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(54) **A METHOD FOR MANUFACTURING A COATED SHEET, A COATED SHEET, A CONTAINERBOARD COMPRISING THE COATED SHEET, A CONTAINER COMPRISING THE COATED SHEET OR THE CONTAINERBOARD AND USE OF THE COATED SHEET**

VERFAHREN ZUR HERSTELLUNG EINER BESCHICHTETEN FOLIE, BESCHICHTETE FOLIE, BEHÄLTERKARTON MIT DER BESCHICHTETEN FOLIE, BEHÄLTER MIT DER BESCHICHTETEN FOLIE ODER DEM BEHÄLTERKARTON UND VERWENDUNG DER BESCHICHTETEN FOLIE

PROCÉDÉ DE FABRICATION D'UNE FEUILLE REVÊTUE, FEUILLE REVÊTUE, CARTON-CAISSE COMPRENANT LA FEUILLE REVÊTUE, RÉCIPIENT COMPRENANT LA FEUILLE REVÊTUE OU LE CARTON-CAISSE ET UTILISATION DE LA FEUILLE REVÊTUE

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## Description

### Field of the application

**[0001]** The present application relates to methods for manufacturing a coated sheet and to coated sheets. The present application also relates to containerboards and products comprising the coated sheet or the containerboard, such as containers and the like, and to uses of the coated sheets for preparing a container.

### Background

**[0002]** Cellulose-based sheets, such as paper or board sheets, are often used in a variety of applications requiring resistance against liquids. Such products may serve as wrappings, packages, containers and the like, for example for food, drinks, or other applicable materials. Cellulose-based materials may be used for example in disposable and/or recyclable products, such as products for packaging food or feed.

**[0003]** However the conventional materials do not provide enough resistance against a variety of substances, such as grease, water, alcohol and water vapour, for example. Further, the other properties, such as mechanic properties, for example flexibility, and recyclability, of the product also need improvement. Therefore there is a need for new cellulose-based materials providing enhanced barrier properties, recyclability, biodegradability, mechanical properties and other properties. The materials should be useful in a wide variety of different applications.

### Summary

**[0004]** It was found out that by using specific coatings based on starch it is possible to obtain versatile cellulosic sheets, which overcome problems of the prior art and provide new or improved properties. These cellulosic sheets provide barrier properties and desired mechanical properties, which sheets may be applied in a variety of products including supports, covers, containers and packages for use with food products and other products. Especially the products may be used in containers wherein it is desired to maintain the moisture content of the contained material at a certain range, and/or to prevent migration of odours, aromas, gases, greases, liquids and the like substances through the container.

**[0005]** The present application provides coated products having a support comprising cellulosic fibrous material i.e. cellulosic fibers, such as recycled cellulosic fibers. The products may be provided as sheets or other forms, or as containerboards, and they may be arranged to be folded into desired structures, such cups, bottles, paper wraps, other disposable containers, plates, trays, or as foldable holders for said products, or into packaging products such as boxes, sleeves, envelopes and the like. The products are fully recyclable after use. It is even possible to separate the coatings from the fibers in the recycling process.

**[0006]** The present application provides a method for manufacturing a coated sheet, the method comprising

- providing a sheet comprising cellulosic fibrous material, for example a sheet comprising paper and/or board, comprising a primer coating layer on the sheet, the primer coating layer comprising potato starch, inorganic filler and latex polymer(s) and having a grammage of the primer coating layer in the range of 1.0-5.0 g/m$^2$, such as 3.0-5.0 g/m$^2$, wherein said sheet comprising cellulosic fibrous material comprising the primer coating layer is obtained by
    - providing a sheet comprising cellulosic fibrous material, such as coated or uncoated sheet, for example a sheet comprising paper and/or board,
    - providing a first aqueous dispersion comprising potato starch in the range of 5-20% (w/w), 40% (w/w) or less inorganic filler, such as ground calcium carbonate, kaolin or talc, or a combination thereof, and 10% (w/w) or less latex polymer(s), for example in the range of 3-10% (w/w), and
    - coating the sheet comprising cellulosic fibrous material with the first aqueous dispersion to obtain the primer coating layer on the sheet, optionally repeating the coating at least once, to obtain a grammage of the primer coating layer in the range of 1.0-5.0 g/m$^2$, such as 3.0-5.0 g/m$^2$;
- providing a second aqueous dispersion comprising potato starch in the range of 5-20% (w/w), and wax; and
- coating the primer coating layer with the second aqueous dispersion to obtain a surface coating layer having a grammage in the range of 1-12 g/m$^2$, such as 4-7 g/m$^2$,

optionally forming one or more fold line(s) to the coated sheet, preferably wherein the coating is carried out with a coating method selected from printing, such as printing by flexography or printing by gravure, air knife, curtain coater, blade coater, and rod coater, such as Mayer bar.

**[0007]** The present application also discloses a method for manufacturing a coated sheet, the method comprising

- providing a sheet comprising cellulosic fibrous material, for example a sheet comprising paper and/or board,
- providing a first aqueous dispersion comprising potato starch and inorganic filler, and optionally wax,
- providing a second aqueous dispersion comprising potato starch, and wax,
- coating the sheet comprising cellulosic fibrous material with the first aqueous dispersion to obtain a primer coating layer, and
- coating the primer coating layer with the second aqueous dispersion to obtain a surface coating layer.

**[0008]** The present application also discloses a coated sheet comprising

- a sheet comprising cellulosic fibrous material, for example a sheet comprising paper or board,
- a primer coating layer on the sheet the primer coating layer comprising potato starch, inorganic filler and optionally wax.

**[0009]** The present application also provides a coated sheet comprising

- a sheet comprising cellulosic fibrous material, for example a sheet comprising paper and/or board,
- a primer coating layer on the sheet, the primer coating comprising potato starch, inorganic filler, such as ground calcium carbonate, kaolin or talc, or a combination thereof, and latex polymer(s), wherein the grammage of the primer coating layer is in the range of 1.0-5.0 g/m$^2$, such as 3.0-5.0 g/m$^2$, and
- a surface coating layer on the primer coating layer, the surface coating comprising potato starch and wax, wherein the grammage of the surface coating layer is in the range of 1-12 g/m$^2$, such as 4-7 g/m$^2$,
- the coated sheet being obtained with the method for manufacturing a coated sheet, as described herein.

**[0010]** The present application provides a containerboard comprising the coated sheet.

**[0011]** The present application discloses products, such as containers, for example disposable containers, item holders, and/or packages and the like comprising the coated sheet and/or the containerboard described herein.

**[0012]** The main embodiments are characterized in the independent claims. Various embodiments are disclosed in the dependent claims. The embodiments and examples are mutually freely combinable unless otherwise explicitly stated. The examples which are not in the scope of the claims may be considered as examples useful for understanding the invention.

**[0013]** The materials provide coatings based on aqueous ingredients. Instead of organic solvents, the whole chemistry is waterborne and thus safe for environment and users. The development has led to flexible and easily mixable aqueous dispersions, which have long and stable shelf life. The obtained products are non-toxic and safe for the users, and can be used in contact with food products. The used dispersions and obtained products are practically VOC and SVOC free.

**[0014]** By using the aqueous dispersions disclosed herein it was possible to obtain a method wherein coating of a cellulosic substrate could be carried out even in one step by using a single dispersion only. The materials and methods are especially applicable and cost-efficient in industrial scale, and enable using existing equipment, such as paper machines and the like devices suitable for manufacturing coated sheets, without modification or only with minor modifications. This saves time and money, as it would be extremely time consuming and expensive to modify an existing device for example to carry out the coating and/or post-processing in several steps. The method may be carried out for example by providing a starch solution or dispersion and a dispersion of inorganic filler, and mixing these prior to use in a container, or even to provide one or more of the ingredients as dry or concentrated form. If two coating units are required, an existing machine with one coating unit may be easily modified to include an additional coating unit.

**[0015]** The present coatings may be applied by using standard paper coating technology, such as blade coating. Use of extrusion coating, which are conventionally used for applying plastic coatings, can be avoided. In the present processes the formed waste can be repulped in the process. With the present dispersions and methods it is possible to obtain a high speed and reliable process with good runnability. High temperatures can be used and high dry matter content can be easily obtained. A variety of machinery can be used, such as horizontal form fill and seal machine (HFFS) or vertical form fill and seal machine (VFFS). The process can be optimized so that less process steps are required, and it is possible to carry out many or most, even all, of the process steps at the same facilities, which reduces the probability of wasting material in handling, storage, transport or further process steps, and also reduces total costs and time required for the process.

**[0016]** The obtained aqueous coating dispersion(s) may be used as such in a coating device. A dispersion may exhibit non-Newtonian behaviour, i.e. it is shear-thinning and therefore when shear forces are applied the viscosity of the dispersion lowers. This provides unique behaviour at the coating blade or the like part. The dispersion enters the coating parts at lowered viscosity because of the shear forces applied in the process, and briefly after the dispersion is applied to the substrate and shearing forces are no longer present, the viscosity will raise back to the original level and facilitates the setting of the coating onto the substrate. Also when stored, the shear-thinning material will be present in viscous

form, which prevents precipitation of ingredients and enhances the shelf-life and enables good storability, also during transport.

**[0017]** The coated sheets provide enhanced mechanical properties, for example enhanced flexibility of the coating. They are heat-sealable and gluable, and can thus be combined with other materials without problems. More particularly the coated sheets exhibit low hot-tack treshold. The coated sheets are printable and a variety of printed or otherwise decorated products may be formed.

**[0018]** The obtained products, such as packages and other containers, are easily foldable and form a steady structure, when erected. The products tolerate folding, defolding and refolding, and do not easily break at the fold line or scoring. The formed folds were durable, i.e. the sheets remained in the folded shape. They may be completely or substantially flat when stored and/or supplied to use, which saves space and helps transporting the products. Further, the products are easily returnable back into the flat form after use. The products are able to withstand mechanical forces, such as package handling. However, the packages can be easily opened, for example by tearing or ripping from an edge, unlike conventional products comprising a layer of plastic.

**[0019]** The products discussed herein refer to products comprising the coated sheets, such as products formed from the coated sheets and products formed from coated sheets combined with other materials, such as laminates with paper or board and/or the containerboards, as well as products comprising the coated sheet as one part of the product, such as a container formed from other material(s) including the coated sheet as a cover or as other part.

**[0020]** The products also provide enhanced chemical properties. The products are suitable to be used with food products, for example to store, to transport, to handle, to serve and/or to provide food products. It was possible to combine different types of coatings or properties of different types of coatings to obtain compatible combinations providing barrier properties against both water and grease, and also against colouring matters, odours, aromas, alcohol and water vapour, so the products obtained from the materials can tolerate aqueous or fatty spills and for example hot food or drinks. The materials provided both oil repellence and oil resistance properties. The products may be used for storing or providing liquids, such as drinks or soup-like food. In foldable or folded products also the folds maintained the barrier properties, which was highly surprising. The "food product" may refer to any suitable edible or drinkable product, or a product containing thereof. Examples of food products include meat, fish, vegetables, fruits, fats, sugars, flours, grains, breads, cereals, muesli, pasta, rice, porridge, spices, animal feed, candies and sweets, such as chocolate, energy and protein bars, biscuits, crackers, snack chips or crisps, chewing gums, food supplements, ice cream sticks, coffee, tea, instant coffee or tea, drinks, soups, stocks, processed foods and other products containing thereof. The food products may be provided as cold or non-heated, heated, or frozen, and they may be cooled, defrosted, heated or frozen in the products. Examples of products containing the coated sheets disclosed herein for use with food products include boxes, pouches, wraps, bags, sacks, sleeves, or other packages for fresh and processed food, such as tv dinners of the like, for frozen foods, packages such as trays for meat or fish, cheese, fast food packages such as pizza boxes, hamburger boxes, French fries boxes, wrappings for wraps, sandwiches, potato crisps/chips bags or other snacks packages, margarine and butter packages, and similar products, and the like. The containers tolerate high temperatures, such as temperatures over 100°C, for example up to 190°C, which may be heatable or ovenable containers, such as trays, and/or resistant to hot drinks, such as hot alcohol drinks, for example warm or hot wine, coffee-alcohol mixture, liquors and the like. Also containers or packages for other kind of products requiring barrier properties may be formed, such as medicament packages, tobacco products, office supply packages, for example ink cartridge packages, paper packages and the like.

**[0021]** The materials used in the methods and products are easily available and are competitively priced. The possibility of using recycled fibers provide environmental values and is therefore desired. As the products also provide chemistry, such as surface chemistry, which comply with recycling requirement, the products may be further recycled after use, so it is possible to obtain disposable and recyclable products. As the polymers are water-soluble and the use of olefins is avoided, the materials used in the products are recyclable and/or repulpable. The starch-based materials are easily compostable and/or biodegradable. Therefore the present materials and products represent green technology and the obtained products are recyclable, biodegradable, compostable, reusable and/or repulpable. It is also preferable to avoid harmful substances such as polyvinyl chloride, polyvinylidene chloride, polystyrene, expanded polystyrene, oxy degradable materials, rigid water soluble plastics, polylactic acid, polycarbonate, acrylics and industrial compostable materials. Use of plastic wrappings or the like in containers can be avoided thus resulting in less waste and ease of use.

**[0022]** However there are risks in using recycled materials, such as recycled fibers, especially in food applications. Food contact tests have proven migration risks concerning all recycled materials in contact with food and feed even when they are coated with polymers. The migration could be blamed of certain health risks, for example when dog feed has been packed in cardboard boxes having a thin coating but no inner bag. The present coating may be used to lower the risks as the coatings exhibit very low permeability for both water and fats as well as for microbes, and are therefore better isolators than conventional coatings. Also the migration of printing inks through the cellulosic substrate, which inks may contain for example harmful mineral oils, can be prevented. It is possible to manufacture food packings without inner bags but still having such desired barrier properties which were previously obtained only by using such bags. On the other hand the present coated sheets may be used as inner bags in such packages. Such inner bags may be used

for packing dry food ingredients, especially ingredients sensitive to moisture, such as flours, spices, bread, cereals and the like. The inner bags may be used also for packing moist ingredients, such as animal food or other foodstuff disclosed herein, or other materials wherein it is important to block the migration of odours or aromas. The inner bag may be used to keep the moisture outside the bag, or to keep the moisture inside the bag, i.e. to maintain the desired moisture content of the packed material.

**[0023]** The combination of the fibrous support, such as a sheet, for example paper, board, liner or the like and the coatings used in the embodiments was found advantageous for obtaining the properties described herein. Both recycled and virgin fibers may be used. The fibrous support and the polymeric coating are compatible, and durable products are obtained. The obtained coated sheets may be also attached to another sheet, such as a board or paper sheet, which may be thicker and/or more rigid, and provide different properties than the coated sheet. Therefore one example comprises the coated sheet and one or more further sheets, which may be based on one or more sheets disclosed herein, wherein the sheets are laminated or otherwise attached to each other. When such laminates or composite are made, it is not necessary to coat the thick and/or rigid supporting material but it is enough that a light and thin coated paper of the present invention is provided and combined with the supporting material(s).

**[0024]** The products are useful not only as cups, packages and the like, as described herein, but in any other applications wherein such coated fibrous materials and/or foldable, formable or bendable products are needed. The coated sheets may be also formed into further shapes or forms without folding, for example in a mould.

**[0025]** The present products may be also used for packing or containing other materials, such as cosmetics, medicaments, food supplements, tobacco products and the like which may benefit from the properties of the present materials. The products may be used for preparing disposable packages, such as unit dose packages suitable for cosmetics, medicaments, food, food supplements, tobacco products or other materials disclosed herein. One example of medical packages include bubble packages or push-through packages, which may be in the form of a strip, also called as a blister strip. Such a package comprises a first sheet or body containing pockets for the medicaments, such as tablets or capsules, and a second covering sheet on the first sheet for sealing the pockets. Conventionally the first sheet is made of plastic and the second sheet is made of aluminium foil. Either one of these, or both, can be replaced with the present coated sheets. The properties of the sheets can be easily adjusted to obtain suitable supporting properties for the body of the blister strip, and for the covering sheet to enable breaking of the sheet to release the medicaments. Similar packages or strips may be also used for providing other products, such as sweets, pastilles, lozenges, cough drops, vitamin pills or other supplements, and the like, or cosmetic products.

**[0026]** The products may be used for forming packages for tobacco products, such as cigarettes, cigars, cigarillos, snuff (snus) or dipping tobacco, loose tobacco such as loose leafs or pellets, chewing tobacco and the like. For example cigars may be packed in single unit packages, such as wraps, comprising the coated sheets.

**[0027]** The present products may be used as a removable covering in containers, such as a tearable covering, for example a wrap, a lid, a membrane or the like. The containers may be jars, pots, bottles, strips and the like, for example made of glass, metal and/or plastics. Currently aluminium foils or plastic-based membranes or sheets are used as such covers or lids, for example in food packages, cosmetic packages and medicament packages. Examples of such food packages include yoghurt cups, instant coffee or tea jars, margarine packages, seals in ketchup and the like bottles, tubs or jars.

**[0028]** The cosmetics may include emulsions, greases, make-ups and the like products, which may contain lipids, liposomes, vitamins, bioactive agents, fragrances, drugs, dyes, colorants and/or the like. The cosmetics may be present as liquid, emulsion, grease or solid, and they may be in the form of unit doses or as larger amounts packed in jars, pots, bottles and the like. Examples of cosmetic containers include grease and emulsions containers or jars. Similar containers may be also used for medicaments, vitamins and other food supplements.

**[0029]** The present products may be also used as or in retail carrier, storage and trash bags, fertilizer sacks, sleeves and tubes, ream wrappings, and labels.

## Description of the figures

**[0030]**

Figure 1 shows the formation of the coatings onto a sheet. A substrate sheet is provided (a), which is first coated with one primer layer (b), then with another primer layer (c), and finally with a surface coating (d).

Figure 2 shows a photo of a food tray formed by deep drawing. The food tray is sealed with a plastic membrane.

Figure 3 shows a graph of measurements of Brookfield viscosities of C15B and C15B2 talcs in starch slurry NF Flow 0901.

Figure 4 shows a graph of measurements of Brookfield viscosities of C15B and C15B2 talcs in starch slurry NF Flow 0901. C15B talc alone was used as a reference.

Figure 5 shows a graph of measurements of ACAV high shear rheology of two barrier coatings. The upper graph represents the Barrier coating color 2.

Figure 6 shows a graph of measurements of Brookfield viscosities C15B2 talcs in starch slurry NF 0901.

**Detailed description**

**[0031]** In this specification, percentage values, unless specifically indicated otherwise, are based on weight (w/w). If any numerical ranges are provided, the ranges include also the upper and lower values. The open term "comprise" also includes a closed term "consisting of" as one option.

**[0032]** One key aspect is to modify starch coating dispersion using both additives and suitable additional polymer chemistry to allow the final coating to have increased elongation, such as 10-100% or more. This makes the coating suitable for coating all kinds of fibrous materials, retaining the barrier properties in running the coated material in various machines, without losing the protective barrier properties.

**[0033]** The result was surprising, because in one example a starch dispersion could be obtained by providing basically only two new elements. The first was a suitable barrier filler, such as talc. The second was formulating the coating using modified latexes. In tests latexes were found out to form a thin flexible capsule for the whole particulate matter of the formulation. This allows elongation and keeps the filler particles oriented using their flatness for slowing down water and fat molecules transmission trough the coating layer.

**[0034]** The present application discloses a sheet (or a substrate) comprising cellulosic fibrous material, such as a coated sheet comprising a substrate comprising cellulosic fibrous material 10, which may be also called as cellulosic sheet, as shown in Figure 1a. The sheet or the substrate may be obtained from dewatered cellulosic pulp, such as mechanical pulp, chemical pulp, thermomechanical pulp, chemithermomechanical pulp, recycled pulp or a combination thereof, as a mixture and/or as layers, wherein the separate layers may contain different materials. The substrate may be a sheet, such as a sheet of paper, board, or the like cellulosic fibrous material, which may be substantially in a planar form. The substrate may be also provided as formed into a shape, which may be at least partly non-planar, i.e. not in a sheet form. The substrate may be provided as uncoated or coated (precoated), such as pigment-coated, for example with kaolin, calcium carbonate, bentonite and/or talc, before adding the polymeric coatings. The substrate may be calendered or uncalendered. The substrate may be bleached or unbleached. It may comprise a combination of two or more of these properties, as a mixture and/or as layers, wherein the separate layers may contain different materials. The substrate may contain virgin or recycled material or a combination thereof, as a mixture and/or as layers, wherein the separate layers may contain different materials. The cellulosic fibrous material may comprise wood fibers or non-wood fibers, or a combination thereof, as a mixture and/or as layers, wherein the separate layers may contain different materials. The wood fibers may be hardwood or softwood. Examples of materials based on wood fibers include kraft liners, such as brown, white top or white coated kraft liners; test liners, such as brown, white top uncoated or white top coated test liners; flutings, such as semi chemical, recycled fluting medium, or light weight recycled medium (LWM) fluting; or carton boards, printing and writing papers, kraft papers, and other boards. Examples of materials based on non-wood fibers include seaweed, wheat, rice, barley, flax, rye, grass and turnip rape. The cellulosic fibers may be virgin or recycled, or a combination thereof. Wood fibers may be preferred as they are abundant, widely available and the methods of manufacturing wood cellulose sheets are well known and they are available in several forms. For the same reasons wood fibers are widely available also as recycled materials, such as recycled papers and boards. However, the hydrophilicity of cellulose makes it a challenging raw material for use in preventing the penetration of hydrophilic liquids.

**[0035]** "Providing a sheet" us used herein may comprise forming a sheet or providing an existing sheet. As the coating may be implemented in existing equipment, such as a paper machine, the cellulose sheet may be manufactured prior to coating. It is also possible to provide a sheet which has been already manufactured separately and/or previously in another process and/or location.

**[0036]** The coated sheet may be used in a variety of final products including packages discussed herein but also in a further sheet-like products. The sheet may be a part of a product containing one or more other cellulosic sheets or products, such as a fluting, or the sheet may be present as a fluting or other corrugated structure or sheet. The sheet may be a linerboard in a corrugated cardboard. The sheet may be a folding board or folding boxboard. However it was found out that corrugated board with a kraft liner is especially suitable for most applications requiring stiffness, such as for heavier weights of several kilograms, for example for packing heavy food products, such as salmon which may have a weight of 2-10 kg, and for providing insulation, such as insulation of heat or cold, for example for heated or frosted food products or other products. The stiffness of a product based on corrugated carboard having a thickness of about 1.1 mm and grammage of about 400 g/m$^2$ was found to be remarkably stiffer compared to a similar product formed from

kraft liner having a grammage of about 300 g/m$^2$.

**[0037]** The substrate may be a kraft sheet, such as a kraft liner, or other substrate comprising or substantially consisting of kraft pulp or obtained from kraft pulp. The kraft process, also known as kraft pulping or sulphate process, is a process for conversion of wood into wood pulp consisting of almost pure cellulose fibers.

**[0038]** Corrugated cardboard, also called as corrugated fibreboard, comprises containerboard or corrugated case material, which is a type of paperboard specially manufactured for the production of corrugated board. It includes both linerboard (liner) and corrugating medium (fluting), the two types of paper or board that make up corrugated board. In general, linerboard made of virgin pulp is called kraft liner, and recycled linerboard is called testliner. However the borders of these categories may become blurred when both virgin and recycled fibers are used in making one product.

**[0039]** Corrugated cardboard is material widely used in packing. It provides properties such as crust resistance, bending resistance, impact resistance, tear resistance, shock absorption, and specific grammages for components or for combined board. The type of liner and fluting have an impact to the properties of the final product. Common flute sizes are "A", "B", "C", "E" and "F" or microflute. Corrugated cardboard can be specified by the construction such as single face, singlewall, or doublewall, flute size, burst strength, edge crush strength, flat crush, basis weights of components (grams per square meter), surface treatments and coatings. TAPPI and ASTM test methods for these are standardized.

**[0040]** Corrugated cardboard provides bending stiffness, which may be useful in packages such as packages designed to replace conventional styrofoam packages. Such packages would exhibit both mechanical strength and barrier properties which makes them ideal for example for storing wet and/or greasy food products, such as fish or meat. Such packages can be used for packing relatively heavy weights, such as up to 10 or 20 kilograms, or even more.

**[0041]** Corrugated cardboard also provides heat isolation properties because of the thickness and multi-layered structure, so with a liner comprising the coated sheet of the embodiments inside the package it is possible to obtain packages which enable freezing, but which do not form a frost layer on the outer surface of the package, and which packages provide release properties for the frozen product.

**[0042]** The sheet as a substrate may be provided according to the requirements of the use of the final product. Different properties may be stressed for specific purposes, such as grammage, thickness, stiffness and/or bending stiffness and or bending moment for larger trays or packages, for example packages having volume of 0.5-1.5 m$^2$.

**[0043]** The sheet may have a grammage (ISO 536) in the range of 80-750 g/m$^2$, 80-500 g/m$^2$, such as 80-400 g/m$^2$, 300-400 g/m$^2$, 80-150 g/m$^2$, 100-140 g/m$^2$, or 120-130 g/m$^2$. Grammage in the range of 200-500 g/m$^2$, such as 300-450 g/m$^2$ or 300-400 g/m$^2$, is suitable for most purposes and provides desired rigidity, such as for trays or the like products which may be formed by deep drawing. A corrugated cardboard may have a grammage in the range of 350-450 g/m$^2$, such as 400-425 g/m$^2$. A board liner, such as a kraft liner, may have a grammage up to about 700 g/m$^2$, for example in the range of 300-700 g/m$^2$.

**[0044]** The sheet may have a thickness (ISO 534) in the range of 0.1-5 mm, such as in the range of 350-1050 μm, for example 400-1000 μm, or 450-950 μm. A thin corrugate cardboard having a thickness in the range of 1-1.5 mm, for example about 1.1 mm, was found suitable for many applications and it could be also processed in several ways, for example deep drawn. A board, such as a kraft liner, may have a thickness in the range of 1-1.5 mm, such as about 1.05 mm.

**[0045]** The sheet may have a bending moment Taber 15° (ISO 2493, TAPPI 489) in the range of 9-125 (MD, machine direction) and/or in the range of 5-125 (CD, cross-direction).

**[0046]** The sheet may have a bending stiffness (DIN 5°, DIN 53121) in the range of 15-130 mNm (MD) and/or 10-50 mNm (CD).

**[0047]** The sheet may have an internal bond strength measured by Scott Bond (TAPPI 569) in the range of 100-150 J/m$^2$, such as in the range of 110-130 J/m$^2$.

**[0048]** In one example the sheet comprises board, such as folding box board, which may be coated on uncoated. The grammage of the board may be in the range of 275-500 g/m$^2$, more particularly 300-400 g/m$^2$ (ISO 536), which was found especially suitable. The thickness of the board may be in the range of 460-1030 μm, such as 500-950 μm (ISO 534). The bending moment Taber 15° in machine direction (MD) may be in the range of 20-124 mNm and/or in the cross direction (CD) in the range of 8.8-56 mNm (ISO 2493). Internal bond strength measured by Scott Bond may be at least 110 J/m$^2$ (TAPPI 569). Such materials are commercially available with trade name PankaBrite by Pankakoski Mill Oy, Finland

**[0049]** In one example the sheet comprises board having a grammage in the range of 300-500 g/m$^2$, bending resistance (Lorentzen & Wettre, ISO 2493) in the range of 335-1350 (MD) and 120-470 (CD), bending stiffness (DIN 5°, DIN 53121) in the range of 30-127 mNm (MD) and 11.6-45.6 mNm (CD), and/or bending moment Taber 15° (TAPPI 489) in the range of 16.2-65.1 mNm (MD) and 5.8-22.7 mNm (CD). Such materials are commercially available with trade name Multiboard EcoKraft by Fiskeby.

**[0050]** In one example the sheet comprises coated board containing two or more fiber layers, such as two chemical pulp layers separated with pressure groundwood layer. The grammage of the board may be in the range of 200-335, thickness in the range of 350-650 μm, bending moment Taber 15° in the range of 9-44 (MD) and 5-22.4 (CD), bending resistance (Lorentzen & Wettre, 15°, ISO 2493) in the range of 184-905 (MD) and 104-464 (CD), and/or bending stiffness

(DIN 5°) in the range of 18-87.2 (MD) and 10-44.7 (CD). Internal bond strength measured by Scott Bond may be about 130 J/m$^2$. Such materials are commercially available with trade name Tambrite by StoraEnso. These materials are especially suitable for trays and folding board boxes, for example.

**[0051]** The sheet may be a linerboard of a corrugated board. In one example the liner is kraft liner, such as uncoated kraft liner, for example uncoated white top kraftliner. Such linerboards may be used for example for retail-ready packaging, foods, beverages, consumer electronics, consumer durables and general packaging. Such sheet may contain a layer of bleached chemical pulp and a layer of unbleached chemical pulp. In one example such sheet has a grammage in the range of 135-200 g/m$^2$, thickness in the range of 155-230 μm, and/or internal bond about 350 J/m$^2$ (TAPPI 569). Such materials are commercially available with trade name MetsäBoard Natural WKL by MetsäBoard, Finland.

**[0052]** In another example a linerboard is coated kraft liner, such as coated white top kraft liner. Such linerboards may be used for example for retail-ready packaging, foods, beverages, consumer electronics, consumer durables and general packaging. Such sheet may contain a layer of blade coating, a layer of bleached chemical pulp and a layer of unbleached chemical pulp. In one example such sheet has a grammage in the range of 135-175 g/m$^2$, thickness in the range of 140-185 μm, and/or internal bond about 350 J/m$^2$ (TAPPI 569). Such materials are commercially available with trade name MetsäBoard Classic WKL by MetsäBoard, Finland.

**[0053]** In another example a linerboard is double-coated kraft liner, such as double-coated white top kraft liner. Such linerboards may be used for example for retail, consumer and shelf-ready packaging, point-of-sales materials, foods, beverages, consumer electronics and consumer durables. Such sheet may contain a layer of double blade coating, a layer of bleached chemical pulp and a layer of unbleached chemical pulp. In one example such sheet has a grammage in the range of 125-250 g/m$^2$, thickness in the range of 120-250 μm, and/or internal bond about 350 J/m$^2$ (TAPPI 569). Such materials are commercially available with trade name MetsäBoard Prime WKL by MetsäBoard, Finland.

**[0054]** The substrate 10, such as a sheet, comprising cellulosic fibrous material may be provided as rolled into a roll, wherein the sheet may be in a form of a web, such as paper or board web. The roll is unwound during the procedure and the substrate is coated as described herein. Alternatively the substrate 10 is formed prior to coating, for example in a paper or board machine. The substrate may be conveyed to one or more coating unit(s) or device(s), which comprise means for coating the substrate. "Coating" as used herein, refers to applying a layer of aqueous mixture, such as a dispersion, which forms a coating onto the substrate to be coated. The coating may be formed by using one or more of any suitable coating means, such as ones disclosed herein. The substrate may comprise one or more coating(s), which may be similar or different. In one example the obtained product is a multi-layer product, which may comprise one or more layer(s) of substrate and one or more layer(s) of coating(s).

**[0055]** Figures 1a-d show examples of a coating process. Figure 1a shows a cellulosic substrate before any coating are applied. In figure 1b a first coating layer 12 is applied onto the substrate 10. In Figure 1c another primer coating layer is applied onto the first primer coating layer. In Figure 1d a topcoat or a surface coating layer 16 is applied onto the primer coating layers 12, 14.

**[0056]** All the coatings of the present method may be applied to the substrate during the operation, for example at the same production premises, substantially at the same location, such as a plant, a mill, a factory or the like. Alternatively, only one or some coating(s) may be applied to obtain an intermediate product, which contains less than all the coating layers of the final product. The intermediate product may be wound into a roll or piled in a stack of sheets. The intermediate product may be then stored, packed, and/or it may be transported to another location, preferably to different premises and/or different geographical location, wherein one or more further coating(s) is/are applied to obtain the final product. The intermediate product may be manufactured by a first operator and further processed by a second operator, which may be different from the first operator and/or at a different location. The transportation may be carried out by using one or more vehicle(s), such as truck(s), train(s), boat(s), aeroplane(s) or the like.

**[0057]** A system for manufacturing the coated sheet described herein may be provided, wherein the system comprises one or more coating unit(s) for forming one or more coating(s) to the sheet, as described herein. In one example the system comprises two coating units, such as blade coating units, wherein first unit is for coating the primer layer and the second unit is for coating the surface layer. Such setup may be called as tandem. The system may also comprise one or more drying unit(s) for drying a coating formed by the one or more coating unit(s). The system may also comprise means for unwounding a roll of the sheet or web comprising cellulosic fibrous material, and/or other means for unpacking the sheets means for transferring the sheet or web comprising cellulosic fibrous material, means for feeding and/or advancing the sheet or the web, means for wounding a coated sheet or web, and/or means for cutting the coated sheet or web into separate sheets, and/or means for forming one or more folds or fold lines to the coated sheets, such as cut sheets. If the product is manufactured at more than one location, such as plant or factory, one or more of said components or units of the system may be located at different locations. In most cases the coated product is wound onto a roll or piled after coating, and after that stored and/or transported to a different location, which may be at the same premises, mill, plant or factory, or at a completely different location, to be further processed, such as for example cut into sheets or other forms of predetermined sizes and/or shapes. The product may be also printed, and/or folds and/or fold lines may be formed to the products. Also these steps may be carried out at the same premises, plant or factory, or at a

completely different location. It is also possible to coat and further process sheets already cut into desired sized and/or shapes, which are not provided as wound into a roll.

**[0058]** The coating may be carried out in one step and/or by using the same (a single) coating composition. The present application provides a method for manufacturing a coated sheet, the method comprising

- providing a sheet comprising cellulosic fibrous material,
- providing a first aqueous dispersion comprising potato starch, inorganic filler(s) and optionally wax(es),
- coating the sheet comprising cellulosic fibrous material with the first aqueous dispersion to obtain a primer coating layer. The coating may be repeated at least once, such as two, three or four times. Also by adjusting one or more coating parameter(s), such as speed, coating thickness and the like, and/or by adjusting the composition of the dispersion, it is possible to obtain a desired coating and/or final product. The obtained coating may be called a primer coating or a first coating and/or it may be the only coating on the sheet. However, depending on the intended use, also further coatings may be applied.

**[0059]** The method may comprise forming or preparing the coated sheet. This may be carried out in a suitable sheet forming device, such as a paper machine or a board machine. In such case the method may comprise providing means for forming a sheet, such as a sheet forming device, and the sheet forming device may further comprise one or more means for coating the (formed) sheet, such as one or more coating device(s) or unit(s). The means for coating the sheet, especially a dried sheet, may be at a suitable location in the forming device, such as after calender section and/or reel section, especially at a location wherein a formed and/or dried sheet is formed and/or provided, in general after the wet end. It is preferred that the formed sheet has a moisture content suitable for coating, such as 10% (w/w) or less, such as in the range of 6-10% (w/w), i.e. the formed sheet is dried or dewatered. The means for coating are preferably at a location wherein the formed sheet is at the moisture content suitable for coating.

**[0060]** Alternatively an existing sheet may be provided, and the method may comprise providing means for coating the sheet. The sheet may be dried, in case it may have a moisture content of 10% (w/w) or less, such as in the range of 0-10% (w/w), for example in the range of 5-10% (w/w), or other applicable moisture content of a paper, board or the like when formed, finished or stored.

**[0061]** In one example the method comprises

- optionally providing means for forming a sheet, such as a sheet forming device,
- providing one or more means for coating the (formed) sheet, such as one or more coating device(s) or unit(s),
- providing a sheet comprising cellulosic fibrous material, such as coated or uncoated sheet,
- providing a first aqueous dispersion comprising potato starch, for example in the range of 5-20% (w/w), inorganic filler, such as ground calcium carbonate, kaolin or talc, or a combination thereof, and optionally wax, and
- coating the sheet comprising cellulosic fibrous material with the first aqueous dispersion to obtain a primer coating layer, optionally repeating the coating at least once. The sheet forming device(s) are used to coat the sheet with the aqueous dispersion(s) disclosed herein, for example using a first coating device to coat the sheet with the first aqueous dispersion and using a second coating device to coat the sheet with the second aqueous dispersion, or using the (same) coating device to coat the sheet with the first aqueous dispersion and subsequently with the second aqueous dispersion.

**[0062]** The coating may be also carried out in two or more steps and/or by using two or more different coating compositions. The present application also provides a method for manufacturing a coated sheet, the method comprising

- providing a sheet comprising cellulosic fibrous material,
- providing a first aqueous dispersion comprising potato starch and inorganic filler,
- providing a second aqueous dispersion comprising potato starch and wax,
- coating the sheet comprising cellulosic fibrous material with the first aqueous dispersion to obtain a primer coating layer, and
- coating the primer coating layer with the second aqueous dispersion to obtain a surface coating layer. The primer coating layer may be dried and/or cured, preferably to contain cross-linked and/or gelatinized starch, before further steps. In general any of the coating described herein may contain cross-linked and/or gelatinized, for example fully or partly, starch.

**[0063]** An intermediate product may be obtained with a method comprising

- providing a sheet comprising cellulosic fibrous material,
- providing a first aqueous dispersion comprising potato starch and inorganic filler, and optionally wax,

- coating the sheet comprising cellulosic fibrous material with the first aqueous dispersion to obtain a primer coating layer. The coating may be repeated at least once, such as two, three or four times. The primer coating layer may be dried and/or cured, preferably to contain cross-linked and/or gelatinized starch, before further steps.

**[0064]** The further coatings may be applied by a different operator and/or at a different location and/or premises. In such case the method for manufacturing a coated sheet may comprise

- providing a sheet comprising cellulosic fibrous material comprising a primer coating layer on the substrate, the primer coating layer comprising potato starch, preferably cross-linked and/or gelatinized, and inorganic filler, such as the coated sheet obtained with the previous method,
- providing a second aqueous dispersion comprising potato starch and wax, and
- coating the primer coating layer with the second aqueous dispersion to obtain a surface coating layer.

**[0065]** In another case, wherein also another primer coating is to be applied by a different operator and/or at a different location and/or premises, the method may comprise

- providing a sheet comprising cellulosic fibrous material comprising a primer coating layer on the substrate, the primer coating layer comprising potato starch, preferably cross-linked and/or gelatinized, and inorganic filler,
- providing a first aqueous dispersion comprising potato starch and inorganic filler,
- providing a second aqueous dispersion comprising potato starch and wax,
- coating the sheet comprising cellulosic fibrous material comprising a primer coating layer on the substrate comprising potato starch and inorganic filler with the first aqueous dispersion to obtain a primer coating layer, such as a second, third or further primer coating layer, and
- coating the primer coating layer with the second aqueous dispersion to obtain a surface coating layer.

**[0066]** The first aqueous dispersion and/or the second aqueous dispersion may also comprise one or more cross-linking agent(s).

**[0067]** The final product may be wound into one or more roll(s), or it may be cut into separate sheets. The roll(s) or the separate sheets may be piled and/or packed and transported to another location, premises and/or to another operator, or they may be further processed at the same premises or location. Products, such as ones discussed herein, may be formed from the coated final products, such as the coated sheets.

**[0068]** The polymers used in the embodiments are provided in aqueous dispersions and may be therefore called aqueous and/or waterborne (dispersed) polymers. The aqueous dispersions discussed herein do not contain substantial amounts organic solvents, and preferably no organic solvents at all. The polymers preferably do not contain olefins.

**[0069]** The waterborne starch polymers used in the embodiments may exhibit polymer heterogeneity. Organic solvent-based polymers are homogeneous in nature, since all polymeric materials tend to be dissolved in the same solvent mixture. This is different for most waterborne polymers, which tend to be present in a compartmentalized way. Most polymeric materials are present in particles, which are separated by the continuous aqueous phase. This enables obtaining particle morphologies that form the basis for specific film morphology after drying of the coating.

**[0070]** Most polymeric materials used in the embodiments form films either by coalescing or cross-linking. The polymers of the embodiments may be present in the dispersion as particles. The particle size may be especially relevant in primers to allow as thin layer as possible to be formed and in top coats/surface layers to close the surface and let wax polymer particles close the gaps. Cross-linking may occur in coating, especially in the surface coating, when water evaporates and/or by the effect of heat, leading to curing of the polymeric material. Cross-linking may be also obtained by introducing one or more cross-linking agent(s), which may be polymeric agent(s), reactive agent(s) or agent(s) capable of forming hydrogen bonds. Cross-linking enhances the flexibility of a coating, so the coating may tolerate mechanical stress better, such as folding. Sugar alcohols and latex polymers are examples of cross-linking agents.

**[0071]** The coated sheet may comprise a primer coating layer on the substrate, the primer coating layer comprising potato starch and inorganic filler, preferably obtained from a mixture of potato starch and inorganic filler. The potato starch may comprise one or more starch polymer(s). In a dried or cured coating the starch is preferably cross-linked, gelatinized/gelled and/or otherwise fixed or set.

**[0072]** The coatings discussed herein may be called as dispersion coatings, which refers to application of a waterborne coating with a high proportion of polymeric substances onto a fiber-based web. More particularly, the mixture of aqueous polymer and inorganic filler may be provided as an aqueous dispersion, wherein the polymers may be present as particles. The coating may be carried out by using any suitable conventional coating method such as blade coating. It was found out that when using blade coating the present dispersions did not accumulate to the blade but rather washed the blade, and the runnability of the dispersions was excellent. The aqueous dispersion is printable, so the primer coating layer(s) may be applied also by using a printing machine. After printing the coating layer may be corona-treated.

**[0073]** The dispersions and/or coating layer(s) disclosed herein, such as the first aqueous dispersion and/or the second aqueous dispersion, may contain latex, such as latex polymer(s) or latex-based polymer(s). For example the dispersion of inorganic filler may be provided with latex polymer(s) as additive. The latex polymer(s) may be provided as an aqueous dispersion.

**[0074]** According to one definition latex is a stable dispersion (emulsion) of polymer microparticles in an aqueous medium. It is found in nature, but synthetic latexes can be made by polymerizing a monomer, such as styrene that has been emulsified with surfactants. The word "latex" may also refer to polymer only. Latex or latex polymer disclosed herein may refer to one or more latex types or to one or more latex polymer(s).

**[0075]** It was found out that not all latexes provide similar properties. There are differences for example in manageability of the material, such as stickiness, and in the obtained properties in the final product. Latex was found to enhance heat-sealability of the coated sheets and well as flexibility rather than elasticity. One latex type especially suitable to be used in the present dispersions comprises anionic styrene-butadiene latex, such as anionic carboxylated styrene/butadiene copolymer, which were easy to handle and use in the equipment, so the dispersion of the latex provided a good flow and did not block the devices. The viscosity of such latex may be less than 400 mPa s, such as less than 350 mPa·s (determined by ISO 1652). Such latex provided excellent flexibility, which enhanced the mechanical properties of a coating, such as durability of a folding. Example of such latexes include Litex types by Synthomer, for example Litex PX 9330. Other suitable latex types used in the tests were Litex PX 9340 and. Litex PX 9340 modified latex versions.

**[0076]** The amount of latex in an aqueous dispersion, such as in the first aqueous dispersion and/or in the second aqueous dispersion, may be for example 10% (w/w) or less, such as 8% (w/w) or less, for example in the range of 3-10% (w/w), 3-8% (w/w), or 5-10% (w/w).

**[0077]** The dispersions disclosed herein, such as the first aqueous dispersion and/or the second aqueous dispersion, may also contain one or more sugar alcohol(s), such as xylitol and/or sorbitol, for example 1% (w/w) or less. These may act as chain forming additives and also enhance the mechanical properties of a coating. Without binding to a specific theory, it is believed that the specific latex polymers and sugar alcohols, especially xylitol, formed bonds between molecules in the coating thus facilitating cross-linking and enhancing flexibility and other mechanical properties. Xylitol was found out to provide excellent properties in this respect, especially in combination with anionic styrene-butadiene latex.

**[0078]** One embodiment provides a coated sheet comprising

- a sheet comprising cellulosic fibrous material,
- a primer coating layer on the sheet comprising potato starch and inorganic filler, and
- a surface coating layer on the primer coating layer comprising potato starch and wax,

wherein the primer coating layer and/or the surface coating layer comprise(s) latex polymer(s), such as anionic styrene-butadiene latex, and/or one or more sugar alcohol(s), such as xylitol and/or sorbitol.

**[0079]** In one embodiment the primer coating layer and/or the surface coating layer comprise(s) gelatinized potato starch, talc, latex polymer(s) and optionally wax.

**[0080]** The dispersions disclosed herein may further contain one or more pigment(s), one or more antifoaming agent(s), one or more dispersing agent(s), one or more stabilizing agent(s) or combinations thereof.

**[0081]** Starch is a natural polymeric carbohydrate comprising a large number of glucose units joined by glycosidic bonds. It may be used especially in applications requiring biodegradability, such as compostability. In general starch contains two types of molecules: the linear and helical amylose and the branched amylopectin. Starch may be modified, such as physically, chemically and/or enzymatically modified, to obtain desired properties. Starches may be modified to enhance their performance in different applications, and/or to increase their stability against excessive heat, acid, shear, time, cooling, or freezing; to change their texture; to decrease or increase their viscosity; to lengthen or shorten gelatinization time; or to increase their visco-stability. For example hydroxypropylation of starch increases viscosity stability. Such modification may be carried out by propylene oxide at levels up to 25% and the resultant starch is usually lightly oxidized, bleached or acid modified after etherification.

**[0082]** One example of starch is potato starch. Potato starch is extracted from potatoes by crushing the potatoes, wherein the starch grains are released from cells. The starch is washed out and dried. Potato starch contains relatively large irregularly shaped, ovoid or pear-shaped granules having an average diameter usually in the range of 5-100 μm, such as 30-100 μm, or rounded granules having an average diameter in the range of 10-35 μm. Potato starch contains about 800 ppm phosphate bound to the starch. This increases the viscosity and gives to an aqueous solution a slightly anionic character, a low gelatinisation temperature of approximately 60°C and high swelling power.

**[0083]** Potato starch is preferred material choice over other starch types for example because of its properties, such as good crosslinkability or gellability. Further, it may be desired to use other starches, such as corn starch, for other purposes in the future, such as for energy or food production. Starch comprises one or more polymer(s), which may be called starch-based polymer(s). The polymer(s) used herein may or may not be modified. The starch may be pretreated

before applied as a coating. For example a coating dispersion, or a dispersion used for forming a coating dispersion, may contain pretreated starch, which may be gelatinized or gelled, and/or crosslinked, either fully or partially. The starch may be treated or pretreated with one or more cross-linking agent(s), chain-forming agent(s) and/or other agent(s) capable of modifying the starch and/or reacting with it.

**[0084]** In one embodiment the starch is hydroxypropylated starch, such as hydroxypropylated starch ether. Such starch may be provided at a pH of the solution in the range of 5.5-7.0. The Brookfield viscosity of such starch may be in the range of 70-200 mPa s, such as 70-150 mPa s, for example 100-150 mPa s, measured at 25% consistency in water at 50°C with Brookfield RVT, spindle 2, 50 rpm. One example of a commercially available hydroxypropylated potato starch is Solam Solcoat P55. In one example the aqueous coating composition comprises both latex-based polymer and starch-based polymer, such as styrene-butadiene latex and hydroxypropylated starch. It is possible to use only biopolymers (bio-based polymers) such as starch, in the coating layer(s), so in such case the aqueous polymer(s) is/are biopolymer(s). Biopolymers are in most cases able to form crosslinks, which is different from synthetic polymers, so biopolymers may form a film already at a room temperature and have a high film formation speed.

**[0085]** The amount of starch in an aqueous dispersion, such as in the first aqueous dispersion and/or in the second aqueous dispersion, may be for example in the range of 5-20% (w/w), such as 5-15% (w/w).

**[0086]** The inorganic filler included in the layers has an impact to the properties of the final product, such as to folding properties and/or to barrier properties. One specific feature of the inorganic filler affecting the efficiency of the barrier properties is the particle shape. Especially when the used polymers provide a relatively permeable layer, such as often in the case of biopolymers, the barrier properties may be enhanced by the selection of suitable inorganic filler(s).

**[0087]** The inorganic filler may comprise ground calcium carbonate, kaolin or talc, or a combination thereof. In one example the inorganic filler has an average particle size of 3.2 μm or less, such as 2 μm or less, such as in the range of 3.2-0.5 μm, such as 3-1.5 μm, and which may be lamellar or plate-like. An improvement in the water vapor barrier properties can be achieved by using a plate-like minerals such as talc. Examples of commercially available inorganic fillers include Talc de Luzenac MOOS10 and Finntalc M15S or C15B.

**[0088]** In one embodiment the inorganic filler comprises or consist of talc. Talc may comprise hydrated magnesium silicate with chemical formula of $Mg_3Si_4O_{10}(OH)_2$. Preferably the talc is provided in a pure form, such as containing at least 97% (w/w) of talc, or at least 98% (w/w), or at least 99% (w/w). The talc may be plate-like or lamellar, which was found to provide good coating with enhanced barrier properties, such as water barrier properties or low permeability for water. Examples of talcs used in the tests include Finntalc C10B and C10B2 and Finntalc C15B and C15B2 by Elementis. In tests talcs with lamellar or plate-like particle types formulated with dispersing and stabilizing additives were found especially suitable. C10B contains fine particles and may be suitable for specific uses. The talc may have a median particle size D50 in the range of 2.6-3.2 μm, such as about 2.9 μm. About 32% of the particles may have a median particle size of less than 2 μm.

**[0089]** A lamellar structure may comprise fine, alternating layers of different materials in the form of lamellae. The lamellarity may be characterized by a lamellarity index, which characterizes the shape of the particle, more particularly its flatness (large dimension/thickness). The lamellarity index may be measured by the difference between, the value of the mean dimension of the particles of the powder obtained by a particle size measurement, for example by laser diffraction using a wet method by standard AFNOR NFX11-666, and the value of the mean diameter D50, which may be obtained by measurement of sedimentation, for example by using standard AFNOR X11-683. The lamellarity index, or the average length:thickness ratio of a particle, may be 2.8 or more, preferably 4 or more, 10 or more or 20 or more, for example in the range of 2.8-100, 4-100, 10-100, 20-100, 20-50 or 10-50, which describe highly lamellar material. The thickness refers to the shortest dimension of the particle and the length to the longest dimension of the particle.

**[0090]** Lamellar inorganic filler, such as lamellar talc, may be microcrystalline, which may have a length:thickness ratio in the range of 5:1 to 20:1, such as about 10:1, or macrocrystaline, which may have a length:thickness ratio in the range of 25:1 to 50:1, such as about 35:1.

**[0091]** The amount of inorganic filler in an aqueous dispersion, such as in the first aqueous dispersion and/or in the second aqueous dispersion, may be for example 40% (w/w) or less, such as 30% (w/w) or less, for example in the range of 10-20% (w/w), 10-30% (w/w), or 20-40% (w/w).

**[0092]** It was found preferable to use talc and potato starch. Optimal results were obtained by using NF02 dispersing and stabilizing additive in 60-63% solids versions of Finntalc C10 B2 and C15 B2. Using 40% C15 B2 slurry in Solam P55 potato starch formulation improved barrier properties with a factor of 75%.

**[0093]** The coating composition(s) may be provided as one or more aqueous dispersion(s) or composition(s). It is possible to provide two or more compositions of ingredients and combine them to obtain the final coating dispersion, especially if the coating is to be carried out in a single coating step. For example the starch and the inorganic filler may be provided as separate dispersions, compositions or mixtures containing required additives, and combined and mixed prior to use. The aqueous dispersions, compositions or mixtures disclosed herein may contain also other auxiliary agents, such as plasticisers, for example citric acid, propylene glycol or the like, which are especially suitable for potato starch, pH-adjusting agent(s), biocides, anti-foaming agents, organic polymers and the like. One or more of the auxiliary agents

may act as cross-linking agent(s) and/or gelling agent(s).

**[0094]** It was found out that it may be advantageous to provide the components of the coating compositions as separate compositions, solutions, dispersions or the like, so that the properties of the ingredients may be adjusted, modified and/or controlled individually, and to obtain better storability and transportability of the ingredients.

**[0095]** In one example the method comprises providing

- a composition A comprising gelatinized potato starch,
- a composition B comprising inorganic filler, preferably as a dispersion,
- optionally composition C comprising latex polymer(s) and wax, preferably also sugar alcohol,

and combining the compositions A, B and optionally C to obtain the aqueous dispersion comprising potato starch and inorganic filler.

**[0096]** One or more of the compositions A, B and C, especially at least A and B, may be provided as dry or dried or concentrated, and/or one or more of them may be provided as a dispersion. A dry composition may have a moisture content of 6% (w/w) or less, such as 4% (w/w) or less, for example 0-3% (w/w). A concentrated composition may have a moisture content of 50% (w/w) or less, such as 30% (w/w) or less. The dry or concentrated composition(s) may be brought into a dispersion form prior to use by adding water. In such case the method may comprise forming a dispersion. Using dried or concentrated compositions facilitate transporting, handling, storing, handling, preserving and providing the components and compositions. The present disclosure provides use of one or more of the compositions A, B and C, as dry, concentrated and/or as dispersion, or a composition or combination obtained by combining said compositions A, B and C, as discussed herein, in the methods disclosed herein, such as for coating a sheet and/or for preparing a composition or a dispersion, such as the first and/or the second aqueous dispersion disclosed herein.

**[0097]** The compositions A, B and C, especially at least A and B, may be provided at an elevated temperature. The providing may include preparing, transporting, storing, and/or providing to mixing, for example. The elevated temperature may be 50°C or higher, such as 60°C or higher, even 65°C or higher or 70°C or higher, for example in the range of 60-66°C or 63-66°C. This helps maximizing the dry matter content, but also eliminates contamination risks. Because most microbes do not survive or grow at such temperatures, there is no need to add any antimicrobials to the dispersions. This also enables using the existing containers, piping or equipment at plants without causing biological risks. Also when warm or hot dispersions or other liquids are used, the need for drying capacity decreases compared to cold coating, and also allows maximum speeds with the machinery. Especially the starch slurry is heat-thinning.

**[0098]** The present application provides each of said compositions A, B and C, and methods for preparing thereof, as well as the obtained combination. The ingredients may be provided as or formed into water solutions, emulsions or dispersions, where applicable. Water may be included to obtain 100% (w/w). The compositions may be combined in amounts suitable to obtain a desired content of one or more ingredient(s) in a final coating dispersion. The compositions may be combined for example in equal volumes or weights.

**[0099]** A starch dispersion or composition (Composition A) contains starch in a pretreated form, which may be gelatinized or gelled. Starch gelatinization is a process of breaking down the intermolecular bonds of starch molecules in the presence of water and heat, allowing the hydrogen bonding sites (the hydroxyl hydrogen and oxygen) to engage more water. Composition A may contain 15-38% (w/w) of starch. Additives such as propylene glycol and ammonia may be included in small amounts, such as 2% (w/w) or less, or 1% (w/w) or less, for example 1-2% (w/w) of propylene glycol and/or 0.05-0.1% (w/w) of ammonia water (25%). In one example a starch dispersion comprises or is obtained by combining

- starch 15-38% (w/w),
- propylene glycol 1-2% (w/w), and
- optionally ammonia (25%) 0.05-0.1% (0.0125-0.025% (w/w) of ammonia). Organic acid, such as citric acid, may be added in an amount in the range of 0.1-0.8% (w/w). Water is added to obtain 100% (w/w).

**[0100]** A method for preparing a starch dispersion or composition (Composition A) may comprise

- providing gelatinized starch, or treating starch with organic acid, such as citric acid, to obtain gelatinized starch in an aqueous solution, preferably 15-38% (w/w) of starch,
- optionally providing one or more additive(s) and/or auxiliary agent(s), such as propylene glycol, such as 1-2% (w/w),
- adjusting pH of the aqueous solution with a base, such as ammonia, preferably to obtain a brief decrease in pH, such as of 1-30 seconds,
- to obtain the starch dispersion or composition. Heating may be provided, such as presented in one or more steps in the following example. Especially the starch solution or dispersion may require initial heat treatment at a temperature of at least 80°C for 15-60 minutes, such as at least 85°C, or at least 90°C, preferably in mixing. The starch

solution should be preferably stored at temperatures above 60°C.

**[0101]** The amount of the used organic acid may be in the range of 0.1-0.8% (w/w), such as 0.2-0.5% (w/w). The amount of the base may be 0.0125-0.025% (w/w).

**[0102]** Preferably the Composition A is prepared by first mixing citric acid to water. The water is heated to over 80°C, such as to the range of 85-90°C, for 15-60 minutes, and mixed. The potato starch is added, optionally with propylene glycol. The temperature may be adjusted to the range of 60-80°C, such as 65-75°C, for this phase. The amount of the used citric acid depends on the pH of the potato starch slurry and water, and it may be in the range of 0.1-0.8% (w/w), such as 0.2-0.5% (w/w). This causes the potato starch to gelatinize, and it also stabilizes the starch dispersion and enables controlling the viscosity thereof, for example it is possible to control how the dispersion thickens during cooling and to control thixotropy of the dispersion. This is important for the handling of the dispersion(s) in the forming equipment, such as a paper machine or the like. Such devices include parts such as pumps and filters, and it is necessary to obtain desired rheological properties of the dispersion(s) so that these parts are not stressed with excess viscosity, thixotropy or the like properties.

**[0103]** When the starch dispersion cools, the viscosity thereof changes. The starch dispersion may be transported at high temperature, such as at 50-60°C, to enable high dry matter content and facilitate pumpability and mixability of the dispersion into the filler dispersion. If the temperature lower down to 45°C or less, the viscosity of a starch dispersion with high dry matter content rises too much and causes handling problems.

**[0104]** After this the starch dispersion is homogenous and stabilized. It may be further filtered to remove any agglomerates. It may be desired to use deionized or otherwise highly pure water to avoid undesired reactions in any later phase(s), for example with waxes or other ingredients or additives. Such water may be used in any of the dispersions discussed herein. It was noticed during the tests that citric acid is the most suitable acid, and especially advantageous when products for food applications are prepared. Finally the obtained starch dispersion is treated with a small amount of ammonia to provide a short pH shock. Preferably efficient mixing is arranged, and the ammonia as aqueous solution may be provided by using injecting means. The addition of the ammonia, which causes a brief decrease in pH, triggers the gelatinization of the starch, and the reaction proceeds quickly and homogenously in the dispersion so that the process is carried out in seconds. This effect was especially surprising and finally the starch was in a form that tolerated storage and transport, but also facilitated handling, processing and formation of the desired final coating dispersion.

**[0105]** A filler dispersion or composition (Composition B) contains inorganic filler as a homogenous and stable dispersion, which is preferably a pumpable slurry. Composition B may contain 30-63% (w/w) of inorganic filler, such as talc. Additives such as rheology modifier to provide anti-saggling, anti-settling and thixothropy flow behaviour, and antifoaming agents may be included in small amounts, such as 2% (w/w) or less, or 1% (w/w) or less, for example 0.25-1.0% (w/w). In one example the filler dispersion comprises

| | |
|---|---|
| -inorganic filler | 30-63% (w/w), |
| -rheology modifier | 0.25-1.0% (w/w), and |
| -optionally antifoaming agent | 0.05-0.1% (w/w). Water is added to obtain 100% (w/w). |

**[0106]** A method for preparing a filler dispersion or composition (Composition B) may comprise combining in an aqueous solution

- 30-63% (w/w) of inorganic filler, such as talc, and optionally
- 0.25-1.0% (w/w) of rheology modifier, and/or
- optionally additives such as antifoaming agent, and mixing to obtain the filler dispersion of composition.

**[0107]** Preferably the Composition B is prepared by adding to heated water (such as 60-80°C, for example about 70°C) a rheology modifier which acts as a dispersing additive and stabilizer and ensures the homogeneity of the dispersion. In one example the rheology modifier is based on modified urea, such as BYK 7420 ES used in the examples. The dispersion may be mixed for at least 5 minutes, such as 5-15 minutes.

**[0108]** Inorganic filler may be provided as additive-free and/or dry powder. It was found out that talc, especially in lamellar and preferably in pure form, was especially suitable for the present purposes. The inorganic filler may be selected according to needs, for example the average particle size may be selected. In tests Finntalc C15B was found suitable for most coating purposes, but in case a smaller particle size was desired, a more fine product Finntalc C10 was used.

**[0109]** Inorganic filler is added and the dispersion is mixed for 15-60 minutes, such as for about 30 minutes. This dispersion may be obtained as a Composition B. It is also possible to add further ingredients to the dispersion/composition,

for example Composition C. Further ingredients or additives may include antifoaming agent(s), wax(es) and further polymeric additives or ingredients.

**[0110]** A flexibility modifier may be provided as a separate mixture, aqueous solution or dispersion (Composition C) to provide elongation and foldability. A flexibility modifier may comprise 22-33% latex polymer(s), for example as an aqueous dispersion. Also one or more wax(es) may be included, for example as an aqueous emulsion, such as in an amount of 12-20%. It was also found that a small amount, such as 1% (w/w) or less, such as 0.3-1.0% (w/w) or 0.3-0.6% (w/w) of suitable sugar alcohol (polyol), such as xylitol, may increase the flexibility remarkably. One or more of these ingredients may be considered as chain-forming agent(s), cross-linking agent(s) or other agents which reinforce, modify and/or facilitate the formation of polymeric structures, especially structures involving starch. In one example the flexibility modifier comprises

| | |
|---|---|
| -latex polymer(s) | 22-33% (w/w) (45-65% (w/w) of 50% (w/w) dispersion), |
| -wax | 12-19% (w/w) (35-54% (w/w) of 35% (w/w) emulsion), and optionally |
| -sugar alcohol | 0.3-1.0% (w/w). |

**[0111]** A method for preparing a flexibility modifier mixture, dispersion or composition (Composition C) may comprise combining

- 22-33% (w/w) of latex polymer(s),
- 12-20% (w/w) of wax, and optionally
- 0.3-1.0% (w/w) of sugar alcohol, and mixing to obtain the flexibility modifier mixture, dispersion or composition.

**[0112]** The present application provides the compositions A, B and C, which may be provided as separate compositions, preferably in a suitable container, and which compositions may be obtained with the methods described herein. The composition(s) may be provided as a dispersion or as dried or concentrated.

**[0113]** The compositions A, B and C may be combined and mixed, preferably briefly prior to use, especially to obtain a coating dispersion. It is also possible to first combine two of these, and then add the third one, such as to combine B and C first. Any of the compositions may be mixed, filtered and/or controlled for homogeneity, particle size, concentration, rheological properties and/or the like properties, and the properties and compositions may be adjusted to obtain desired properties and compositions of the compositions, mixtures and/or dispersions. Mixing may be carried out by using one or more mixer(s) in one or more suitable container(s), reactor(s) or the like vessel(s). Any of the compositions may be stored and/or transported in a suitable container and provided or conveyed to the process in suitable form and/or at suitable location. Preferably the compositions or dispersions are pumpable.

**[0114]** The ingredients may be finally present in a single aqueous dispersion, which may be the coating dispersion. It is also possible to provide two or more different coating dispersions if two or more different coatings are to be applied, for example in two or more coating steps. In one example the aqueous dispersion, such as any of the coating dispersions disclosed herein, such as the first aqueous dispersion and/or the second aqueous dispersion, or a coating, such as the primer coating and/or the surface coating, comprises gelatinized potato starch, talc, latex polymer(s) and optionally wax, preferably also sugar alcohol and/or other additive(s) discussed herein.

**[0115]** One embodiment of the method comprises coating a primer coating layer with the first aqueous dispersion before coating with the second aqueous dispersion. In this way a second primer coating layer is obtained, so the primer coating contains two layers, or even more layers may be applied and obtained, such as three or four layers, wherein each of the layers may be same or different. In most cases the formed primer layers may be same material. When applying the primer coating it may be desired to apply at least two layers to obtain high quality layer having desired barrier properties. It was noticed that the first primer coating layer will close most of the pores in the cellulosic substrate and binds most of the protruding fibers, but only when the second primer coating layer is applied, all the pores may be fully closed and the rest of the fiber ends are bound. In this way such a primer coating is obtained, which is in direct contact with the cellulosic support and covers it properly. A primer coating is especially advantageous when recycled fibers are used. The primer coating may be applied by using coating devices such as symsizer or softsizer. The (primer) coating provides oil and grease barrier properties. It may also provide water vapour barrier properties. When the first, second and optionally any further primer layer are formed from the same dispersion and/or contain the same essential ingredients mentioned herein, it is possible to provide the coating dispersion from a single container or vessel, which may be a very large one, such as about 1000 liters or even more. This simplifies the procedure, such as handling and applying of the dispersion, and the device arrangement.

**[0116]** The (primer) coating may be applied to obtain a grammage of 1.0-3.0 g/m$^2$ in each layer, or at least in the first layer. The second and further primer layer(s) may be obtained by applying less aqueous dispersion than in the first layer, for example 10-20% less. The total grammage of all the primer layers in the final product may be in the range of 3.0-5.0

g/m$^2$.

**[0117]** On top of the primer coating layer there may be another coating layer, such as a surface coating layer comprising organic polymer and wax, preferably obtained from a mixture of aqueous organic polymer and wax. This coating is based on different chemistry from the primer coating, so it has a different composition. The mixture of the potato starch and the wax may be provided as an aqueous dispersion, wherein the starch polymers may be present as particles. As discussed for the primer layer, also the surface coating may be carried out by using any suitable conventional coating method such as blade coating. The aqueous dispersion is printable, so the surface coating layer may be applied also by using a printing machine. After printing the coating layer may be corona-treated.

**[0118]** The polymer in the surface coating may comprise one or more potato starch-based polymer(s. These may be solvent-free, and they may be provided as a dispersion, such as a colloidal dispersion, or as an emulsion. They may be modified, such as anionically modified.

**[0119]** The surface coating may be applied to obtain a grammage of the surface coating in the range of 1-12 g/m$^2$, such as 4-7 g/m$^2$. The obtained grammage may depend on the coating method and device. For example by printing by flexography (flexo) it is possible to obtain a grammage of about 2 g/m$^2$ at each printing run. On the other hand, by coating with a blade it is possible to obtain a grammage of up to 12 g/m$^2$ at one coating run. In one example the surface coating is applied to obtain a grammage 1.4-1.6 g/m$^2$ in one run, and for example three runs may be applied.

**[0120]** The grammage of total coating in a final coated sheet may be in the range of 7-12 g/m$^2$. The total coating may contain talc in the range of 32-54% (w/w), starch in the range of 20-32% (w/w), and other additives in the range of 10-16% (w/w). If sugar alcohol is present the content thereof may be in the range of 0.5-2% (w/w). In one example the coating comprises about 50% (w/w) or talc, about 25% (w/w) of starch and about 15% (w/w) of other additives. The grammage of inorganic filler in the total coating may be in the range of 2.2-6.5 g/m$^2$. The grammage of starch in the total coating may be in the range of 1.4-3.8 g/m$^2$. The grammage of other additives in the total coating may be in the range of 0.7-1.9 g/m$^2$. The other additives comprises at least latex and/or sugar alcohol. These ranges were found to be suitable for industrial production purposes and to obtain the properties discussed herein.

**[0121]** The coatings disclosed herein may contain wax. However, if a (primer) coating is to be coated with another coating, it may not be desired to include wax in the previous coating layer, such as the primer coating layer, which could prevent and deteriorate the attachment of the further coating layer. In such case therefore the first dispersion and/or the first coating preferably does not contain wax. The wax may comprise for example polyethylene wax, polypropylene wax, montan wax, or paraffin wax. The wax may be cationic wax. In one example the wax is cationic wax based on a modified polypropylene wax. The wax may be provided as an aqueous emulsion. The amount of wax in an aqueous dispersion, such as the first aqueous dispersion and/or the second aqueous dispersion, may be in the range of 4-7% (w/w). The wax is present in the outermost layer, which may therefore provide also release properties, for example in containers such as trays or the like, wherein a further removable film is attached to the container, and which is to be removed before using the content of the container. The wax present in the surface coating facilitates tearing or otherwise removing the film, which may be plastic film, a metal film or foil, such as aluminium foil, or other film or sheet, such as cellulosic sheet, which may be the present coated sheet or other coated sheet.

**[0122]** The surface coating may or may not contain inorganic filler, more particularly the similar inorganic fillers as used in the primer coating. If inorganic filler is present, the content thereof may be low compared to the primer layer, such as 10% (w/w) or less, or 5% (w/w) or less, for example in the range of 1-10% (w/w), 1-5% (w/w) or 3-10% (w/w). In some examples the surface has a light filler dosage (about 5% solids) to obtain surface modification. It is also possible to use barrier filler such as kaolin or talc to improve the total resistance of water and oils.

**[0123]** The surface coating may however contain an inorganic friction agent, which is particular agent for example having an average particle diameter in the range of 5-100 nm, such as 5-50 nm. The inorganic friction agent may have a specific surface are (BET, ISO 9277) in the range of 30-800 m$^2$/g, such as 50-500 m$^2$/g. The inorganic friction agent may comprise silica, such as fumed silica or precipitated silica. One example of a commercial fumed silica is Aerosil 200. The surface coating may contain inorganic friction agent in the range of 0.04-0.35% (w/w). The inorganic friction agent may be added to the second dispersion in an amount in the range of 0.1-0.5% (w/w), or it may be predispersed to pH-controlled water, such as in pH 8.5-9, in amount of 10-20% (w/w), such as about 15% (w/w), and this is added to the second dispersion in an amount up to 5% (w/w).

**[0124]** The surface coating cannot be usually further coated with a dispersion because of the wax, so it cannot be below the primer coating, and it is usually the outermost coating. The surface coating exhibits release and water-repellent properties. This is advantageous for example for frozen products, such as food products, which are easily released from the package for example during defrosting already at room temperature.

**[0125]** The coating dispersions disclosed herein may contain one or more auxiliary agents or additives, such as stabilizers, usually in minor amounts, such as less than 10% (w/w) or less than 5% (w/w) or less than 2% (w/w). For example, anti-settling additive(s) may be added to prevent sedimentation of a coating dispersion. Also rheology modifier(s) may be added, such as one or more thickener(s), such as urethane thickener(s). In one example a small amount of ethanol and propylene glycol mixture is added, such as about 2% (w/w) ethanol and about 4% (w/w) propylene glycol

in the total dispersion, to stabilize and/or to adjust rheology of the dispersion.

**[0126]** Examples of commercially available additives used in the tests include Tego Antifoam, ammonia water 25%, IPA/water, PG, Rheo 2800, 3800 thickeners, BYK 7420 ES, Optiflo 1000, Optiflo 1010, BYK wax additives such as Aquacer grades 494, 497, 501, 506, 513, 519, 526, 528, 539, 541, 561, 565, 593, 597, 1547; and surface modifiers such as different variants for opacity, gloss, friction, flexibility, wear resistance, crack resistance, and/or heat resistance.

**[0127]** Especially the rheological properties, such as viscosity, of the surface coating dispersion may need adjusting, for example increasing. In one example one or more thickener(s) or other rheology modifier(s) is/are added to increase the viscosity, especially if the coating is applied using one or more rollers, especially rubber rollers, which may tend to lift the dispersion from the surface during application if the viscosity is low. This way it is possible to obtain a better quality of the coating. A thickener may have an effect to rheology, but may not be considered an actual rheology modifier. Rheologically active additives, which may be considered as actual rheology modifiers, differ from thickeners. Rheology modifiers effect changes in viscosity over a specific range of shear rate, which leads to non-Newtonian flow, such as thixotropy. In contrast, thickeners effect an increase in viscosity over the whole range of shear rate by increasing only the viscosity of the liquid phase (liquid phase thickeners). The thickeners usually do not change the flow (or the rheology), at least in substantial amounts.

**[0128]** However, it is possible to obtain desired thickness and/or other rheological properties of a dispersion without adding a separate thickener, such as synthetic thickener. The selection of suitable (gelatinized) starch, cross-linking agent(s) and/or other agent(s) may be enough to provide desired thickness.

**[0129]** The Brookfield viscosity of the surface coating dispersion may be in the range of 300-2000 mPa s, such as 400-1800 mPa·s at a shear rate range of 200-1000, such as 300-800 or 300-600. The Brookfield viscosity may be measured by using spindle 2 at the consistency of the dispersion (not diluted) at 23±1 °C.

**[0130]** The dispersions for the coatings may be provided at a dry matter content of 40-63% (w/w). Exceptionally high dry matter contents may be obtained by using specific dispersing techniques. The inorganic filler in the first dispersion may be predispersed directly to the starch using only a small amount of water in the range of 7-15%, such as about 10% (w/w), which is significantly lower than the amount 50% (w/w) generally used for dispersing such agents. This leads to specific forming of the dispersion and for example specific rheological properties of the obtained dispersions, such as shear thinning properties. Shear thinning is non-Newtonian behaviour of fluids whose viscosity decreases under shear strain. It is sometimes considered synonymous for pseudoplastic behaviour and it is usually defined as excluding time-dependent effects, such as thixotropy

**[0131]** In some examples the coating is carried out with a coating method and/or means for coating/coating means selected from printing, such as printing by flexography or printing by gravure, air knife (air brush), curtain coater, blade coater, and rod coater, such as Mayer bar. It is not desired to use extrusion coating.

**[0132]** In one example the means for coating comprise printing (coating) means, such as a printer, for example a flexographic printer or gravure printer. The printing means, as well as other coating means and/or other equipment where applicable, may comprise feeding means, such as roll-feed means, for feeding and/or advancing the sheet to be coated or printed.

**[0133]** In one example the means for coating comprise flexographic coating means. Flexography refers to a printing process utilizing a flexible relief plate. It can be used for printing various types of substrates, including plastic and cellulosic substrates, and it is suitable for printing large areas of solid coating. The water-based dispersions disclosed herein are highly suitable to be used in flexographic printing.

**[0134]** In one example the means for coating comprise blade coating means. Blade coating, also known as knife coating or doctor blading, is a method for coating large area films on rigid or flexible substrates. The obtained thickness of the coating is well-defined because of the controlled gap size of the blade to the surface.

**[0135]** In one example the means for coating comprise air knife coating means. Air knife is a toll which may be used for blowing off liquid or debris from products as they travel on conveyors. An example of an air knife is a pressurized air plenum containing a series of holes or continuous slots through which pressurized air exits in a laminar flow pattern. The exit air velocity then creates an impact air velocity onto the surface of the object the air is directed. This impact air velocity alters the surface of a product without mechanical contact. Air knives can be used to remove liquids, control the thickness of liquids, dry the liquid coatings, remove foreign particles, cool product surfaces or create a hold down force to assist in the mechanical bonding of materials to the surface. In the coating process the air knife is combined with means for applying the coating dispersion onto the surface, such as a roller or a drum. The term "air knife" as used herein refers to this arrangement.

**[0136]** After coating the formed layer may be dried, especially before applying another coating layer. The system for forming the coated sheet may contain one or more drying unit(s). Heat may be used for drying, and the heat may induce changes in the structure of the layers, which may be desired. The drying may be carried out for example by air drying, such as by blowing warm or hot air, or by infra-red dryer. The water contention of the used dispersions may be high, for example about 50% or more, such as up to 70-90%, so an efficient drying is required. It was found out that when using the dispersions of the embodiments, for example acrylic dispersion, the drying of the dispersion coating was even ten

times faster than that of prior art dispersions. Fast drying enables using high machine speed and full capacity, which has been problematic as the machines are often designed to be used with fast evaporating organic solvents. Using water-based dispersions has been previously very slow and therefore problematic.

**[0137]** The wet coating layer undergoes significant transformations during the drying process. During drying, the water evaporates from the coating layer, leading to packing of the dry matter, and coalescence of synthetic polymers then results in a honeycomb-like structure. Drying means, such as infrared dryers may be provided to assist the fusion of the polymers into a homogeneous film. This provides improved barrier properties and also improves the mechanical properties. Any damage to the coating layer in finishing and converting properties should be avoided to maintain the desired barrier properties.

**[0138]** The coated sheets described in this disclosure may be obtained with any of the manufacturing methods disclosed herein. The dried or dewatered final product may have a moisture content of 10% (w/w) or less, such as in the range of 0-10% (w/w), 1-10% (w/w), 5-10% (w/w) or 5-8% (w/w), which is often the moisture content of a cellulosic product at ambient conditions. Such sheets are antistatic unlike for example plastic films, and can be used in processes and as the final products without problems relating to staticity.

**[0139]** The obtained coated sheets exhibit properties which are especially suitable for the uses disclosed herein, such as water absorption capacity, water vapor transmission rate and grease resistance. Values in the following ranges were measured for such sheets at Potatum Oy's laboratory. The measurements may be carried out at a temperature presented in the standard, which may be 23±1°C unless otherwise indicated.

**[0140]** The coated sheet had a water absorption capacity (Cobb 30 min, DIN EN ISO 535) in the range of 1-25 g/m$^2$, more particularly in the range of 1-5 g/m$^2$. The Cobb test determines the amount of water that is taken up by a defined area of cartonboard or other applicable sheet through one-sided contact with water, within a certain amount of time.

**[0141]** The coated sheet had a water vapor transmission rate (WVTR 50%) in the range of 28-4.0 g/m$^2$, more particularly in the range of 4.0-10.0 g/m$^2$. The WVTR value is presented per 24h. WVTR was determined according to ISO15106-1/ASTME398 (humidity sensor method), but also other methods can be used, such as ISO 15106-2/ASTM F1249 (infrared sensor method), ISO15106-3 (electrolytic sensor method) and ASTM E96/GB 1037 (gravimetric method).

**[0142]** The coated sheet had a grease resistance (KIT, TAPPI T559) in the range of 8-12, such as in the range of 10-12. In most cases the grease resistance was about 12, which is the top value, such as in the range of 11-12, or 12. The Kit Test measures the degree of repellence or anti-wicking of paper and boards which have been treated with fluorochemical sizing agents used to prevent wetting of the cellulose fibres of the material. Test solutions with varying strengths of castor oil, toluene, heptane and turpentine are used. The highest numbered solution (the most aggressive) that remains on the surface of the paper without causing failure is reported as the 'kit rating' (maximum 12).

**[0143]** In one embodiment the coated sheet has a water absorption capacity (Cobb 30 min, DIN EN ISO 535) in the range of 1-5 g/m$^2$, grease resistance (KIT, TAPPI T559) of about 12 and a water vapor transmission rate 24 h (WVTR 50%, ASTME398) 4.0-10.0 g/m$^2$. Such a product is versatile, and it is especially suitable for keeping moisture in a container and also for keeping moisture outside the container. In one specific example the coated sheet has a water absorption capacity (Cobb 30 min, DIN EN ISO 535) in the range of 1-3 g/m$^2$, grease resistance (KIT, TAPPI T559) of about 12 and a water vapor transmission rate 24 h (WVTR 50%, ASTME398) 4.0-6.0 g/m$^2$. It was noted that with the present coatings it was relatively easy to obtain such values.

**[0144]** The present application provides a coated sheet or a product comprising the coated sheet formed into any of the shapes, forms, products or the like disclosed herein. The shapes, forms or products may be formed by using any suitable forming method, such as deep drawing, and/or forming device.

**[0145]** The sheets or coated sheet may be printed to contain graphical images and/or text by using any suitable printing ink(s). Such prints may be further coated with polymeric coating(s), such as with one or more coating(s) of the embodiments. A coating applied onto a printing or onto a previous coating may be called as an overcoat.

**[0146]** The sheet may be coated also on the opposite side to the barrier coating discussed herein. The opposite side of the sheet may be coated by using same or different coating materials compared to the barrier coatings discussed herein, such as by using conventional top coats. The coating on the opposite side may be applied to obtain a printable surface, which may be then printed, and optionally overcoated. The barrier coatings may also prevent the printing ink from migrating through the cellulosic sheet.

**[0147]** The final products disclosed herein may be manufactured by using deep drawing. Deep drawing is very economic way of producing large amounts of disposable food containers. Deep drawing may be performed for sheets coated with the present coatings or products comprising a sheet coated with the present coating, such as a coated sheet combined with another sheet, which may be a thicker sheet, such as board or thick paper, and which may provide rigidity and/or other mechanical properties. Deep drawing means the shaping of a board or a sheet into rigid, hollow shapes, sometimes with several cavities. Board or sheet properties like tear strength and high elongation-to-break usually determine the depth of forming. However, with even wider variety of boards or other sheets comprising the present coating or products may be used. For example in a case of a tray a board formed into a container often has a flange to facilitate the use of the tray. The flange will also increase the stiffness, which is important since stiffness is reduced in the creased and

shaped areas.

**[0148]** The raw material for deep drawing may be one-side or two-side coated board or board comprising the coated sheet, or corrugated cardboard comprising a coated liner. The printing operation is reel fed and the board is rewound after printing. Depending on the depth of the tray or other form, the forming process is performed in one or two steps. Since the deep drawing operation performs a mechanical deformation the following strength properties are vital: strong, tough board with high elongation-to-break, high tear strength, hygiene and low odour, and very good adhesion of the coating.

**[0149]** When forming products by deep drawing it is especially challenging to obtain completely impermeable products, especially to maintain grease barrier properties, since the sheets will be at least partly damaged in the process at the edges or other parts of the products which have gone through heavy deformation. However, with the present coatings, which can tolerate deformation, impermeable product may be obtained such as ones having uniform barrier properties throughout the whole product. Further, it is possible to form such products from corrugated cardboard by deep drawing, which has not been possible previously.

**[0150]** In one embodiment the coated sheet, and/or a product comprising the coated sheet, which may be a containerboard comprising the coated sheet or other product, comprises one or more fold line(s) 34, preferably for folding the sheet, the containerboard and/or other applicable product into a predetermined form, such as shown in Figure 2. The predetermined form may be any form or product described herein. A manufacturing method may comprise form ing such one or more fold line(s) to the coated sheet, to a containerboard and/or to other applicable product comprising the coated sheet, for example by prefolding or by pressing. The fold lines act as guides to fold the sheet, the containerboard and/or the product into the desired shape. The coated sheet, the containerboard and/or the product comprising the coated sheet may be arranged to be folded into a desired form, such as into a package such as a box, a wrapping or a sleeve, or the like, such as discussed herein. Such a sheet, containerboard or other product may be stored and transported as a flat sheet, or as a pile of several flat sheets, which saves space and helps the transportation, and the products may be folded into the final forms at the point of use. The coatings can tolerate the folding and are not easily damaged. The fold lines or folded edges maintain the barrier properties. A fold line may be straight or curved, or a combination of straight, curved and/or other shapes. A fold line may be designed to be folded into an angle of at least 140 degrees, such as at least 90 degrees, which is common angle in boxes and the like structures. During folding process even narrower angles may be formed. In product folded for storage and transport the folded angle may be close to 0 degrees, which means that the two sides separated by the folding line are substantially perpendicular. The higher the folding degree, the more challenging it is to maintain the barrier properties at the fold line. Other types of folds may be formed or provided in analogous way.

**[0151]** The coated sheet, or a product comprising the coated sheet, may be in a form of a container or it may be a part of a container, and/or a container may comprise or consist of the coated sheet or the product comprising the coated sheet. A container refers to any receptacle or enclosure for holding a product, and it may be used for example in storage, packaging, shipping, providing, selling and/or using the contained product. The container may be provided as such, i.e. without a contained product, or with a contained product. The container may be any of the containers, packages, vessels, holders, receptacles, trays or the like discussed herein. The container may or may not contain folding lines in the coated sheet. The container may or may not contain other materials. The container may have any suitable shape, such as a cylindrical shape, a rectilinear shape, and it may be rigid or flexible, or a combination thereof. The container may be any suitable shipping container, or a part thereof, such as a corrugated box, an intermediate bulk container, an unit load device, which may be a crate or the like, or a flexible intermediate bulk container (FIBC).

**[0152]** One example provides a package comprising the coated sheet described herein, such as a package for foodstuff or food product, a cosmetic package or a medical package, or for other products which may contain water and/or oil or grease or other substance(s) disclosed herein, or are to be protected from water and/or oil or grease or said other substance(s). A package may be a box, an envelope, a bag, a sleeve or the like, which may be based on paper and/or board, such as containerboard. It may be foldable and/or obtained by folding and therefore contain one or more fold line(s). The products which are to be protected from water and/or oil or grease, in addition to food products, include for example medical products, such as pharmaceutical products, tobacco products, fine paper, textiles, and the like.

**[0153]** One example of a package for food or other applicable products is shown in Figure 2, the package comprising a deep drawn tray formed from the coated sheet, which may be optionally sealed with a (tearable or removable) film or membrane, such as plastic, cellulosic or composite film, for example PET of OPP plastic film, such as a metallized plastic film, and/or sealed with another coated sheet, which may be different, for example thinner, than the package itself. The polymeric coatings disclosed herein may facilitate the attachment of the film to the package. One example provides foodstuff or food product packed in a package comprising the coated sheet described herein.

**[0154]** The container as used herein may comprise any receptacle or enclosure for holding a product used in storage, packaging, and shipping, but the term is intended to cover also any other packages and forms which may be used for serving or providing matter and/or goods, for example as disclosed herein. The term "package" may be used interchangeably to cover all the applicable uses. A "container" may be considered referring to "a container and a package",

or to plurality and/or to a combination thereof. The present application provides a container comprising the coated sheet or the corrugated containerboard, such as wherein the container is or comprises a package, for example a package for food product, a package for cosmetics, such as a cosmetic product or cosmetic ingredient, formulation or composition, a package for medicament or a package for tobacco product. The container may be in a form of a box, a pouch, a wrap, a bag, a sack, a sleeve, a tube, a tray, a cup, an inner bag, an unit dose package, or a blister strip. The coated sheet may present as a tearable or removable cover on a container or a package such as a tub, a jar, a pot, a bottle, a tin or a strip. The packages may be used for packing, or they may contain, any of the packable materials disclosed herein. The coated sheets may be attached to other materials, such as containers or strips disclosed herein with suitable adhesive and/or by using other adhering agent(s) or means, such as heat, if required. For example a tearable or removable cover may be attached to a tub, a jar, a pot, a bottle, a tin or a strip with a layer of adhesive.

**[0155]** The present disclosure provides use of the coated sheet or the containerboards, or a product comprising the coated sheet or the containerboard, disclosed herein for preparing a container, such as a package, for a product or for packing products, such as a package for or for packing a food product, a cosmetic product, a medicament product or a tobacco product or other product(s) discussed in previous.

**[0156]** The present disclosure provides use of the polymeric composition(s) and/or dispersion(s) disclosed herein for coating a sheet comprising cellulosic fibrous material.

**[0157]** Single sheet materials can be prepared using suitable known machines. One side preprinted and/or precoated can be prepared for example by using 4-unit flexo machine designed to kraft papers and liners with grammage in the range of 60-450 g/m$^2$. The opposite side may be prepared for example with Arsoma printing and converting machine to print and overcoat optional designs and to convert final products.

**[0158]** Corrugated materials can be prepared using suitable known machines. For example top liners with one side printed and overcoated or only coated with barrier chemicals of the embodiments to allow food and feed contact can be prepared as discussed in previous for the single materials. The liners and fluting can be laminated to Kraft/F flute/kraft structure and converted to final products such as trays, packages etc., using Bobst machines.

**Examples**

**Example 1**

**[0159]** A coated sheet called NF 52 Bioseal was manufactured by using two dispersing and mixing stages.

**[0160]** Formulation No:1 comprised starch and was prepared by using gas heating and pilot mixer as follows:
Water 6.0 kg was heated to 85-90°C before adding citric acid 1,0 kg and mixing it 20 minutes before adding 1.0 kg propylene glycol and 4.0 kg Solcoat P55. The solution was mixed for 30 minutes keeping the liquid at 65-75°C. Finally 50 g ammonia water 25% was added and mixed slowly.

**[0161]** A one kg sample was taken and filtered in order to monitor, that the whole solids content is in liquid form without any agglomerates. It is advantageous to see the quality before continuing with the formulation. When mixture is complete it is taken to another vessel (bucket) for hold until the pigment slurry is ready.

**[0162]** Pigment slurry is prepared as follows:
Formulation No:2 comprised 6.0 kg water, which was heated to 70°C before adding 250 g BYK 7420 ES and mixing it for 5 minutes before adding 6.0 kg Finntalc C15B and then mixing for 30 min. The next addition was Tego Antifoam 50 g; 2.0 kg Aquacer 597 and finally 4.0 kg Litex PX 9330 (German version of special latex, 50% (w/w)). The mixture was completed with 10 minutes slow speed dispersing and then monitoring the quality of it by filtering one kg, and if OK, combining the mixture by adding the starch batch into it and mixing the whole formulation for the final 1 0 minutes.

**[0163]** The mixing times were longer than in expected production, but they were designed for obtaining a batch of high quality barrier coating, which is evaluated by RK-coater and bars 0-4 to monitor the Cobb results in comparison to earlier barrier versions.

**[0164]** In the following certain preferred properties and criteria for the used materials are listed. Many of these features were observed and/or confirmed by testing. One or more of these features may be required or included.

1. Solcoat P 55 is suitable for cooking and to be used as a natural binder for pigments
2. Finntalc C15B is purified magnesium silicate having no other chemistry
3. Propylene Glycol (PG) is purified food quality product
4. Waxes are of natural origin or designed for direct food contact
5. Modified latex is designed for food contact
6. pH modifiers are of food quality
7. Sorbitol and xylitol are manufactured for food sweetening purposes
8. Antifoaming agents are allowed in limited dosage
9. Water is purified or pure

10. Dispersing and stabilizing agents are designed for food use

**[0165]** The following compositions for preparing the dispersions were tested (percentages by weight).

Dosage variations in testing potato starch (in water):

**[0166]**

1. Solcoat P 55 15-38%
2. PG 1-2%
3. Ammo (25%) 0.05-0.1%

Talc slurry formulations and mixing ratio (in water):

**[0167]**

1. Finntalc C15B 30-60%
2. BYK 7420 ES 0.25-1.0%
3. Antifoam 0.05-0.1 %

Flexibility modifier (to obtain elongation and foldability)

**[0168]**

1. Litex 9330/9340 45-65%
2. Wax 35-54%
3. Xylitol 0.3-1.0%

**[0169]** Also sorbitol was tested for modifying flexibility, but xylitol provided better properties are was found more suitable.

**Example 2**

**[0170]** Three different coated calandered virgin cellulosic sheets were tested for water absorption capacity (Cobb 60 s, DIN EN ISO 535), for water vapor transmission rate (WVTR), and for grease resistance (KIT, TAPPI T559). The samples were 1) a sheet coated with Litex 9340 based primer, 2) a sheet coated with polymeric dispersion obtained from four monomers by twin boiler processing, and 3) a sheet according to an embodiment coated with a aqueous dispersion containing about 12% (w/w) potato starch, about 7.5% (w/w) of latex, about 24% (w/w) of Finntalc C15 B talc, and about 1% (w/w) of xylitol. The results are presented in Table 1.

Table 1

| Sample | 1 | 2 | 3 |
|---|---|---|---|
| Cobb 60 s | 0.4 | 1.25 | 17.4 |
| WVTR 50% | 19 | 5.4 | 4.4 |
| WVTR 75% | 120 | 28 | 30 |
| KIT | 12 | 12 | 12 |

**[0171]** It was also noticed in further tests that when wax was added to the coating of Sample 3, the water absorption decreased significantly.

**Example 3**

**[0172]** Rheological properties of dispersions containing talcs and potato starches were measured. Brookfield viscosity (BR) was determined from the samples by using spindle 3 and using different shear rates, such as BR 100 rpm x 10:

BR 50 rpm X 20 ja BR 20 x 50. The differences in the results indicates pumpability and stability of the dispersions as well as runnability with the coating unit.

**[0173]** The viscosity measurement of the potato starch were carried out for a warm dispersion, such as about 65°C, which corresponds to the temperature used in the actual process. Such measurements are also relevant for evaluating the behavior of the dispersion in the processing machines, such as runnability or other processability.

**[0174]** Figure 3 shows measurements of Brookfield viscosities of C15B and C15B2 (Finntalc, Elementis) talcs in starch slurry NF Flow 0901 with different shear rates. Samples with different mixture ratios were used. The highest viscosities were obtained with NF0901 0.25 parts C15B, then with NF0901 1 parts C15B2, then NF0901 0.5 parts C15B2, and the lowest values were obtained for NF0901 0.25 parts C15B2.

**[0175]** Figure 4 shows a graph of measurements of Brookfield viscosities of C15B and C15B2 talcs in starch slurry NF Flow 0901. C15B talc alone was used as a reference (lowest viscosity values). The overall highest viscosities were obtained for NF 0901 1 parts C15B2.

**[0176]** Figure 5 shows a graph of measurements of ACAV high shear rheology of two barrier coatings. The upper graph represents the Barrier coating color 2.

**[0177]** Different dosage levels on NF0901 and different solids content levels for final slurry were tested. Figure 6 shows a graph of measurements of Brookfield viscosities C15B2 talcs in starch slurry NF 0901. The highest overall viscosities were obtained for C15B2+NF0901 0.25 63%, and the lowest viscosities for C15B2+NF0901 0.25 59%.

**[0178]** Brookfield viscosities (Br) with different rpms and densities of C15B2 and NF0901 slurry samples were analyzed. The results are shown in Table 2.

Table 2

| | C15B2 | C15B2+NF0901 0.25 | C15B2+NF0901 0.25 | C15B2+NF0901 0.25 | C15B2+NF0901 0.18 |
|---|---|---|---|---|---|
| Solids | 63.0 | 63.0 | 60.9 | 59.1 | 61.2 |
| Br100, mPa·s | 160 | 475 | 210 | 155 | 170 |
| Br 50, mPa·s | 150 | 430 | 230 | 160 | 200 |
| Br 20, mPa·s | 260 | 600 | 360 | 275 | 325 |
| Density g/l | 1580 | 1446 | 1420 | 1401 | 1430 |

**[0179]** The Brookfield viscosities were measured at 23±1°C unless otherwise indicated.

## Claims

**1.** A method for manufacturing a coated sheet, the method comprising

- providing a sheet comprising cellulosic fibrous material, for example a sheet comprising paper and/or board, comprising a primer coating layer on the sheet, the primer coating layer comprising potato starch, inorganic filler and latex polymer(s) and having a grammage of the primer coating layer in the range of 1.0-5.0 g/m$^2$, such as 3.0-5.0 g/m$^2$, wherein said sheet comprising cellulosic fibrous material comprising the primer coating layer is obtained by

  - providing a sheet comprising cellulosic fibrous material, such as coated or uncoated sheet, for example a sheet comprising paper and/or board,
  - providing a first aqueous dispersion comprising potato starch in the range of 5-20% (w/w), 40% (w/w) or less inorganic filler, such as ground calcium carbonate, kaolin or talc, or a combination thereof, and 10% (w/w) or less latex polymer(s), for example in the range of 3-10% (w/w), and
  - coating the sheet comprising cellulosic fibrous material with the first aqueous dispersion to obtain the primer coating layer on the sheet, optionally repeating the coating at least once, to obtain a grammage of the primer coating layer in the range of 1.0-5.0 g/m$^2$, such as 3.0-5.0 g/m$^2$;

- providing a second aqueous dispersion comprising potato starch in the range of 5-20% (w/w), and wax; and
- coating the primer coating layer with the second aqueous dispersion to obtain a surface coating layer having a grammage in the range of 1-12 g/m$^2$, such as 4-7 g/m$^2$,

optionally forming one or more fold line(s) to the coated sheet, preferably wherein the coating is carried out with a coating method selected from printing, such as printing by flexography or printing by gravure, air knife, curtain coater, blade coater, and rod coater, such as Mayer bar.

**2.** The method of claim 1, comprising manufacturing the sheet comprising cellulosic fibrous material comprising the primer coating layer on the sheet by

- providing a sheet comprising cellulosic fibrous material, such as coated or uncoated sheet, for example a sheet comprising paper and/or board,
- providing a first aqueous dispersion comprising potato starch in the range of 5-20% (w/w), 40% (w/w) or less inorganic filler, such as ground calcium carbonate, kaolin or talc, or a combination thereof, and 10% (w/w) or less latex polymer(s), for example in the range of 3-10% (w/w), and
- coating the sheet comprising cellulosic fibrous material with the first aqueous dispersion to obtain the primer coating layer on the sheet, optionally repeating the coating at least once, to obtain a grammage of the primer coating layer in the range of 1.0-5.0 g/m$^2$, such as 3.0-5.0 g/m$^2$.

**3.** The method of any of the preceding claims, wherein the first aqueous dispersion and/or the second aqueous dispersion comprises latex polymer(s), such as anionic styrene-butadiene latex, for example 10% (w/w) or less, such as 8% (w/w) or less, for example in the range of 3-10% (w/w), 3-8% (w/w), or 5-10% (w/w), for example wherein the first aqueous dispersion and/or the second aqueous dispersion comprises gelatinized potato starch, talc, latex polymer(s) and optionally wax.

**4.** The method of any of the preceding claims, wherein the first aqueous dispersion and/or the second aqueous dispersion comprises one or more sugar alcohol(s), such as xylitol and/or sorbitol, for example 1 % (w/w) or less, such as 0.3-1% (w/w).

**5.** The method of any of the preceding claims, comprising providing

- a composition A comprising gelatinized potato starch,
- a composition B comprising inorganic filler, preferably as a dispersion,
- optionally composition C comprising latex polymer(s) and wax, preferably also sugar alcohol,

and combining the compositions A, B and optionally C to obtain the aqueous dispersion comprising potato starch and inorganic filler.

**6.** The method of claim 5, wherein the composition A comprises

| | |
|---|---|
| -starch | 15-38% (w/w), |
| -propylene glycol | 1-2% (w/w), and |
| -optionally ammonia | 0.0125-0.025% (w/w), and/or |

wherein the composition B comprises

| | |
|---|---|
| -inorganic filler | 30-63% (w/w), and optionally |
| -rheology modifier | 0.25-1.0% (w/w), and/or |
| -antifoaming agent | 0.05-0.1% (w/w), and/or |

wherein the composition C comprises

| | |
|---|---|
| -latex polymer(s) | 22-33% (w/w), |
| -wax | 12-19% (w/w), and |

(continued)

-optionally sugar alcohol 0.3-1.0% (w/w).

**7.** A coated sheet comprising

- a sheet comprising cellulosic fibrous material, for example a sheet comprising paper and/or board,
- a primer coating layer on the sheet, the primer coating comprising potato starch, inorganic filler, such as ground calcium carbonate, kaolin or talc, or a combination thereof, and latex polymer(s), wherein the grammage of the primer coating layer is in the range of 1.0-5.0 g/m$^2$, such as 3.0-5.0 g/m$^2$, and
- a surface coating layer on the primer coating layer, the surface coating comprising potato starch and wax, wherein the grammage of the surface coating layer is in the range of 1-12 g/m$^2$, such as 4-7 g/m$^2$,
- the coated sheet being obtained with the method of any of the claims 1-6.

**8.** The coated sheet of claim 7, wherein the primer coating layer and/or the surface coating layer comprise(s) latex polymer(s), such as anionic styrene-butadiene latex, for example wherein the primer coating layer and/or the surface coating layer comprise(s) gelatinized potato starch, talc, latex polymer(s) and optionally wax, for example wherein the grammage of total coating in the coated sheet is in the range of 7-12 g/m$^2$.

**9.** The coated sheet of claim 7 or 8, wherein the primer coating layer and/or the surface coating layer comprise(s) one or more sugar alcohol(s), such as xylitol and/or sorbitol.

**10.** The method of any of the claims 1-6 or the coated sheet of any of the claims 7-9, wherein the starch is hydroxypropylated starch.

**11.** The coated sheet of any of the claims 7-10 having a water absorption capacity (Cobb 30 min, DIN EN ISO 535) in the range of 1-5 g/m$^2$, grease resistance (KIT, TAPPI T559) of about 12 and/or a water vapor transmission rate 24 h (WVTR 50%, ASTME398) 4.0-10.0 g/m$^2$.

**12.** A containerboard comprising the coated sheet of any of the claims 6-11.

**13.** The coated sheet of any of the claims 7-11 or the containerboard of claim 12, comprising one or more fold line(s).

**14.** A container comprising the coated sheet of any of the claims 7-13 and/or the containerboard of claim 12 or 13, such as wherein the container is or comprises a package, for example a package for food product, a package for cosmetics, a package for medicament or a package for tobacco product, for example a container in a form of a box, a pouch, a wrap, a bag, a sack, a sleeve, a tube, a tray, a cup, an inner bag, an unit dose package, a blister strip, or wherein the coated sheet is present as a tearable cover on a container such as a tub, a jar, a pot, a bottle, a tin or a strip.

**15.** Use of the coated sheet of any of the claims 7-13 or the containerboard of claim 12 or 13 for preparing a container, such as a package, for a product, such as for a food product, for a cosmetic product, for a medicament product or for a tobacco product.

**16.** Use of an aqueous dispersion comprising potato starch in the range of 5-20% (w/w) and wax and/or use of an aqueous dispersion comprising potato starch in the range of 5-20% (w/w), 40% (w/w) or less inorganic filler and 10% (w/w) or less latex polymer(s) for coating a sheet comprising cellulosic fibrous material with the method of any of the claims 1-6.

## Patentansprüche

**1.** Verfahren zur Herstellung eines beschichteten Blattes, das Verfahren umfassend

- Bereitstellen eines Blattes, das Cellulosefasermaterial umfasst, beispielsweise eines Blattes, das Papier und/oder Pappe umfasst, das eine Grundierungsbeschichtungsschicht auf dem Blatt aufweist, wobei die Grundierungsbeschichtungsschicht Kartoffelstärke, anorganischen Füllstoff und Latexpolymer(e) umfasst und ein Flächengewicht der Grundierungsbeschichtungsschicht im Bereich von 1,0-5,0 g/m$^2$, wie 3,0-5,0 g/m$^2$, aufweist, wobei das Blatt, das Cellulosefasermaterial umfasst, das die Grundierungsbeschichtungsschicht umfasst, er-

mittelt wird durch
- Bereitstellen eines Blattes, das Cellulosefasermaterial umfasst, wie beispielsweise ein beschichtetes oder unbeschichtetes Blatt, zum Beispiel ein Blatt, das Papier und/oder Pappe umfasst,
- Bereitstellen einer ersten wässrigen Dispersion, die Kartoffelstärke im Bereich von 5-20 % (Gew.-%), 40 % (Gew.-%) oder weniger anorganischen Füllstoff, wie gemahlenes Calciumcarbonat, Kaolin oder Talk oder eine Kombination davon, und 10 % (Gew.-%) oder weniger Latexpolymer(e), beispielsweise im Bereich von 3-10 % (Gew.-%), umfasst, und
- Beschichten des Blattes, das Cellulosefasermaterial umfasst, mit der ersten wässrigen Dispersion, um die Grundierungsbeschichtungsschicht auf dem Blatt zu ermitteln, optionales Wiederholen der Beschichtung mindestens einmal, um ein Flächengewicht der Grundierungsbeschichtungsschicht im Bereich von 1,0-5,0 g/m$^2$, wie 3,0-5,0 g/m$^2$, zu ermitteln;
- Bereitstellen einer zweiten wässrigen Dispersion, die Kartoffelstärke im Bereich von 5-20 % (Gew.-%) und Wachs umfasst; und
- Beschichten der Grundierungsbeschichtungsschicht mit der zweiten wässrigen Dispersion, um eine Oberflächenbeschichtungsschicht mit einer Grammatur im Bereich von 1-12 g/m$^2$, wie 4-7 g/m$^2$, aufzuweisen, optionales Ausbilden einer oder mehrerer Falzlinie(n) auf dem beschichteten Blatt, wobei die Beschichtung vorzugsweise mit einem Beschichtungsverfahren durchgeführt wird, das ausgewählt ist aus Druck, wie beispielsweise Flexodruck oder Tiefdruck, Luftmesser, Vorhangstreichmaschine, Klingenstreichmaschine und Stangenstreichmaschine, wie beispielsweise Mayer bar.

**2.** Verfahren nach Anspruch 1, umfassend die Herstellung des Blattes aus Cellulosefasermaterial, das die Grundierungsbeschichtungsschicht auf dem Blatt umfasst, durch

- Bereitstellen eines Blattes, das Cellulosefasermaterial umfasst, wie beispielsweise ein beschichtetes oder unbeschichtetes Blatt, zum Beispiel ein Blatt, das Papier und/oder Pappe umfasst,
- Bereitstellen einer ersten wässrigen Dispersion, die Kartoffelstärke im Bereich von 5-20 % (Gew.-%), 40 % (Gew.-%) oder weniger anorganischen Füllstoff, wie gemahlenes Calciumcarbonat, Kaolin oder Talk oder eine Kombination davon, und 10 % (Gew.-%) oder weniger Latexpolymer(e), beispielsweise im Bereich von 3-10 % (Gew.-%), umfasst, und
- Beschichten des Blattes, das Cellulosefasermaterial umfasst, mit der ersten wässrigen Dispersion, um die Grundierungsbeschichtungsschicht auf dem Blatt zu ermitteln, optionales Wiederholen der Beschichtung mindestens einmal, um ein Flächengewicht der Grundierungsbeschichtungsschicht im Bereich von 1,0-5,0 g/m$^2$, wie 3,0-5,0 g/m$^2$, zu ermitteln.

**3.** Verfahren nach einem der vorstehenden Ansprüche, wobei die erste wässrige Dispersion und/oder die zweite wässrige Dispersion Latexpolymer(e), wie anionischen Styrol-Butadien-Latex, beispielsweise 10 % (Gew.-%) oder weniger, wie 8 % (Gew.-%) oder weniger umfasst, zum Beispiel im Bereich von 3-10 % (Gew.-%), 3-8 % (Gew.-%) oder 5-10 % (Gew.-%), wobei die erste wässrige Dispersion und/oder die zweite wässrige Dispersion beispielsweise gelatinierte Kartoffelstärke, Talk, Latexpolymer(e) und optional Wachs umfasst.

**4.** Verfahren nach einem der vorstehenden Ansprüche, wobei die erste wässrige Dispersion und/oder die zweite wässrige Dispersion einen oder mehrere Zuckeralkohol(e), wie Xylit und/oder Sorbit, beispielsweise 1 % (Gew.-%) oder weniger, wie 0,3-1 % (Gew.-%) umfasst.

**5.** Verfahren nach einem der vorstehenden Ansprüche, umfassend das Bereitstellen

- einer Zusammensetzung A, die gelatinierte Kartoffelstärke umfasst,
- einer Zusammensetzung B, die einen anorganischen Füllstoff umfasst, vorzugsweise als Dispersion,
- optional Zusammensetzung C, die Latexpolymer(e) und Wachs, vorzugsweise auch Zuckeralkohol, umfasst,

und der Kombination der Zusammensetzungen A, B und optional C, um die wässrige Dispersion zu ermitteln, die Kartoffelstärke und anorganischen Füllstoff umfasst.

**6.** Verfahren nach Anspruch 5, wobei die Zusammensetzung A Folgendes umfasst

- Stärke 15-38 % (Gew.-%),
- Propylenglykol 1-2 % (Gew.-%), und
- optional Ammoniak 0,0125-0,025 % (Gew.-%), und/oder wobei die Zusammensetzung B Folgendes umfasst
- anorganischer Füllstoff 30-63 % (Gew.-%), und optional

- Rheologiemodifikator 0,25-1,0 % (Gew.-%), und/oder
- Entschäumer 0,05-0,1 % (Gew.-%), und/oder wobei die Zusammensetzung C Folgendes umfasst
- Latexpolymer(e) 22-33 % (Gew.-%),
- Wachs 12-19 % (Gew.-%), und
- optional Zuckeralkohol 0,3-1,0 % (Gew.-%).

**7.** Beschichtetes Blatt, umfassend

- ein Blatt, das Cellulosefasermaterial umfasst, zum Beispiel ein Blatt, das Papier und/oder Pappe umfasst,
- eine kohlenstoffhaltige Grundierungsbeschichtungsschicht auf dem Blatt, wobei die Grundierungsbeschichtung Kartoffelstärke, anorganischen Füllstoff, wie gemahlenes Calciumcarbonat, Kaolin oder Talkum, oder eine Kombination davon, und Latexpolymer(e) umfasst, wobei die Grammatur der Grundierungsbeschichtungsschicht im Bereich von 1,0-5,0 g/m$^2$, wie 3,0-5,0 g/m$^2$, liegt, und
- eine Oberflächenbeschichtungsschicht auf der Grundierungsbeschichtungsschicht, wobei die Oberflächenbeschichtung Kartoffelstärke und Wachs umfasst, wobei die Grammatur der Oberflächenbeschichtungsschicht im Bereich von 1-12 g/m$^2$, wie 4-7 g/m$^2$, liegt,
- wobei das beschichtete Blatt mit dem Verfahren nach einem der Ansprüche 1 bis 6 ermittelt wird.

**8.** Beschichtetes Blatt nach Anspruch 7, wobei die Grundierungsbeschichtungsschicht und/oder die Oberflächenschicht Latexpolymer(e), wie beispielsweise anionischen Styrol-Butadien-Latex, umfasst, wobei die Grundierungsbeschichtungsschicht und/oder die Oberflächenbeschichtungsschicht beispielsweise gelatinierte Kartoffelstärke, Talkum, Latexpolymer(e) und optional Wachs umfasst, wobei das Gesamtgewicht der Beschichtung in dem beschichteten Blatt beispielsweise im Bereich von 7-12 g/m$^2$ liegt.

**9.** Beschichtetes Blatt nach Anspruch 7 oder 8, wobei die Grundierungsbeschichtungsschicht und/oder die Oberflächenschicht einen oder mehrere Zuckeralkohol(e), wie Xylit und/oder Sorbit, umfasst.

**10.** Verfahren nach einem der Ansprüche 1 bis 6 oder das beschichtete Blatt nach einem der Ansprüche 7 bis 9, wobei die Stärke hydroxypropylierte Stärke ist.

**11.** Beschichtetes Blatt nach einem der Ansprüche 7 bis 10, das eine Wasseraufnahmekapazität (Cobb 30 min, DIN EN ISO 535) im Bereich von 1 bis 5 g/m$^2$, eine Fettbeständigkeit (KIT, TAPPI T559) von etwa 12 und/oder eine Wasserdampfdurchlässigkeitsrate 24 h (VWTR 50 %, ASTME398) von 4,0 bis 10,0 g/m$^2$ aufweist.

**12.** Behälterkarton, der das beschichtete Blatt nach einem der Ansprüche 6 bis 11 umfasst.

**13.** Beschichtetes Blatt nach einem der Ansprüche 7 bis 11 oder Behälterkarton nach Anspruch 12, der eine oder mehrere Faltlinie(n) umfasst.

**14.** Behälter, der das beschichtete Blatt nach einem der Ansprüche 7 bis 13 und/oder den Behälterkarton nach Anspruch 12 oder 13 umfasst, wobei der Behälter eine Verpackung ist oder eine solche umfasst, beispielsweise eine Verpackung für ein Lebensmittelprodukt, eine Verpackung für Kosmetika, eine Verpackung für ein Medikament oder eine Verpackung für ein Tabakprodukt, beispielsweise ein Behälter in Form einer Schachtel, eines Beutels, einer Umhüllung, eines Beutels, eines Sacks, einer Hülse, eines Rohrs, eines Tabletts, eines Bechers, eines Innenbeutels, einer Einheitspackung, eines Blisterstreifens, oder wobei das beschichtete Blatt als abreißbare Abdeckung auf einem Behälter wie einer Wanne, einem Glas, einem Topf, einer Flasche, einer Dose oder einem Streifen vorhanden ist.

**15.** Verwendung des beschichteten Blattes nach einem der Ansprüche 7 bis 13 oder des Behälterkartons nach Anspruch 12 oder 13 zum Zubereiten eines Behälters, wie beispielsweise einer Verpackung, für ein Produkt, wie beispielsweise für ein Lebensmittelprodukt, für ein kosmetisches Produkt, für ein Arzneimittelprodukt oder für ein Tabakprodukt.

**16.** Verwendung einer wässrigen Dispersion, die Kartoffelstärke im Bereich von 5-20 % (Gew.-%) und Wachs umfasst, und/oder Verwendung einer wässrigen Dispersion, die Kartoffelstärke im Bereich von 5-20 % (Gew.-%), 40 % (Gew.-%) oder weniger anorganischen Füllstoff und 10 % (Gew.-%) oder weniger Latexpolymer(e) umfasst, zum Beschichten eines Blattes, das Cellulosefasermaterial umfasst, mit dem Verfahren nach einem der Ansprüche 1 bis 6.

## Revendications

1. Procédé de fabrication d'une feuille enduite, le procédé comprenant

- la fourniture d'une feuille comprenant un matériau fibreux cellulosique, par exemple une feuille comprenant du papier et/ou du carton, comprenant une couche de revêtement primaire sur la feuille, la couche de revêtement primaire comprenant de la fécule de pomme de terre, une charge inorganique et un ou plusieurs polymères de latex et ayant un grammage de la couche de revêtement primaire dans la plage de 1,0 à 5,0 g/m$^2$, tel que de 3,0 à 5,0 g/m$^2$, dans lequel ladite feuille comprenant un matériau fibreux cellulosique comprenant la couche de revêtement primaire est obtenue par
- la fourniture d'une feuille comprenant un matériau fibreux cellulosique, tel qu'une feuille enduite ou non enduite, par exemple une feuille comprenant du papier et/ou du carton,
- la fourniture d'une première dispersion aqueuse comprenant de la fécule de pomme de terre dans la plage de 5 à 20 % (p/p), 40 % (p/p) ou moins de charge inorganique, telle que du carbonate de calcium broyé, du kaolin ou du talc, ou une combinaison de ceux-ci, et 10 % (p/p) ou moins d'un ou plusieurs polymères de latex, par exemple dans la plage de 3 à 10 % (p/p), et
- l'enduction de la feuille comprenant un matériau fibreux cellulosique avec la première dispersion aqueuse pour obtenir la couche de revêtement primaire sur la feuille, éventuellement en répétant l'enduction au moins une fois, pour obtenir un grammage de la couche de revêtement primaire dans la plage de 1,0 à 5,0 g/m$^2$, tel que de 3,0 à 5,0 g/m$^2$ ;
- la fourniture d'une seconde dispersion aqueuse comprenant de la fécule de pomme de terre dans la plage de 5 à 20 % (p/p) et de la cire ; et
- l'enduction de la couche de revêtement primaire avec la seconde dispersion aqueuse pour obtenir une couche de revêtement de surface ayant un grammage dans la plage de 1 à 12 g/m$^2$, tel que de 4 à 7 g/m$^2$,

éventuellement la formation d'une ou plusieurs lignes de pliage sur la feuille enduite, de préférence dans lequel l'enduction est effectuée avec un procédé d'enduction choisi parmi une impression, telle qu'une impression par flexographie ou une impression par gravure, à la lame d'air, à la coucheuse à rideau, à la coucheuse à lame, et à la coucheuse à barre, telle que la barre Mayer.

2. Procédé selon la revendication 1, comprenant la fabrication de la feuille comprenant un matériau fibreux cellulosique comprenant la couche de revêtement primaire sur la feuille par

- la fourniture d'une feuille comprenant un matériau fibreux cellulosique, tel qu'une feuille enduite ou non enduite, par exemple une feuille comprenant du papier et/ou du carton,
- la fourniture d'une première dispersion aqueuse comprenant de la fécule de pomme de terre dans la plage de 5 à 20 % (p/p), 40 % (p/p) ou moins de charge inorganique, telle que du carbonate de calcium broyé, du kaolin ou du talc, ou une combinaison de ceux-ci, et 10 % (p/p) ou moins d'un ou plusieurs polymères de latex, par exemple dans la plage de 3 à 10 % (p/p), et
- l'enduction de la feuille comprenant un matériau fibreux cellulosique avec la première dispersion aqueuse pour obtenir la couche de revêtement primaire sur la feuille, éventuellement en répétant l'enduction au moins une fois, pour obtenir un grammage de la couche de revêtement primaire dans la plage de 1,0 à 5,0 g/m$^2$, tel que de 3,0 à 5,0 g/m$^2$.

3. Procédé selon l'une quelconque des revendications précédentes, dans lequel la première dispersion aqueuse et/ou la seconde dispersion aqueuse comprend un ou plusieurs polymères de latex, tel qu'un latex de styrène-butadiène anionique, par exemple 10 % (p/p) ou moins, tel que 8 % (p/p) ou moins, par exemple dans la plage de 3 à 10 % (p/p), 3 à 8 % (p/p) ou 5 à 10 % (p/p), par exemple dans lequel la première dispersion aqueuse et/ou la seconde dispersion aqueuse comprend de la fécule de pomme de terre gélatinisée, du talc, un ou plusieurs polymères de latex et éventuellement de la cire.

4. Procédé selon l'une quelconque des revendications précédentes, dans lequel la première dispersion aqueuse et/ou la seconde dispersion aqueuse comprend un ou plusieurs alcools de sucre, tels que le xylitol et/ou le sorbitol, par exemple 1 % (p/p) ou moins, tel que 0,3 à 1 % (p/p).

5. Procédé selon l'une quelconque des revendications précédentes, comprenant la fourniture

- d'une composition A comprenant de la fécule de pomme de terre gélatinisée,

- d'une composition B comprenant une charge inorganique, de préférence sous forme de dispersion,
- éventuellement d'une composition C comprenant un ou plusieurs polymères de latex et de la cire, de préférence également de l'alcool de sucre,

et la combinaison des compositions A, B et éventuellement C pour obtenir la dispersion aqueuse comprenant de la fécule de pomme de terre et une charge inorganique.

**6.** Procédé selon la revendication 5, dans lequel la composition A comprend

| | |
|---|---|
| - de l'amidon | 15 à 38 % (p/p), |
| - du propylène glycol | 1 à 2 % (p/p), et |
| - éventuellement de l'ammoniac | 0,0125 à 0,025 % (p/p), et/ou |

dans lequel la composition B comprend

| | |
|---|---|
| - une charge inorganique | 30 à 63 % (p/p), et éventuellement |
| - un modificateur de rhéologie | 0,25 à 1,0 % (p/p), et/ou |
| - un agent antimousse | 0,05 à 0,1 % (p/p), et/ou |

dans lequel la composition C comprend

| | |
|---|---|
| - un ou plusieurs polymères de latex | 22 à 33 % (p/p), |
| - de la cire | 12 à 19 % (p/p), et |
| - éventuellement de l'alcool de sucre | 0,3 à 1,0 % (p/p). |

**7.** Feuille enduite comprenant

- une feuille comprenant un matériau fibreux cellulosique, par exemple une feuille comprenant du papier et/ou du carton,
- une couche de revêtement primaire sur la feuille, le revêtement primaire comprenant de la fécule de pomme de terre, une charge inorganique, telle que du carbonate de calcium broyé, du kaolin ou du talc, ou une combinaison de ceux-ci, et un ou plusieurs polymères de latex, dans laquelle le grammage de la couche de revêtement primaire est dans la plage de 1,0 à 5,0 g/m$^2$, tel que de 3,0 à 5,0 g/m$^2$, et
- une couche de revêtement de surface sur la couche de revêtement primaire, le revêtement de surface comprenant de la fécule de pomme de terre et de la cire, dans laquelle le grammage de la couche de revêtement de surface est dans la plage de 1 à 12 g/m$^2$, tel que de 4 à 7 g/m$^2$,
- la feuille enduite obtenue avec le procédé selon l'une quelconque des revendications 1 à 6.

**8.** Feuille enduite selon la revendication 7, dans laquelle la couche de revêtement primaire et/ou la couche de revêtement de surface comprennent un ou plusieurs polymères de latex, tel qu'un latex de styrène-butadiène anionique, par exemple dans laquelle la couche de revêtement primaire et/ou la couche de revêtement de surface comprennent de la fécule de pomme de terre gélatinisée, du talc, un ou plusieurs polymères de latex et éventuellement de la cire, par exemple dans laquelle le grammage de revêtement total dans la feuille enduite est dans la plage de 7 à 12 g/m$^2$.

**9.** Feuille enduite selon la revendication 7 ou 8, dans laquelle la couche de revêtement primaire et/ou la couche de revêtement de surface comprennent un ou plusieurs alcools de sucre, tels que le xylitol et/ou le sorbitol.

**10.** Procédé selon l'une quelconque des revendications 1 à 6 ou feuille enduite selon l'une quelconque des revendications 7 à 9, dans lequel l'amidon est de l'amidon hydroxypropylé.

**11.** Feuille enduite selon l'une quelconque des revendications 7 à 10, ayant une capacité d'absorption d'eau (Cobb 30 min, DIN EN ISO 535) dans la plage de 1 à 5 g/m$^2$, une résistance à la graisse (KIT, TAPPI T559) d'environ 12 et/ou un taux de transmission de la vapeur d'eau en 24 heures (WVTR 50 %, ASTME398) de 4,0 à 10,0 g/m$^2$.

**12.** Carton d'emballage comprenant la feuille enduite selon l'une quelconque des revendications 6 à 11.

**13.** Feuille enduite selon l'une quelconque des revendications 7 à 11 ou carton d'emballage selon la revendication 12, comprenant une ou plusieurs lignes de pliage.

**14.** Contenant comprenant la feuille enduite selon l'une quelconque des revendications 7 à 13 et/ou carton d'emballage selon la revendication 12 ou 13, par exemple dans lequel le contenant est ou comprend un emballage, par exemple un emballage pour produit alimentaire, un emballage pour cosmétique, un emballage pour médicament ou un emballage pour produit du tabac, par exemple un contenant sous la forme d'une boîte, d'un sachet, d'une enveloppe, d'un sac, d'un sac grande contenance, d'un manchon, d'un tube, d'un plateau, d'une tasse, d'un sachet intérieur, d'un emballage à dose unitaire, d'une plaquette thermoformée, ou dans lequel la feuille enduite est présente sous la forme d'un couvercle déchirable sur un contenant tel qu'une barquette, un bocal, un pot, une bouteille, une boîte de conserve ou une bande.

**15.** Utilisation de la feuille enduite selon l'une quelconque des revendications 7 à 13 ou du carton d'emballage selon la revendication 12 ou 13 pour préparer un contenant, tel qu'un emballage, pour un produit, tel que pour un produit alimentaire, pour un produit cosmétique, pour un médicament ou pour un produit du tabac.

**16.** Utilisation d'une dispersion aqueuse comprenant de la fécule de pomme de terre dans la plage de 5 à 20 % (p/p) et de la cire et/ou utilisation d'une dispersion aqueuse comprenant de la fécule de pomme de terre dans la plage de 5 à 20 % (p/p), 40 % (p/p) ou moins de charge inorganique et 10 % (p/p) ou moins d'un ou plusieurs polymères de latex pour enduire une feuille comprenant un matériau fibreux cellulosique avec le procédé de l'une quelconque des revendications 1 à 6.

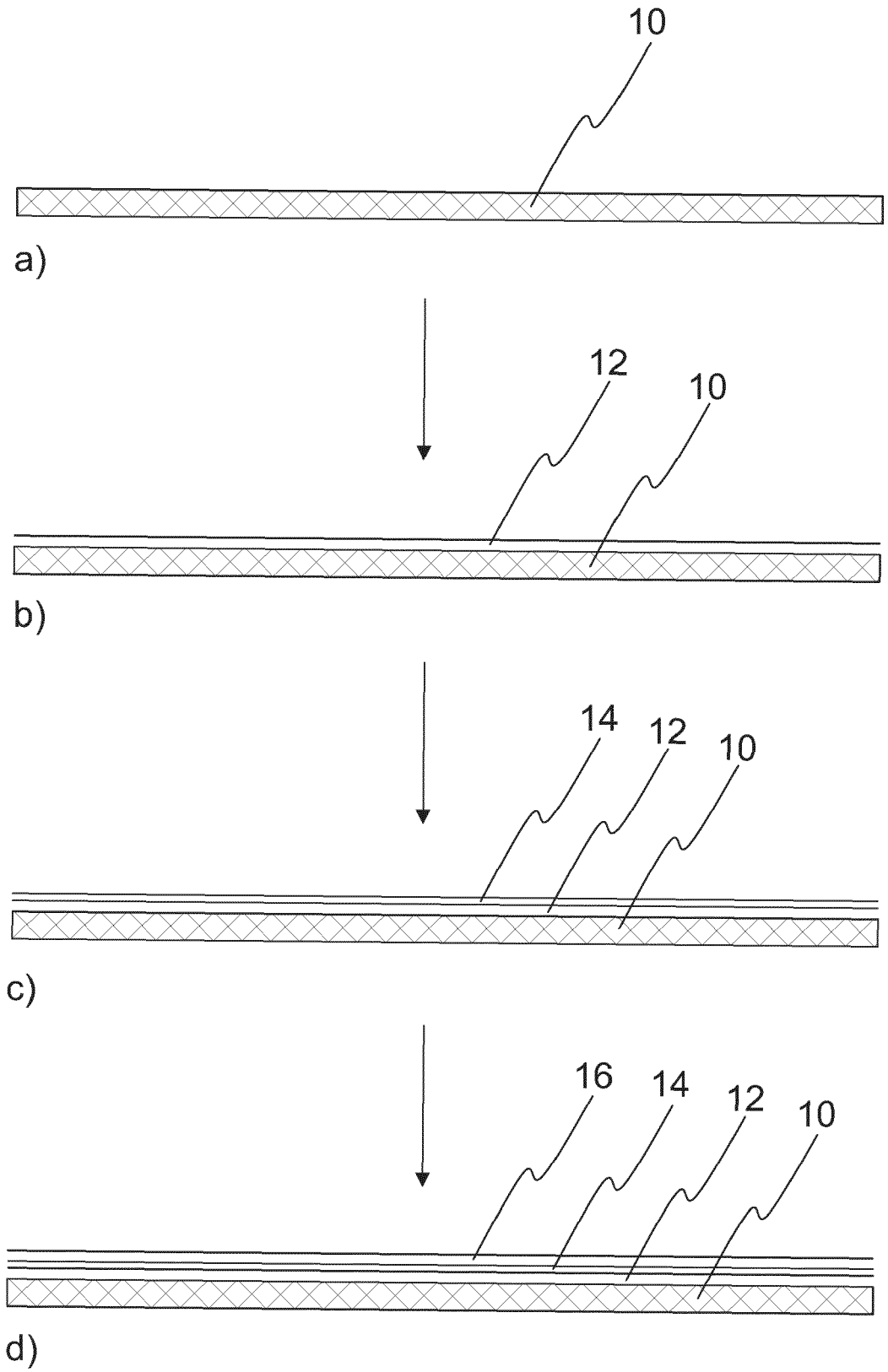


Fig. 1

Fig. 2

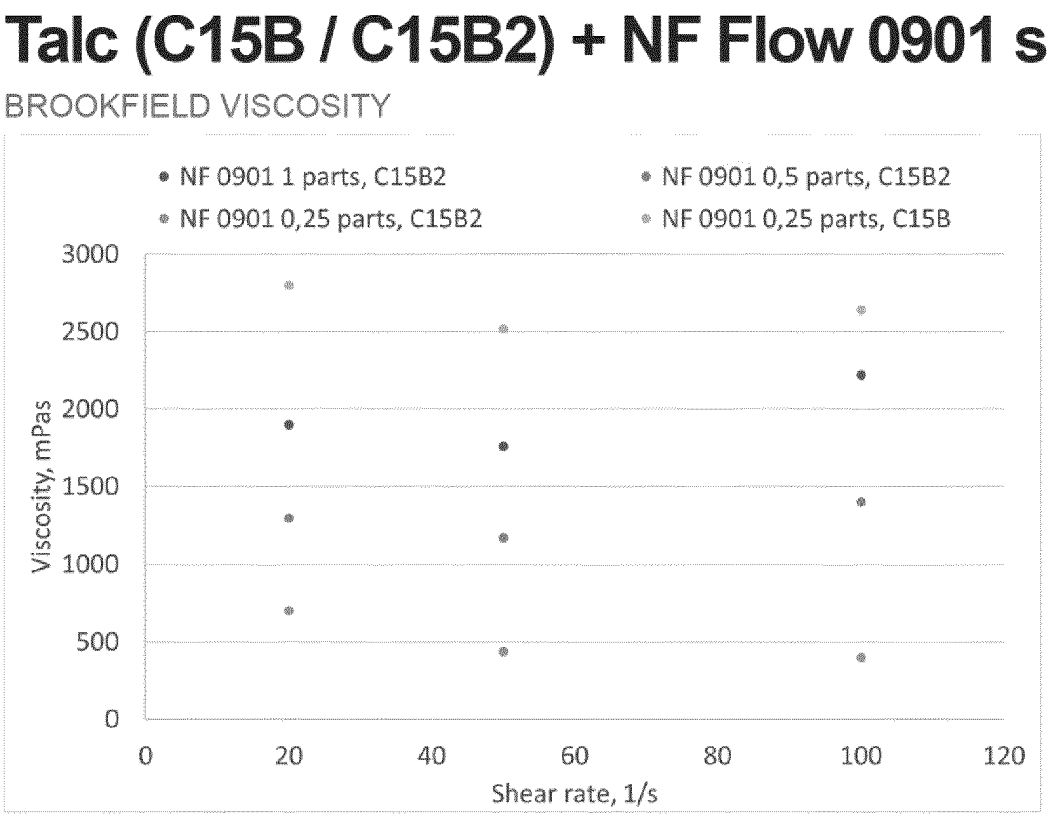
Talc (C15B / C15B2) + NF Flow 0901 slurry
BROOKFIELD VISCOSITY
NF 0901 1 parts, C15B2
NF 0901 0,5 parts, C15B2
NF 0901 0,25 parts, C15B2
NF 0901 0,25 parts, C15B
Viscosity, mPas
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
Shear rate, 1/s

Fig. 3

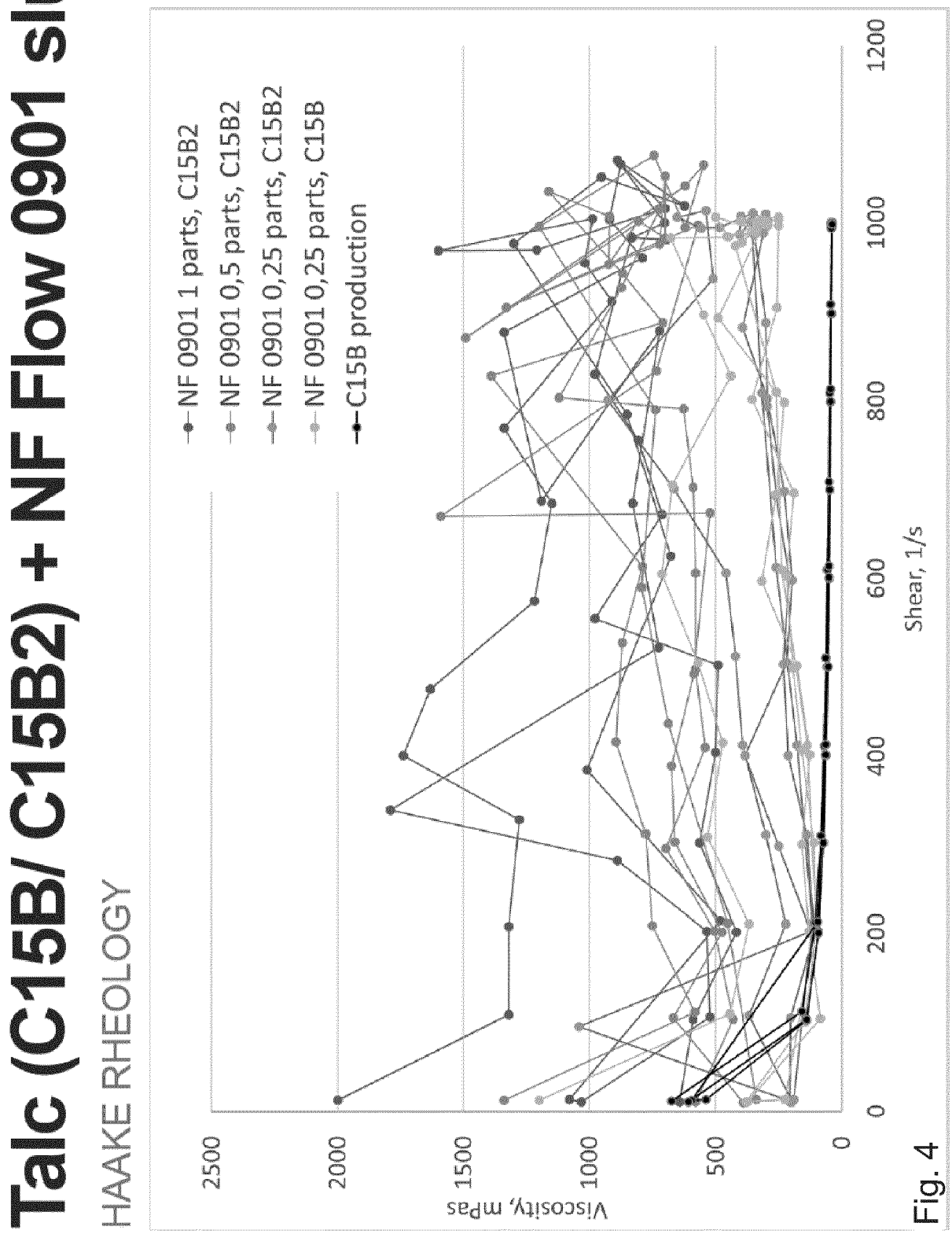
Talc (C15B/ C15B2) + NF Flow 0901 slurry
HAAKE RHEOLOGY
NF 0901 1 parts, C15B2
NF 0901 0,5 parts, C15B2
NF 0901 0,25 parts, C15B2
NF 0901 0,25 parts, C15B
C15B production
Viscosity, mPas
Shear, 1/s
2500
2000
1500
1000
500
0
0
200
400
600
800
1000
1200

Fig. 4

# Barrier coating color with NF 3039 dispersion

VISCOSITY ANALYSIS

| Coating color 1 | | |
|---|---|---|
| BR100 | 140 | mPas |
| BR50 | 140 | mPas |
| BR20 | 175 | mPas |

Talc C15 B 50 % (NF 0901 0,25 %), 50 % NF 3039

| Coating color 2 | | |
|---|---|---|
| BR100 | 450 | mPas |
| BR50 | 520 | mPas |
| BR20 | 675 | mPas |
| Solids | 53,3 | % |

Talc C15B 50 % (NF 0901 0,25 %), 50 % NF 3039 + 2 parts Optiflow T-1000

| Coating color 3 | | |
|---|---|---|
| BR100 | 470 | mPas |
| BR50 | 540 | mPas |
| BR20 | 650 | mPas |
| Solids | 53,9 | % |

Talc C15B 30 % (NF 0901 0,25 %), 70 % NF 3039 + 2 parts Optiflow T-1000

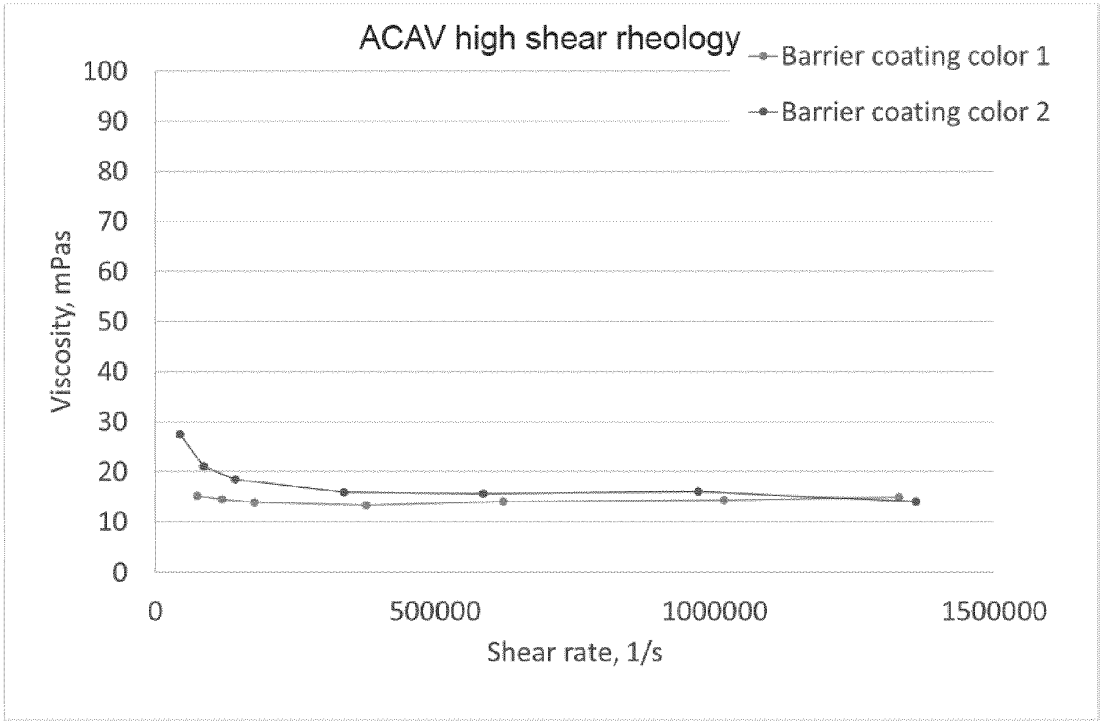


Fig. 5

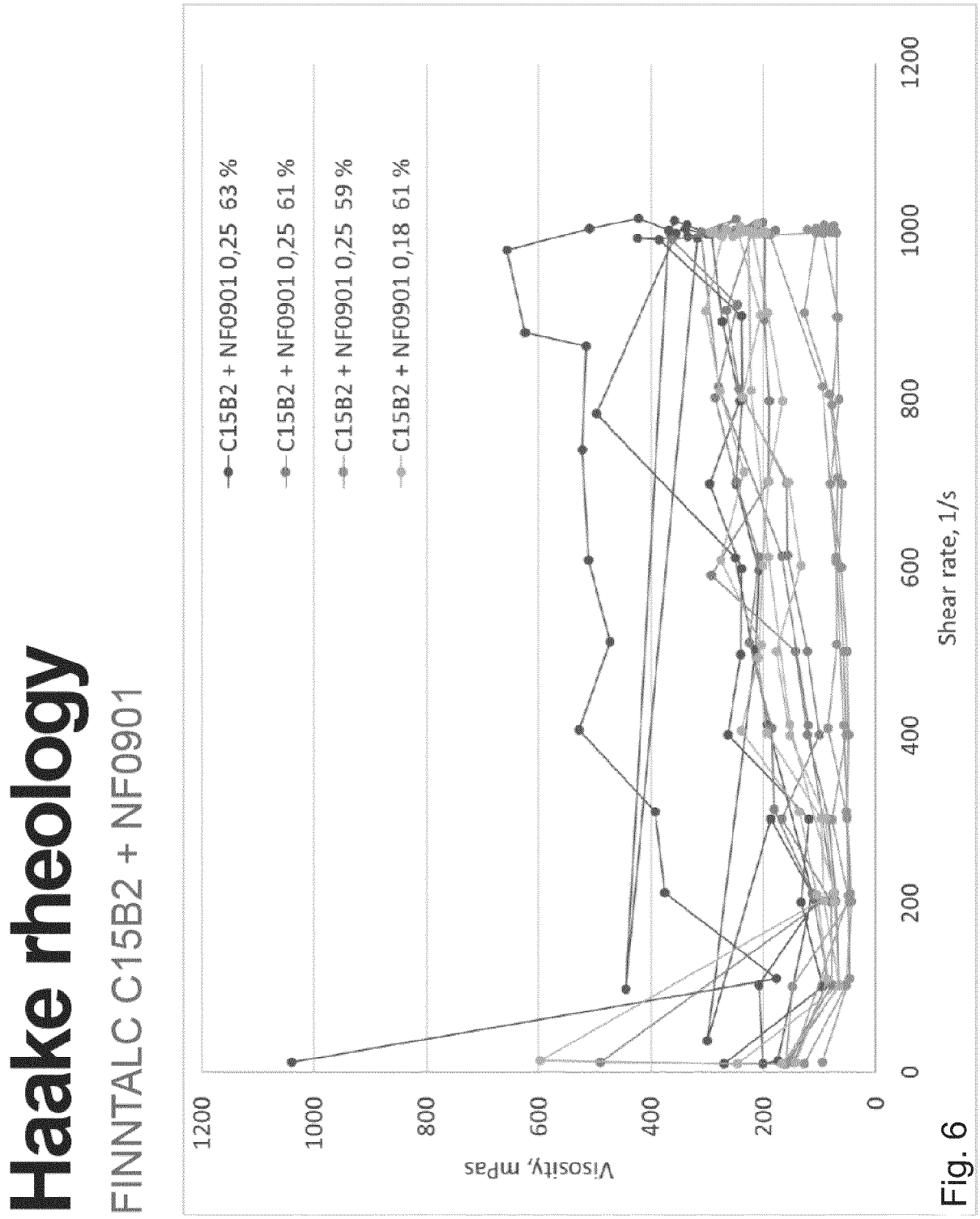
Haake rheology
FINNTALC C15B2 + NF0901
C15B2 + NF0901 0,25 63 %
C15B2 + NF0901 0,25 61 %
C15B2 + NF0901 0,25 59 %
C15B2 + NF0901 0,18 61 %
Viscosity, mPas
Shear rate, 1/s
0
200
400
600
800
1000
1200

Fig. 6