Title: METHOD OF PRODUCING BOARDS

Abstract: The present invention concerns a method for producing a board, wherein a foamed fibrous layer is formed by contacting foam forming of a fibrous slush and said foamed fibrous layer is dried to form a web, wherein polyvinyl alcohol is used as a foaming agent in foam forming. The invention also concerns a system for producing a board and a board with at least one dried foamed fibrous layer, wherein the foamed fibrous layer is made from a mixture of fibrous slush with foam formed from water and polyvinyl alcohol.
Method of Producing Boards

Technical Field

The present invention relates to a method of producing a paperboard (in the following also “fibrous web”) by foam forming. The method is suitable for forming various products of paperboard material, in particular it is suitable for the production of high bulk cartonboard products, such as folding box board or white lined chipboard. The invention also concerns paperboards thus obtained.

Background

Fibrous webs can be produced by foam forming which gives many advantages. In a foam, the fibres do not flocculate. When a web is made from such a fibrous foam is dewatered, for example by applying suction to the foam through a wire, the fibres will retain their non-flocculated state and form a web with good formation. The structural pressure that the foam applies to the structure when water is removed by suction is much smaller than the pressure exerted by conventional removal of water from fiber slush. The technology gives rise to a high bulk in the products.

Foam forming on a foraminous wire to yield a non-woven fibrous web is disclosed in a number of patent documents, including GB 1129757, GB 1329409, GB 1395757, GB 1397378, GB 1431603 and US 4944843, all assigned to Wiggins Teape (Radfoam).

In addition, US 3,326,745 teaches that formation of a paper web can take place between a foraminous forming fabric and a felt, with the forming fabric and felt being carried by two adjacent turning rolls, the arrangement being such that the forming fabric and felt are brought substantially into contact along web formation areas thereof lying along one or both of these rolls. After dewatering in the formation areas, the formed web follows and is carried by the felt, and subsequent dewatering and transference to steam heated driers occurs as the web travels with the felt.

US 6,413,368 B1 discloses an apparatus and process for producing foam formed fibrous web in which the furnish is made up by mixing a thin water slurry of fibers at a consistency
in the range of from about 0.5 to about 7 weight percent fibers with sufficient aqueous foam containing a surfactant and having an air content in the range of from about 55 to about 80 percent by volume to form a foamed fiber furnish containing from about 0.1 to about 3 weight percent fibers which is supplied directly to the forming felt or wire of a twin wire papermaking machine, adding makeup surfactant and discarding excess aqueous foam from the process as required to maintain the desired volume of foamed liquid therein.

Furthermore US 2005/0039870 A1 teaches a method and apparatus for foam forming, wherein fibrous foam suspension is introduced from a head box of a production machine to the web forming section thereof. At least one solid material is mixed into the foam in the head box. The method and the apparatus are suitable for manufacturing various web-like products of cellulose, glass fiber, aramide, sisal or other corresponding fiber material.

Paperboards comprise layers of high bulk. Although the formation of fibrous non-woven layers by foam formation having high bulk is, as such, taught in the art, the internal strength properties of such layers is still unsatisfactory for applications in which strength in the z-direction of the layer is of considerable importance, such as paperboards.

GB 1431603 discloses a method of increasing internal strength by grinding, by use of reinforcing chemicals and by wet pressing, but while some improvement has been obtained in the art, bulk has been lost simultaneously.

Further art is disclosed in US 6419792.

Wall paper base is typically produced with the conventional water forming technology. The wall paper needs to be substantially dimension stable in order to avoid shrinking when applying wet glue paste, i.e. a minimum wet expansion of the wall paper substrate would be beneficial. A cellulose fibre matrix as such is normally not notably dimension stable, since moisture causes swelling of the fibres and can break the hydrogen bonds between the fibres. Therefore, synthetic fibres are often used to form a dimension stable structure inside the cellulose fibre matrix.
Synthetic fibres typically tend to be unevenly distributed in the cellulose fibre matrix. Firstly, cellulose fibres and synthetic fibres are mainly orientated along the machine direction of the paper machine. Secondly, synthetic fibres are longer, stiffer, more hydrophobic, and may have a different density than cellulose fibres. Therefore, synthetic fibres have a tendency to bundle, flocculate, or form a layer near the bottom side of the web. This may cause adhesion to the dryer cylinders, surface dusting, and unevenness of the web which can lead to uneven water absorption and gluing problems as well as cause uneven print density. Synthetic fibres also do not form hydrogen or other strong chemical bond with each other or with the cellulose fibres. The internal strength of the web is low and the negative impact on the formation lowers the internal strength further such that retention to the web can be poor causing dusting.

Internal strength is also critical to wall paper processing and application. Low internal strength may result in web breaks during a converting process such as printing or laminating. During application to the wall, a fault in alignment is often not apparent until the paper is mostly glued to the wall. In such cases the wall paper is pulled off while the paste is still wet and then the wall paper is reapplied. It would be beneficial to avoid delamination of the paper. Additionally, applied dry wall paper should be removable from the wall without delamination. Internal bond strength is the key to prevent delamination during use. Commonly, agents are used to prevent strength loss when wetting a wall paper sheet.

Document WO 2008/040635 A1 discloses a wall paper substrate for a wall paper that can be peeled in a dry manner, has a minimal wet expansion and consists of a multilayer strip with an upper and lower side, between which are arranged a fibrous lower layer of a fibre mixture on cellulose basis and synthetic fibres and a fibrous upper layer of a fibre mixture on cellulose basis and free of synthetic fibres.
Summary of Invention

Technical Problem

The present invention relates to the production of paperboard products which contain layers having a high bulk. In particular, the present invention addresses the issue of manufacturing paperboard products wherein layers of high bulk are needed which simultaneously exhibit properties of good internal strength, as evidenced by at least one of improved Scott Bond and improved strength in z-direction.

An aim of the present invention is to provide for the production of multilayered paperboards, such as folding box boards and white lined chipboards, where high-bulk layer are arranged as middle layers of the paperboard product.

A third aim of the present invention is to manufacture fibrous layers having surface weights of generally 110 to 750 g/m², wherein at least a part of the products exhibit in combination high bulk and good internal strength, in particular exhibiting minimum target values of the exemplary middle layer of cartonboard of a) bulk > 1.8 g/m³ and b) Scott Bond > 100 J/m².

A fourth object of the present invention is to provide a method of producing, by foam forming on a foraminous wire, paperboards which meets the aforementioned target values.

Furthermore the present invention also aims at paperboards having one or a plurality of layers of which at least one meets the afore-mentioned target values.

These and other objects are achieved by the present invention, as hereinafter described and claimed.

Solution to Problem

In one aspect, the invention concerns a method for producing a paperboard, wherein at least one foamed fibrous layer is provided, and said at least one foamed fibrous layer is
dewatered on the wire of a paperboard machine to form a web, wherein a water-soluble or dispersible foaming polymeric agent is used as a foaming agent. More specifically, the polymeric foaming agent is selected from the group of water-soluble or dispersible glycans, in particular polysaccharides and derivatives thereof, and other hydrophilic polymers and copolymers, such as poly(vinyl alcohol) and poly(vinyl acetate) and copolymers thereof.

Such foaming agent have been found to be capable of efficiently bonding to the fibres during foam formation to produce a web with good formation, which upon dewatering gives a fibrous matrix having high bulk and excellent internal strength properties.

Disclosed herein is also an arrangement for producing a paperboard. Comprised therein are preferably one or several of the following: At least one foam generator for production of fibrous foam from fibrous slush, water and at least one hydrophilic polymer; a web former for producing a web from the fibrous foam; a dewatering unit for the web; and means for drying of the dewatered fibrous web.

The invention also concerns a paperboard with at least one dried foamed fibrous layer, wherein the at least one foamed fibrous layer is made from a mixture of fibrous slush with foam formed from water and at least one hydrophilic polymer.

More specifically, the method according to the present invention is characterized by what is stated in the characterizing part of claim 1.

A board according to the present invention is characterized by what is stated in the characterizing part of claim 12.

Advantageous Effects of Invention

Considerable advantages are obtained by means of the invention. The use of a hydrophilic polymer as a foaming agent enhances the internal strength of a foam formed layer. Hand sheet tests have showed that by the use of a hydrophilic polymeric foaming agent, such as poly(vinyl alcohol), a folding boxboard middle layer produced from chemithermo-
mechanical pulp (CTMP) without starch or retention agents has a Scott Bond value of 123 J/m³ and bulk value of 3.71 g/m³. In addition, the layer retains the high bulk provided by foam forming.

The results show that it is possible to produce a high bulk middle layer of folding boxboard having advantageous strength properties with hydrophilic polymers as foam forming agents.

This also shows the possibility of forming the middle layer of folding boxboard from less refined CTMP pulp and with polyvinyl alcohol use to reach the needed strength properties.

In the tests referred to above, the samples were wet pressed.
The present invention also enables the use of less refined fiber material in high bulk fiber web.

The economical and the ecological influences of the present invention are for example savings in chemical consumptions. No other strength chemicals, such as starch or retention aids, are needed and using coarser CTMP pulp enables savings in refining energy.

Using foam forming it is also typically possible to remarkably reduce production costs and simultaneously improve properties of current products. The present invention will retain the benefits obtained by foam formation. For example, compared to water forming technology the forming consistency may be increased substantially with foam. Foam forming technology requires significantly less water than conventional paper and paperboard manufacturing which leads to minimization of the amount of raw water intake and the amount of waste water to be treated in treatment plants. Pulp contains large amounts of air, providing better opportunities for influencing the properties of the end-product. Foam forming technology reduces energy consumption, while saving on raw materials, and also widens remarkably the raw material choice.

Foam forming technology applied to paperboard manufacture using hydrophilic polymers as foaming agents further introduces new opportunities for fiber based products. Thus, it is possible to improve the properties of existing packaging, cartonboard, and the manufacture
of different types of highly porous, light-weight and smooth products, such as hygiene products, insulators and filters. Foam forming technology may also be the solution for printed intelligence and electronics and microcellulose applications.

The results show that, for example in a high bulk middle layer of folding boxboard, the required strength properties can be obtained with polyvinyl alcohol. When using polyvinyl alcohol as a foaming agent especially good Scott Bond values are obtained. By contrast, with sodium lauryl sulfate and non-ionic forming agents, foaming is achieved but no particular improvement of internal strength.

The results also show that it is possible to produce high bulk wall paper sheets having advantageous strength properties with hydrophilic polymers as foam forming agents. Synthetic fibres can be evenly orientated in all directions of the wall paper due to the foam forming manufacturing process, thus providing an advantageous wet expansion of the wall paper substrate. Additionally, adhesion to dryer cylinders can be minimized, surface dusting can be reduced, and the evenness of the web can be improved. Such a wall paper further provides better visual appearance and better functionality both in converting operations and end use.

Brief Description of Drawings

For a more complete understanding of particular embodiments, reference is now made to the following descriptions, taken in conjunction with the accompanying drawings. In the drawings,

Figure 1 illustrates a schematic view of a typical papermaking machine line to explain the steps of producing cartonboard;

Figure 2 shows the various types of boards included in the concept of “paperboard”;

Figure 3 shows a table with values of a middle layer of folding boxboard according to tests of the present invention in a laboratory; and

Figure 4 depicts in a schematic fashion the structure of a multilayered product.
Description of Embodiments

As discussed above, the present technology basically concerns a method for producing a board, comprising the steps of

- producing a fibrous foam from cellulosic or lignocellulosic fibres, water and a foaming agent;
- forming the fibrous foam on a foraminous wire into a foamed layer;
- dewatering the fibrous foam layer on the foraminous wire, for example by suction, to form a dewatered web; and
- drying the web thus obtained is dried to give a foamed fibrous web.

Optionally, the fibrous web can be formed as a stand-alone layer or it can be formed as part of a multilayered product for example by combining the above web forming procedure with the simultaneous formation of 2 to 5 webs.

The terms “paperboard” or “cartonboard” are used for designating fibrous web or fibrous layer which is provided by the present invention. Figure 2 shows the various boards types included in the general concept of “paperboard”. Thus, included are cartonboards, other paper boards and containerboards. The terms “paperboard” or “cartonboard” also contain wall papers as will be discussed below.

The foam forming of the at least one fibrous layer is preferably carried out by mixing the fibrous slush with foam formed from water and the foaming agent so as to provide a foamed fibrous slush which is fed onto a wire to form the fibrous layer. The preferred consistency of the fibrous slush is 0.6 % to 7 % by weight.

The water and foaming agent are preferably used for forming the foam having an air content of 40 % to 80 %, e.g. 55 % to 75 %, by volume. The concentration of the foaming agents is preferably 100 to 5000 ppm, in particular 150 ppm – 1000 ppm, calculated from the total weight of the liquid.
The at least one foamed fibrous layer is preferably wet pressed. Then the at least one foamed fibrous layer is dried to form a dried web or board, for example by cylinder drying. Drying can also be carried out as air drying by suction air through the web.

The web is preferably cartonboard made up of multiple layers of pulp. The top and/or bottom layers are preferably of bleached chemical pulp and may be coated with pigments. Mechanical pulp, semi-chemical pulp, chemical pulp, thermomechanical pulp or chemithermomechanical pulp or recycled pulp can be contained in the middle layer of the cartonboard.

In the present technology, foam formation, in particular on a paperboard machine, is carried out with the use of a foaming agent capable of acting as a surface active agent while simultaneously acting as a binder in the formed structure.

Generally, the foaming agent is selected from anionic, cationic, non-ionic and amphoteric surface active agents and surfactants, including polyvinyl alcohol and foamable starches, proteins, and combinations thereof.

Optionally at least one additional binder is used in an amount of 0.005–10 % by weight, preferably 0.05–0.5 % by weight, particularly preferably 1–2 % by weight.

In a preferred embodiment, the foaming agent is polymeric and selected from the group of hydrophilic polymers of natural or synthetic origin which are capable of achieving both foaming and binding. Typically, suitable polymers are of a kind which are soluble or at least readily dispersible in water. The polymers contain suitable polar groups attached directly to the main chain of the polymer or via side groups to the main chain.

Suitable natural and seminatural polymers are exemplified by glycans, in particular polysaccharides and physical and chemical derivatives thereof. Examples include finely divided cellulose or cellulose derivatives, biopolymers such as binders based on starch derivatives, natural gum latexes, alginates, guar gum, hemicellulose derivatives, chitin, chitosan, pectin, agar, xanthan, amylose, amylopectin, alternan, gellan, mutan, dextran, pullulan, fructan, locust bean gum, carrageenan, glycogen, glycosaminoglycans, murein, bacterial capsular polysaccharides, and the like.
Naturally, mixtures of polymeric compounds can also be used.

Other hydrophilic polymers and copolymers, are represented by hydroxyl-substituted synthetic polymers and copolymers thereof, such as polyvinyl alcohols, polyvinyl acetate dispersions, ethyl vinyl alcohol dispersions, polyurethane dispersions, acrylic latexes, styrene butadiene dispersions.

One particularly preferred foaming agent is polyvinyl alcohol. The structure of partially hydrolyzed polyvinyl alcohol is given below:

\[
\begin{array}{c}
\text{CH}_2 \\
\text{CH} \\
\text{OR}_n
\end{array}
\]

wherein \( R = \text{H or COCH}_3 \)

Polyvinyl alcohol used as a foaming agent according to the present invention has preferably a degree of hydrolysis from 80 % up to 99 %, preferably between 85 % and 99 %.

Polyvinyl alcohol used as foaming agent according to the present invention has a molecular weight between 10000 g/mol and 50000 g/mol, in particular between 15000 g/mol and 40000 g/mol, preferably between 20000 g/mol and 35000 g/mol.

Turning now to the embodiment illustrated in the drawings, Figure 1 depicts a conventional process of producing cartonboard with a board machine line can be subdivided into the steps of pulping, stock preparation, short circulation, forming, pressing, drying, coating, calendaring, and reeling. Figure 1 illustrates a 3-ply cartonboard line, but the invention can be used in 1 to multiply board machines.

Mechanical Pulping is for example used to manufacture fibrous products such as printing and writing papers, paperboard, newsprint or tissue. Mechanical pulp provides high bulk
and good opacity. Mechanical Pulp can be combined with chemical pulps to produce a mixture of properties and characteristics. Chemical pulp is pulp which is prepared from cooked wood chips. Hybrid pulping methods, e.g. chemithermo-mechanical pulping (CTMP), use a combination of chemical and thermal treatment. Chemothermomechanical pulp is a preferred raw material in the process and products of the present invention, in particular less refined CTMP. In multilayered products, one or more layer can be of this CTMP, while other layers may be produced from other types of pulp.

The pulp may be for example made from any broad-leaved tree such as a tree from the betulaceae family, e.g. birch or aspen, from the salicaceae family, from eucalyptus, mixed tropical hardwood or pines or from any combination of the aforementioned. The pulp may be also for example made from any conifer such as spruce or pine or from any combination thereof. The pulp may be also made from a combination of broad-leaved trees and conifers.

The percentage of conifers in the pulp may reach for example from 20 % to 100 %, in particular from 50 % to 100 % and preferably from 75 % to 100 %.

The pulp may be also for example made from any annual such as straw, common reed, reed canary grass, bamboo, sugarcane or any grass plant.

Stock preparation systems modify the raw materials in such a way that the stock supplied to the board machine line suits the requirements of the board machine line. The quality of the stock supplied to the board machine line influences the quality of the cartonboard. Additives such as binders, fillers, sizing agents, retention agents or other chemicals may be added to the stock. Binder may be starch, which can be modified or unmodified starch, preferably starch derived from wheat, potato, rice, corn or cassava.

According to the present invention a board is produced by forming at least one foamed fibrous layer, wherein a hydrophilic polymer is used as a foaming agent in contacting foam forming, and drying said at least one foamed fibrous layer to form said web.

The foam forming of the at least one fibrous layer is preferably carried out by mixing a fibrous slush with foam formed from water and the foaming agent so as to provide a
foamed fibrous slush which is fed onto a wire and dewatered to form the web which is then
dried to form the board. The preferred consistency of the fibrous slush is 0.6 % to 7 % by
weight. The water and foaming agent are used for forming the foam, preferably, having an
air content of 40 % to 80 %, e.g. 55 % to 75 %, by volume. The concentration of the
foaming agents is typically 150 ppm–1000 ppm, calculated from the total weight of the
liquid, in particular the liquid phase of the slush. The size of the bubbles can vary.
Typically, bubble diameters are typically between 10 µm and 300 µm, in particular
between 20 µm and 200 µm and normally between 20 µm and 80 µm.

In the invention the hydrophilic polymer is mixed with pulp either in a stock preparation or
short circulation in one or several paperboard ply(s). Typically the hydrophilic polymer
can be added into chests or directly to the approaching pipe in the short circulation. After
the addition or simultaneously therewith, air is mixed with the pulp. Air can be generated
for example in a normal pulper with a mixing rotor or pumping high pressure air into
approaching pipe before the headbox. A foamed fibrous slush is thus created.

The foamed fibrous slush is conducted from one or several headbox(es) 1 onto one or
several wire section(s). On the wire section foamed fibrous slush is drained typically with
foils, foilboxes, vacuum boxes or vacuum rolls. As a result, a board web is formed. After
the wire section the dry content of the web is typically between 18 and 30 %, calculated
from the total weight of the web.

From the wire section the web is conducted to the press section, where dewatering is
carried out in roll nips. The dry content is increased up to 40 to 50 % in the press section.

After the press section, the web is directed onto the drier section. On the drier section,
typically hot cylinders are used for evaporating water from the web.

After the drier section the board machine typically has coating and calendaring units where
the final surface of the paper board is made.
Examples

The present invention has been tested at laboratory conditions. Figure 2 contains a table with bulk values and Scott Bond values of a middle layer of folding boxboard according to the tests.

According to preferred embodiments for manufacturing the board of the present invention, fiber material and nanocellulose mixture is mixed with prefabricated foam produced using polyvinyl alcohol. The foam generally has an air content of about 60 % to 70 %. The web is made from this fiber foam for example by suction of the foam through the wire. An excellent formation is reached because in stable foam the distances between particles remain and no flocculation takes place. After the web forming the fiber web is dried, for example by suction air through the web, e.g. using a suction slit.

Tests of different embodiments of the present invention using different polyvinyl alcohol grades as foaming agents in order to maximize the benefits of polyvinyl alcohol have showed that in laboratory scale it is for example possible to produce a middle layer of folding boxboard with CTMP pulp containing 10 % nanofibrillated cellulose (NFC) having a bulk value of 2.99 g/m³ and Scott Bond value of 153 J/m² when using a first polyvinyl alcohol grade and foam forming.

Tests of a second embodiment of the present invention have showed that in laboratory scale it is possible to produce a middle layer of folding boxboard with CTMP pulp containing 10 % NFC having a bulk value of 2.60 g/m³ and Scott Bond value of 281 J/m² when using a second polyvinyl alcohol grade and foam forming.

The tests of a third embodiment of the present invention have showed that in laboratory scale it is possible to produce a middle layer of folding boxboard with CTMP pulp containing 10 % NFC having a bulk value of 2.68 g/m³ and Scott Bond value of 314 J/m² when using the second polyvinyl alcohol grade and foam forming.

Tests of a fourth embodiment of the present invention have showed that in laboratory scale it is also possible to produce a middle layer of folding boxboard using coarser CTMP pulp
(574 CSF) without NFC, starch and retention aid additions having a bulk value of 3.71 g/m³ and Scott Bond value of 123 J/m² when using the second polyvinyl alcohol grade and foam forming.

The reference values of a middle layer of folding boxboard containing 10 % NFC with sodium lauryl sulfate (SDS) as a foaming agent instead of polyvinyl alcohol are for example 3.11 g/m³ and 136 J/m², respectively.

The reference values (bulk value and Scott Bond value) of a middle layer of folding boxboard containing 10 % NFC with a non-ionic foaming agent instead of polyvinyl alcohol are for example 3.15 g/m³ and 137 J/m², respectively.

As can be seen from the table, use of polyvinyl alcohol as a foaming agent offers the possibility to achieve middle layers of folding boxboard with a bulk value of at least up to 3.90 g/m³. Using sodium lauryl sulfate as a foaming agent instead of polyvinyl alcohol middle layers of folding boxboard with a bulk value between 2.45 g/m³ and 3.11 g/m³ can be achieved. Use of a non-ionic foaming agent instead of polyvinyl alcohol can lead to middle layers of folding boxboard with a bulk value between 3.15 g/m³ and 3.45 g/m³.

As can be also seen from the table, use of polyvinyl alcohol as a foaming agent offers the possibility to achieve middle layers of folding boxboard with a Scott Bond value between 105 J/m² and 314 J/m². Using sodium lauryl sulfate as a foaming agent instead of polyvinyl alcohol middle layers of folding boxboard with a Scott Bond value between 70 J/m² and 149 J/m² can be achieved. Use of a non-ionic foaming agent instead of polyvinyl alcohol can lead to middle layers of folding boxboard with a Scott Bond value between 112 J/m² and 137 J/m².

Tests of a fifth embodiment of the present invention have showed that in laboratory scale it is possible to produce a middle layer of folding boxboard using coarser CTMP pulp (574 CSF) without NFC, starch and retention aid additions, which suits the aforementioned target values, when using a polyvinyl alcohol with a degree of hydrolysis of 88.0 %. The polyvinyl alcohol may have another degree of hydrolysis, e.g. a degree of hydrolysis of 87.0 % or 89.0 %.
Tests of a sixth embodiment of the present invention have showed that in laboratory scale it is possible to produce a middle layer of folding boxboard using coarser CTMP pulp (574 CSF) without NFC, starch and retention aid additions, which suits the aforementioned target values, when using a polyvinyl alcohol with a molecular weight of 27000 g/mol. The polyvinyl alcohol may have another molecular weight, e.g. a molecular weight of 25000 g/mol or 35000 g/mol.

In Figure 3, a multilayered product produced according to the present invention is shown schematically. The product may be for example folding boxboard consisting of a middle layer arranged between a top layer and a lower layer. The top layer and the lower layer may be for example from bleached or unbleached chemical pulp. The middle layer on the other hand may be of chemithermomechanical pulp. The top layer and/or the lower layer may be further coated with an optional pigment coating which is not shown in Fig. 3.

The board exhibits generally a grammage (surface weight) of about 50 to 750 g/m². A middle layer of folding boxboard according to the present invention may be of any weight, in particular the weight may be between 10 g/m² and 300 g/m². Tests of a seventh embodiment of the present invention have showed that in laboratory scale it is possible to produce a middle layer of folding boxboard using coarser CTMP pulp (574 CSF) without NFC, starch and retention aid additions, which suits the aforementioned target values and has a weight of 200 g/m². The middle layer of folding boxboard may have another weight, e.g. a weight of 100 g/m² or 300 g/m².

Any other layer, e.g. a first other layer, a second other layer, a lower layer or a top layer, may be produced using the method of the present invention or any other method. The first other layer may be the lower layer and the second other layer may be the top layer. The number of layers in a multilayered product according to the invention is at least two. Folding boxboard according to the invention can for example also consist of five layers, i.e. a middle layer, a first other layer, a second other layer, a top layer and a lower layer.

In case of multilayered products any other layer, e.g. a first other layer, a second other layer, a lower layer or a top layer, may be according to the invention of any weight. In particular the weight of any other layer may be between 10 g/m² and 100 g/m². Tests of an
eighth embodiment of the present invention have showed that in laboratory scale it is possible to produce a middle layer of folding boxboard using coarser CTMP pulp (574 CSF) without NFC, starch and retention aid additions, which suits the aforementioned target values and is connected to a top layer which has a weight of 50 g/m². The top layer of folding boxboard may have another weight, e.g. a weight of 20 g/m² or 80 g/m². It is further possible to produce a middle layer of folding boxboard using coarser CTMP pulp (574 CSF) without NFC, starch and retention aid additions, which suits the aforementioned target values and is connected to a lower layer which has a weight of 50 g/m². The lower layer of folding boxboard may have another weight, e.g. a weight of 20 g/m² or 80 g/m².

In another embodiment of the present invention, wall paper is provided comprising a fibrous layer exhibiting in combination a) bulk > 1.8 g/m³ and b) Scott Bond > 100 J/m³. In other words, the terms “paperboard” and “board” in accordance with the disclosure of this document also comprise wall paper or other paper products within the meaning of the invention. The grammage (surface weight) of the wall paper may be in the range between 60 g/m² and 200 g/m², for example 90 g/m² or 110 g/m². The wall paper may comprise one layer or more than one layer. The wall paper may comprise two layers, for instance.

Additionally, the wall paper may include synthetic fibers according to certain embodiments. The synthetic fibers may be, for example, made of polyester. Use of synthetic fibers in the fibrous foam provides isotropy of the fibers, i.e. the fibers are orientated evenly in all directions in order to withstand tension. The synthetic fibres are carried by the three dimensional structure of the foam before removal of the foam on the forming section. The foam separates the fibres thereby reducing flocculation and poor formation. This more uniform three-dimensional orientation improves the retention of the synthetic fibres, builds stronger networks because the synthetic fibres are bound to each other in all directions, and also results in a more even formation. The improved synthetic fibre distribution and bond in the web provide better dimension stability, less dusting, better visual appearance and better functionality both in converting operations and end use.

Although the present invention has been described in detail for the purpose of illustration, various changes and modifications can be made within the scope of the claims. Different polyvinyl alcohol grades, different NFC percentages, starch and retention aid additions and
use of other pulp than (coarser) CTMP pulp can for example lead to other embodiments with other characteristics. In addition, it is to be understood that the present disclosure contemplates that, to the extent possible, one or more features of any embodiment may be combined with one or more features of any other embodiment.

Industrial Applicability

The fiber web according to the invention may be used in a broad range of paperboards. Within the scope of the invention, the following paperboards may be mentioned: Wallpaper Base, Duplex Wallpaper Base, Gypsum liners and boards and Core board. The containerboards include liners, such as kraftliners and testliners, and fluting and mediums, such as semi chemical fluting and recycled mediums.

In the present context, particularly interesting are, however, the cartonboards, which include folding box boards, white lined chipboards, greyboards, liquid packaging boards and food service boards, as well as solid bleached boards and coated unbleached boards and carrier boards. Thus, the fiber web can be a middle layer of folding boxboard, a cardboard product, a packaging, a hygiene product, an insulator, or a filter.

The fiber web according to the invention can also be used in the preparation of wall paper.
Citation List

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GB 1395757
GB 1397378
GB 1431603
US 4944843
US 6419792
WO 2008/040635 A1
Claims:

1. Method of producing a paperboard which comprises at least one fibrous web, wherein a fibrous foam is provided, said fibrous foam is formed into a foamed fibrous layer which is dewatered and dried to form said web, wherein a hydrophilic polymer is used as a foaming agent for forming said fibrous foam.

2. The method according to claim 1, wherein foam forming is carried out by mixing a fibrous slush with foam formed from water and the foaming agent so as to provide a foamed fibrous slush which is fed onto a wire to form the foamed fibrous layer.

3. The method according to claim 1 or 2, wherein the consistency of the fibrous slush is 0.6 % to 7 % by weight.

4. The method according to any of the preceding claims, wherein foam having an air content of 40 % to 80 %, e.g. 55 % to 75 %, by volume, is used.

5. The method according to any of the preceding claims, wherein the concentration of the foaming agent is about 150 ppm–1000 ppm, calculated from the total weight of the liquid.

6. The method according to any of the preceding claims, wherein the at least one foamed fibrous layer is wet pressed after dewatering.

7. The method according to any of the preceding claims, wherein the foaming agents is selected from water-soluble and dispersible foaming polymeric agent, in particular water-soluble or dispersible glycans, in particular polysaccharides and derivatives thereof.

8. The method according to any of the preceding claims, wherein the foaming agents is selected from water-soluble and dispersible foaming polymeric agent, in particular water-soluble or dispersible hydrophilic polymers and copolymers, such as poly(vinyl alcohol) and poly(vinyl acetate) and copolymers thereof.

9. The method according to any of the preceding claims, wherein the hydrophilic polymer is used as a foaming agent in an efficient amount to provide a bulky fibrous layer which
exhibits properties of good internal strength, as evidenced by at least one of improved Scott Bond and improved strength in z-direction.

10. The method according to any of the preceding claims, comprising providing a fibrous layer exhibiting in combination a) bulk > 1.8 g/m² and b) Scott Bond > 100 J/m².

11. The method according to any of the preceding claims, wherein synthetic fibres are provided in the fibrous foam.

12. A board with at least one dried foamed fibrous layer containing non-flocculated fibers, processed with foam formed from water and a hydrophilic polymer as a foaming agent.

13. The board according to claim 12, wherein the at least one dried foamed fibrous layer is arranged between a first other layer and a second other layer.

14. The board according to claim 12 or 13, which contains mechanical pulp, semi-chemical pulp, chemical pulp, thermomechanical pulp, chemithermomechanical or recycled pulp.

15. The board according to any of the claims 12 to 14, wherein the web is cartonboard made up of multiple layers of pulp.

16. The board according to claim 15, wherein a bottom and/or top layer is of bleached chemical pulp.

17. The board according to claim 16, wherein the bottom and/or top layer is coated with pigments.

18. The board according to any of claims 12 to 17, wherein the board is a cardboard product or a part thereof.

19. The board according to any of claims 12 to 18, wherein the board is a cartonboard, in particular a cartonboard selected from folding box boards, white lined chipboards,
greyboards, liquid packaging boards, food service boards, solid bleached boards, coated unbleached boards and carrier boards.

20. The board according to any of claims 12 to 19, wherein the foaming agent is selected from water-soluble and dispersible foaming polymeric agent, in particular water-soluble or dispersible glycans, in particular polysaccharides and derivatives thereof.

21. The board according to any of claims 12 to 19, wherein the foaming agent is selected from water-soluble and dispersible foaming polymeric agent, in particular water-soluble or dispersible hydrophilic polymers and copolymers, such as poly(vinyl alcohol) and poly(vinyl acetate) and copolymers thereof.

22. The board according to any of claims 12 to 21, wherein the fibrous layer exhibits a combination of high bulk and good internal strength, in particular a) bulk > 1.8 g/m³ and b) Scott Bond > 100 J/m³.

23. The board according to any of claims 12 to 22, wherein the board has a weight of 110 to 750 g/m² and wherein at least a part of the products exhibits in combination: a) bulk > 1.8 g/m³ and b) Scott Bond > 100 J/m³.

24. The board according to any of claims 12 to 23, wherein the at least one dried foamed fibrous layer comprises synthetic fibres.

25. The board according to any of claims 12 to 14, comprising a wall paper.
Fig. 1
Fig. 2
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Fig. 3

Fig. 4
**INTERNATIONAL SEARCH REPORT**

**International application No**
PCT/FR2015/056335

A. CLASSIFICATION OF SUBJECT MATTER

INV. D21F9/00 D21F11/00

ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D21F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronics database consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C. See patent family annex.

Notes:
* Special categories of cited documents:
  *"A" document defining the general state of the art which is not considered to be of particular relevance
  *"E" earlier application or patent but published on or after the international filing date
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Date of the actual completion of the international search: 28 July 2015

Date of mailing of the international search report: 04/08/2015

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Authorized officer: Pregetter, Mario
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