire pattern repeat unit is used as the basis. In the evaluation (in the present case by means of *Volume Graphics VG Studio Max*), a circular template is used for the embossed elevations in the mesh pattern, in order to measure the diameter of the smallest circle, which can circumscribe the complete embossed elevations (that is to say can be drawn around the latter and enclose the latter) (as described above with reference to the definition of the equivalent diameter of the embossed elevations). The measurement should be exactly within +/− 0.6 mm. The diameter of the circumscribing circle is the equivalent diameter of the embossed elevations.

After determining the equivalent diameters of the embossed elevations in the mesh pattern, the numerical value of the diameters is taken as the mean value of at least five individual measurements.

In this case, any very small embossed elevations which are present, i.e. embossed elevations with an equivalent diameter of less than 5% of the fibre length are not taken into account.

Thickness of the nonwoven fabric in the area of the embossed grooves and width of the embossed grooves

In order to determine the thickness of the nonwoven material in the region of the embossed grooves, a computer-tomographic image of the nonwoven material in cross section is undertaken.

The thinnest areas of at least five embossed grooves are optically determined (in the present case by means of *Volume Graphics VG Studio Max),* and the mean value found. As a result, the thickness of the nonwoven is obtained in the region of the embossed grooves.

To determine the width of the embossed grooves, the thickness of the nonwoven fabric is first determined. This corresponds to the thickness of the nonwoven in the region of the embossed elevations.

From the thickness of the nonwoven fabric in the region of the embossed grooves and the thickness of the nonwoven in the region of the embossed elevations the arithmetic mean is subsequently determined. The resulting value corresponds to the thickness of the nonwoven in the region of the inflection points W, which can now be optically drawn into the computer tomography image. If the shortest distance between two inflection points W delimiting the same groove is measured, thus, the width of this embossed groove is obtained. This measurement is carried out for at least five embossed grooves and the mean value is calculated.

Determination of the proportion of the embossed elevations and of the embossed grooves on the total surface

To determine the proportion of embossed elevations on the total surface of the nonwoven fabric, the same is adhesively affixed to a metal plate of the same dimension (8 x 4 cm) and a total weight of 114 g ± 10 g and without applying additional pressure is moved in circles over a commercially available stamp pad (ten times clockwise and ten times counter-clockwise). As a result, the embossed elevations become coloured. This sample can subsequently be scanned or photographed and evaluated by means of image processing software (in the present case by means of *Adobe Photoshop)*. For this purpose, the proportion of embossed elevations on the overall surface can be determined pixel-based on the colour difference of the coloured surfaces to the non-coloured surfaces. At least one triple determination is carried out.

The differential measurement of the total surface and the proportional surface share of the embossed elevations results in the proportional surface share of the embossed grooves on the total surface of the nonwoven fabric.

Thickness of the nonwoven fabric

Method based on the test specification DIN EN ISO 9073-2: 1997, the thickness of the nonwoven fabric is measured using a precision thickness gauge having a test area of 25 cm^2 and 0.5 kPa pressure. At least ten points of the sample are measured and the average value is subsequently formed.

Weight per unit area

Based on the test specification DIN EN ISO 9073-1: 1989, at least ten samples are used for determining the weight per unit area, sample size of 100 mm x 100 mm, said samples are weighed and the measured values are multiplied by 100. The average value is formed from these individual values.

Length of staple fibres

Depending on the type of fibre, the single-fibre length measurement is carried out using the input or output two-tweezers method based on DIN 53808-1: 03. Deviating from the test standard, the number of measurements is n = 50.

Care must be taken to ensure that the fibres are not shortened during removal from the nonwoven fabric. This applies especially to thermally bonded and embossed nonwoven fabrics.

Determination of melting point

The determination of the melting point of the thermoplastic material is performed according to the test specification DIN EN ISO 11357-3: 2013.

Determining tensile strength

The maximum tensile force is determined according to the test specification DIN EN ISO 9073-3: 1992.

Determination of bending length

The bending length is determined based on the test specification DIN EN ISO 9073-7: 1998. The sample size is 250 × 50 mm. Three individual measurements are carried out and the mean value is formed in mm. The smaller the bending length, the lower the bending stiffness.

The invention is explained in more detail below on the basis of an example.

Example I

In an exemplary nonwoven fabric according to the invention, the production is carried out in a dry laying method. The invention relates to a fibre mixture consisting of 50% viscose fibres (1.7 dtex, 50 mm), 30% polyester fibres (0.9 dtex, 38 mm) and 20% polypropylene melt adhesive fibres (2.2 dtex, 40 mm) homogeneously mixed and placed into a pile by means of a carding machine. After doubling of the pile layers, consolidation takes place by needling before this non-woven material is additionally heat-fixed in a furnace. Furthermore the nonwoven is subjected to a stretching process. The subsequent embossing process imparts a mesh pattern to the nonwoven fabric in the form of fish scales. In addition, a design pressure can be applied to the nonwoven fabric before or after the embossing unit.

The nonwoven fabric according to the invention has a weight per unit area of 145 g/m² , the thickness in the region of the embossed elevations being 1.4 mm, the thickness in the region of the embossed grooves is 0.7 mm, the equivalent diameter of one mesh pattern unit is 6.5 mm. The result is that the fibres are thermally bound on average at least at two points. Furthermore, the ratio of the width of the embossed grooves and the thickness of the nonwoven material in the region of the embossed elevations is 1/2, which has a positive effect on the bending stiffness of the nonwoven fabric, as well as the ratio of the width of the embossed grooves and the thickness of the nonwoven fabric in the region of the embossed grooves which assumes a value of 1 in this advantageous embodiment.

To measure and calculate the dimensions of the embossed elevations and embossed grooves, a computer-tomographic 3D model of the nonwoven was produced. The determination of the thickness of the nonwoven fabric in the region of the embossed elevations, the measuring of the weight of the nonwoven as well as its strength and bending stiffness was undertaken in accordance with the above mentioned test instructions.

The special configuration of the mesh pattern which covers 30 % of the total surface of the nonwoven fabric (measured by way of colouring the raised areas and software-assisted, pixel-based analysis) leads to homogenising the tensile strength in the longitudinal and transverse directions and also a reduction of the bending length in at least one direction (measured in accordance with the test specification DIN EN ISO 9073-7:1998) to less than 10 mm of the nonwoven fabric.

By applying the specific mesh pattern the nonwoven becomes more stable and at the same time more flexible and is therefore eminently suitable as a wiping cloth and/or wiping material in a wiping mop.

Claims

1. Nonwoven fabric (1) comprising framework fibres and an at least partially fused thermoplastic material, in particular at least partially fused thermoplastic binding fibres, wherein at least the framework fibres are staple fibres and wherein the nonwoven material (1) has a thermally embossed mesh pattern consisting of a plurality of intersecting embossed grooves (2) between which a plurality of embossed elevations (5) are arranged, **characterised in that**

– the equivalent diameter (7) of the embossed elevations (5) is less than 50% of the fibre length of the framework fibres;

– the ratio of the width (3) of the embossed grooves (2) to the thickness (6) of the nonwoven fabric in the region of the embossed elevations (5) is less than or equal to 4/5 and

– the ratio of the width (3) of the embossed grooves (2) to the thickness (4) of the nonwoven fabric in the region of the embossed grooves (2) is 0.5 to 2.

2. Nonwoven fabric (1) according to claim 1, **characterised in that** the proportion of the surface of the embossed grooves (2) to the total surface of the nonwoven fabric (1) comprises more than 15% of the total surface of the nonwoven fabric (1).

3. Nonwoven fabric (1) according to one or more of the preceding claims, **characterised in that** the framework fibres have an average length of 15 mm to 85 mm.

4. Nonwoven fabric (1) according to one or more of the preceding claims, **characterised in that** the framework fibres have a titre between 0.1 dtex and 2.6 dtex.

5. Nonwoven fabric (1) according to one or more of the preceding claims, **characterised by** a weight per unit area of between 50 g/m² and 300 g/m² .

6. Nonwoven fabric (1) according to one or more of the preceding claims, **characterised in that** the proportion of the at least partially fused thermoplastic material is between 5 wt.-% and 30 wt.-%.

7. Nonwoven fabric (1) according to one or more of the preceding claims, **characterised in that** at least a part of the framework fibres are needled and/or bound to a binding agent.

8. Nonwoven fabric (1) according to one or more of the preceding claims, **characterised in that** the embossed grooves (2) are intermittently arranged.

9. Nonwoven fabric (1) according to one or more of the preceding claims, **characterised in that** it is constructed in one layer..

10. Nonwoven fabric (1) according to one or more of the preceding claims, **characterised in that** the mesh pattern is formed as a diamond pattern, honeycomb pattern, fish scale pattern, waffle pattern, linen pattern and/or butterfly pattern.

11. Nonwoven fabric (1) according to one or more of the preceding claims, **characterised by** a MD/CD ratio of the maximum tensile force of greater than 0.65.

12.. A method for producing a nonwoven fabric (1) according to one or more of the preceding claims, comprising the following method steps:

– provision of a fibrous web comprising staple fibres and a thermoplastic material, in particular thermoplastic binding fibres;

– consolidation of the fibrous web by means of needling, binding agents and/or thermal loading;

– thermal embossing of a mesh pattern by at least partial fusing of the thermoplastic material, wherein the mesh pattern has

– a plurality of intersecting embossed grooves (3) between which a plurality of embossed elevations (7) is arranged,

– the equivalent diameter of the embossed elevations (7) is less than 50% of the fibre length of the framework fibres;

– the ratio of the width of the embossed grooves to the thickness of the nonwoven fabric (1) in the region of the embossed elevations (6) is smaller than or equal to 4/5.

13. Method according to claim 12, **characterised in that** the consolidation is performed at least by needling and optionally additionally by means of a binding agent and/or thermal loading, for example in a calander or a furnace.

14. Use of a nonwoven material (1) according to one or more of the preceding claims as a wiping cloth for domestic and/or commercial applications and/or as a wiping material for a wiping mop.