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(71) Applicants:
- **Neenah Gessner GmbH**
  83052 Bruckmühl (DE)
- **Mativ Luxembourg**
  5326 Contern (LU)

(72) Inventors:
- **Niederhuber, Armin**
  83052 Bruckmühl (DE)
- **Birnkhammer, Martha**
  83052 Bruckmühl (DE)
- **Cherkas, Oxana**
  29393 Quimperle (FR)

(74) Representative: **Hoffmann Eitle**
Patent- und Rechtsanwälte PartmbB
Arabellastraße 30
81925 München (DE)

(54) LOW OPACITY PAPER PACKAGING MATERIAL

(57) A low grammage, low opacity and heat-sealable paper is disclosed. The low opacity and heat-sealable paper is made from a fibrous web containing highly refined cellulose fibers. The fibrous web can be first coated with a bio-based wax, such as a coconut-based wax. The fibrous web is also coated with a coating composition that forms a heat-sealable coating on an exterior surface of the coated paper. The product can have excellent transparent or translucent characteristics. The product also has excellent heat-sealable properties making the product well suited for producing packages.

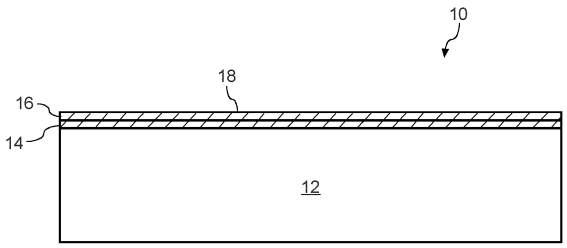

FIG. 1

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Description

BACKGROUND

[0001] Transparent or translucent materials are used in all different types of applications. Transparency, for instance, is a highly desirable quality in packaging materials. For example, although packaging materials are necessary to protect products during shipping and sales, consumers prefer to be able to view the product through the packaging.

[0002] In the past, most transparent or translucent materials, including packaging materials, were formed from plastic materials, such as polyester polymers and polyolefin polymers. These plastic materials, however, are derived from non-renewable, fossil resources, including petroleum-based resources. These resources are not sustainable, are not renewable, and produce polymer products that do not readily degrade. Thus, efforts have been made in the past in an attempt to produce transparent or translucent materials from renewable resources, such as cellulose materials.

[0003] For example, low opacity or transparent papers have been developed and produced in the past. Transparent paper products, for instance, have been used in the form of tracing paper or clear windows for envelopes. These materials, however, have had limited success in producing packaging materials because the materials do not have sufficient heat-seal properties.

[0004] Further, in order to produce a transparent or translucent paper, non-renewable resources or components that do not readily biodegrade were combined with the paper. For example, one type of paper produced in the past was manufactured from wood pulp fibers that may have been combined with an enzyme, such as xylanase. These substrates typically had a relatively high basis weight in order to provide sufficient strength or other mechanical properties. In order to reduce the thickness of the cellulose paper, densify the paper, and produce transparent properties, the paper was combined with petroleum-based chemicals or synthesized resins and then fed through a supercalendering process. As used herein, during supercalendering, a paper is first calendered by pressing it between metal cylinders or rollers. Afterwards, the paper is sent through an additional set of calenders to produce an even smoother and glossier paper, referred to as a supercalendered paper. The supercalender includes several cylinders alternating between polished metal and soft resilient surfaces. The supercalender applies pressure, heat, and friction to glaze both surfaces of the paper to make the paper smooth and/or glossy.

[0005] Transparent or translucent papers made in the past as described above have various drawbacks and deficiencies. For instance, as stated above, even though the fibers used to produce the paper are obtained from renewable resources and are biodegradable and compostable, the papers are typically combined with petroleum-based chemicals or other synthetic resins that can frustrate the goal of producing biodegradable materials. In addition, although supercalendering can be very effective at changing the properties of the paper, the process is very energy intensive. In addition, the above papers fail to include heat-seal characteristics.

[0006] Barrier properties to water, water vapor, and grease are important for packaging materials. Usually, these properties are also achieved with petroleum-sourced materials.

[0007] In view of the above, a need currently exists for a low opacity paper that can be greater than 90% bio-sourced and can be biodegradable and/or compostable. A need also exists for a low opacity paper that can be produced without supercalendering and possibly using less materials, such as less cellulose fibers. A need also exists for a low opacity paper that does not contain petroleum-based raw materials and have good barrier properties. A need further exists for a low opacity paper that also has heat-seal characteristics so that the paper can be thermally bonded to itself for forming packages with see-through characteristics.

SUMMARY

[0008] It is an object of the present invention to provide an alternative to plastic films currently on the market. More particularly, the present disclosure is directed to a low opacity paper that can be made at relatively low basis weights, without containing any petroleum-based resources, and without having to supercalender the paper, thus reducing the energy requirements needed to make the product. The low opacity paper of the present disclosure can also be formulated to be completely biodegradable and compostable. In addition, the low opacity paper can have an excellent balance of properties including high transparency and low permeability for providing high barrier properties, good mechanical properties for converting and handling, and excellent heat-seal properties.

[0009] In one aspect, the present disclosure is directed to a paper product with low opacity characteristics. The paper product comprises a fibrous web containing cellulose fibers. The cellulose fibers contained in the web can be refined to a relatively high degree as may be measured according to a freeness value. The freeness value (° SR) measures generally the rate at which a dilute suspension of refined fibers may be drained. The freeness is measured by the Schopper Riegler Method for drainability. As used herein, freeness can be measured according to DIN EN ISO 5267-1 :2000. The cellulose fibers contained in the web can have a degree of refining of greater than about 60° SR, such as greater than about 70° SR. The fibers generally have a freeness value of less than about 100° SR, such as less

than about 90° SR. The fibrous web, in one aspect, can also have a relatively low basis weight for enhancing transparency. For instance, the basis weight of the web can be less than about 38 g/m^2, such as less than about 35 g/m^2, such as less than about 33 g/m^2, such as less than about 30 g/m^2, such as less than about 28 g/m^2, such as less than about 25 g/m^2, such as less than about 23 g/m^2, and generally greater than about 10 g/m^2, such as greater than about 12 g/m^2. In a preferred embodiment, the basis weight of the fibrous web is in the range of 10 to 24 g/m^2 and preferably 10 to 18 g/m^2. The fibrous web defines a first surface and a second surface. As will be readily understood by the skilled person, the first surface and the second surface are the main surfaces of the fibrous web, which may also be referred to as "upper" and lower" surface and are located opposite to each other.

[0010] In accordance with the present disclosure, at least two different coating compositions can be applied to a surface of the fibrous web. The first coating comprises a transparency agent, such as a bio-based wax or oil for lowering opacity. The second coating composition, on the other hand, can form a heat-sealable coating that can be applied over the transparency agent coating on the first surface and/or the second surface of the fibrous web, and preferably on just one of the first surface and the second surface of the fibrous web. This is the subject of feature (i) in claim 2. In a variant, the first and the second coating compositions can be applied to opposite surfaces of the fibrous web, namely, the first and the second surface thereof, as is the case in feature (ii) in claim 2. According to another aspect of the disclosure, the second coating composition can be combined with the transparency agent coating composition and applied to the web as a single coating. This is the subject of claim 1.

[0011] The heat-sealable coating composition, also when combined with the transparency agent coating composition, can form an exterior surface of the paper product. The heat-sealable coating can comprise a polymer, such as a thermoplastic polymer or a protein. The polymer can be a polyester, a protein, a polysaccharide, a polysaccharide ester, a polysaccharide ether, or a polysaccharide ether ester. The protein can be casein, whey, or the like. Paper products made in accordance with the present disclosure can display an opacity of less than about 45% when tested according to ISO 2471 :2008. For example, the opacity can be less than about 40%, such as less than about 35%.

[0012] The amount of the transparency agent incorporated into the product can depend on various factors. The basis weight (dry) of the transparency agent coating can be from about 0.5 g/m^2 to about 18 g/m^2, including all increments of 0.5 g/m^2 therebetween. For instance, the transparency agent coating can have a basis weight of greater than about 2 g/m^2, such as greater than about 4 g/m^2, such as greater than about 5 g/m^2, such as greater than about 6 g/m^2, such as greater than about 7 g/m^2, such as greater than about 8 g/m^2. The basis weight of the transparency agent coating can be less than about 20 g/m^2, such as less than about 15 g/m^2, such as less than about 12 g/m^2, such as less than about 10 g/m^2, such as less than about 8 g/m^2.

[0013] In one embodiment, the transparency agent can be water miscible and applied to the fibrous web as an aqueous composition.

[0014] As described above, in one aspect, the heat-sealable coating can comprise a polymer. In one aspect, the polymer can be a thermoplastic starch or a protein. The heat-sealable coating can be applied to the cellulose layer so as to have a dry basis weight of greater than about 1 g/m^2, such as greater than about 3 g/m^2, such as greater than about 4 g/m^2, such as greater than about 5 g/m^2, and generally less than about 20 g/m^2, such as less than about 15 g/m^2, such as less than about 10 g/m^2, such as less than about 8 g/m^2. When combined with the transparency agent, the basis weight of the coating can be greater than about 3 g/m^2, such as greater than about 5 g/m^2, such as greater than about 8 g/m^2, such as greater than about 12 g/m^2, and generally less than about 35 g/m^2, such as less than about 30 g/m^2, such as less than about 25 g/m^2, such as less than about 20 g/m^2

[0015] In one aspect, the fibrous web can comprise a wetlaid web. The fibrous web can contain wood pulp fibers alone or in combination with bast fibers. The wood pulp fibers, for instance, can be softwood fibers, hardwood fibers, or combinations thereof. The paper product can be produced without containing any paraffins, mineral oils, or hydrocarbon oils. Thus, in one aspect, the paper product can be repulpable and compostable.

[0016] The fibrous web (prior to applying any coatings) can contain cellulose fibers generally in an amount greater than about 65% by weight, such as in an amount greater than about 75% by weight, such as in an amount greater than about 80% by weight, such as in an amount greater than about 85% by weight, such as in an amount greater than about 90% by weight, such as in an amount greater than about 95% by weight. Cellulose fibers are generally present in the fibrous web in an amount of 100% by weight, or in an amount of less than about 99% by weight, such as in an amount less than about 98% by weight.

[0017] In one particular embodiment, the fibrous web can contain first cellulose fibers blended with second cellulose fibers. The first cellulose fibers can have an average fiber length that is shorter than the average fiber length of the second cellulose products. The first cellulose fibers, for instance, can be contained in the fibrous web in an amount from about 30% to about 70% by weight and the second cellulose fibers can be present in the fibrous web in an amount from about 70% to about 30% by weight based upon the total weight of fibers contained in the web. The first cellulose fibers, for instance, can have an average fiber length of from about 2.5 mm to about 5 mm.

[0018] The paper product of the present disclosure can have a combination of beneficial properties. For instance, the paper product can be relatively thin having a thickness of less than about 80 μm, such as less than about 70 μm, such

as less than about 60 μm, and generally greater than about 30 μm according to EN ISO 534:2011. The paper product can also have a Gurley air permeability according to ISO 5636:2003 of less than about 45,200 seconds, such as less than about 20,000 seconds, such as less than about 10,000 seconds, such as less than about 1000 seconds, and generally greater than about 600 seconds. The paper product can also have a water drop resistance greater than 5 min according to TAPPI T 432 cm-09 (2μL of water volume is used in test). The paper product can have a water vapor barrier at 23°C and 50%HR of less than 80 g/m^2/day, such as less than 50 g/m^2/day and greater than about 0.1 g/m^2/day according to ASTM E96/E96M - 15:2014 (coated side on top, measurement made during 3 days).

[0019] The present disclosure is also directed to a packaging formed from the coated paper. In one embodiment, the packaging can define a hollow enclosure or interior volume that is formed between two layers of the coated paper. The coated paper can be heat-sealed together along the margins of the product. In one aspect, paper can be used as a packaging material for food, tobacco, cosmetics, pharmaceutical products, and other products.

[0020] The present disclosure, in another aspect, is also directed to a method for producing a low opacity paper product as described above. The method includes coating a fibrous web with an aqueous composition containing a bio-based wax or oil, such as a coconut-based wax or oil, a rice-based wax, a palm-based wax or oil and/or a soy-based wax or oil. In accordance with the present disclosure, a second coating is then applied to the fibrous web that forms a heat-sealable coating on the web. The heat-sealable coating can be applied over the first coating.

[0021] In another aspect, the heat sealable composition can be combined with the transparency agent composition to form a single coating on the web that has heat sealable properties.

[0022] The method can further include calendering the coated fibrous web. The coated fibrous web can be calendered after the first coating has been applied and/or after the heat-sealable coating has been applied. Herein, the coating comprising the heat-sealable composition is sometimes referred to as "heat-sealable coating". In one aspect, the aqueous composition containing the transparency agent is coated on the fibrous web using a size press. The heat-sealable coating, on the other hand, can also be applied by a size press or can be applied in an offline process using, for instance, a knife coating technique.

[0023] Other features and aspects of the present disclosure are discussed in greater detail below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] A full and enabling disclosure of the present disclosure is set forth more particularly in the remainder of the specification, including reference to the accompanying figures, in which:

Figure 1 is a cross-sectional view of one embodiment of a low opacity paper made in accordance with the present disclosure.

[0025] Repeat use of reference characters in the present specification and drawings is intended to represent the same or analogous features or elements of the present invention.

DEFINITIONS

[0026] As understood herein, a "coating" (provided) on the surface(s) of the fibrous web can be obtained by applying a generally liquid coating agent on the surface(s) of the fibrous web by means of any suitable coating, impregnation or saturation technique, such as for example air knife coating, roll-to-roll coating, blade coating, spray coating, Mayer rod coating, direct gravure printing, offset gravure printing, reverse gravure printing, smooth roll coating, curtain coating, bead coating, slot coating, fill press coating or impregnation via a size press. The coating can be a continuous coating or a discontinuous coating. Accordingly, along the lateral dimension of the fibrous web, the coating can be present in a part of or the complete fibrous web. When applying the coating composition to the fibrous web, it will penetrate into some of the internal spaces and pores between the fibers of the fibrous web resulting in saturation and/or impregnation of the fibrous web with the coating (composition). That is, in the present invention the coating will permeate into the fibrous web, in particular internal spaces and pores therein, and apart from this it can cover and preferably does cover at least part of the first and/or the second surface of the fibrous web in the form of a surface coating. In other words, a "coating" (provided) on the fibrous web as understood herein covers the saturation and impregnation of the fibrous web.

[0027] As used herein, the term "low opacity" means transparent or translucent. A product is considered to have low opacity when the product displays an opacity of, e.g., less than about 45% when tested according to ISO 2471:2008. Low opacity characteristics refer to the characteristics which provide a paper product with transparency or translucency, such as the presence of a transparency agent.

[0028] As used herein, the term "transparency agent" refers to an agent which decreases the opacity of fibrous web when applied inside or on the fibrous web. Examples include plant or animal derived waxes or oils, such as a coconut-based wax, a palm-based wax, and/or a soy-based wax. Plant or animal derived components as understood herein can be obtained from biomass. The transparency agent can be a bio-based wax or oil.

[0029] As used herein, the term "biomass" is broadly understood as encompassing all kinds of plant and animal material

and material derived from the same. Biomass does not include petroleum or petroleum-derived products.

[0030] The biomass for use in the present invention may comprise macromolecular compounds, examples of which are lignin and polysaccharides, such as starch, proteins, cellulose, hemicellulose.

[0031] As will be appreciated, certain kinds of biomass may include both plant and animal-derived material. As examples, manure (dung), night soil and sewage sludge can be mentioned. While the biomass for use in the present invention is preferably plant biomass, i.e. biomass of or derived from plants, certain contents of animal biomass (i.e. biomass of or derived from animals) may be present therein. For instance, the biomass may contain up to 30 % of animal biomass. According to a preferred embodiment, the biomass for use in the present disclosure, which is preferably plant biomass, contains more than 70 wt%, most preferably more than 90 wt%, of polysaccharides and lignines in terms of the solid contents of the biomass.

[0032] For instance, the plant biomass may be agricultural plant material (e.g. agricultural wastes) or all kinds of wood material.

[0033] Without limitation, examples of biomass are crop, agricultural food and waste, feed crop residues, wood (such as wood flour, wood waste, scrap wood, sawdust, chips and discards), straw (including rice straw), grass, leaves, chaff, and bagasse. Furthermore, industrial and municipal wastes, including waste paper can be exemplified. Biomass also encompasses oils and waxes obtained or derived from plant or animal materials.

[0034] As used herein, a "biodegradable" component is a component that is capable of being decomposed by living organisms, such as bacteria or fungi. A biodegradable component can thus be decomposed by the action of microorganisms such as bacteria or fungi with or without oxygen. In one aspect, a biodegradable component fulfills the requirements of at least one of the international industrial standards ISO 14855:2018, ISO 14853:2017, and ASTM D5338:2015.

[0035] As used herein, the term "compostable" refers to components that can disintegrate into non-toxic, natural elements. Compostable components, for instance, can degrade at a rate consistent with similar organic materials. Compostable components degrade when exposed to microorganisms, humidity, and/or heat to yield a finished compost product. Coated papers made according to the present disclosure can be formulated to meet international industrial standards ISO 17088:2021, DIN EN 13432:2007, DIN EN 14995:2007, and/or ASTM 6400:2021 defines the requirements for industrially compostable components.

[0036] The term "pulp" as used herein refers to fibers from natural sources such as woody and non-woody plants. Woody plants include, for example, deciduous and coniferous trees. Non-woody plants include, for example, cotton, flax, esparto grass, milkweed, straw, jute, hemp, and bagasse. Pulp fibers can include hardwood fibers, softwood fibers, and mixtures thereof.

[0037] As used herein, opacity is measured according to ISO 2471:2008. Opacity is a measure of the ability of the paper product to obstruct the passage of light through it. The lower is the level of opacity, the higher is the level of translucency/transparency.

[0038] As used herein, the term "fibrous web" refers to sheet made from the pulp by a wetlaid process without coating.

[0039] As used herein, the term "bio-based wax or oil" refers to wax or oil which have a bio-based content more than 90%. Examples include coconut-based wax, a palm-based wax and/or a soy-based wax.

[0040] As used herein, the term "repulpable" means that the paper disintegrates during the pulping process in water.

DETAILED DESCRIPTION

[0041] It is to be understood by one of ordinary skill in the art that the present discussion is a description of exemplary embodiments only and is not intended as limiting the broader aspects of the present disclosure.

[0042] In general, the present disclosure is directed to a low opacity paper with heat-seal properties. In one aspect, the paper can be transparent. Alternatively, the paper can be formulated to be translucent. The low opacity paper of the present disclosure can be formed exclusively from sustainable resources that meets all of the requirements for entering the paper recycle stream after use. In the past, for instance, transparent papers typically contained components derived from fossil-based resources, such as petroleum-derived products. The low opacity paper of the present disclosure, however, can be produced without containing any mineral oils or hydrocarbons, including mineral oil saturated hydrocarbons and mineral oil aromatic hydrocarbons. In addition, in one aspect, the low opacity paper can be formulated to be paraffin-free. The low opacity paper can be constructed in order to meet all of the requirements for food contact and food handling.

[0043] In addition, the low opacity paper of the present disclosure can have excellent barrier and heat-seal properties. A heat-seal coating, for instance, can form an exterior surface of the paper product. The heat-seal coating not only facilitates the formation of thermal bonds between the coated paper and an adjacent surface, such as another layer of the coated paper, but can also be made entirely from sustainable, biodegradable, and compostable materials.

[0044] Also of advantage is that the low opacity paper of the present disclosure can be developed so as to minimize the use of materials while still having sufficient mechanical properties for handling, processing, and end use applications. For instance, the low opacity paper of the present disclosure can be manufactured at relatively low basis weights and

at relatively low thicknesses.

[0045] In one aspect, the low opacity paper of the present disclosure is formed from a fibrous web containing cellulose fibers that have been refined to a relatively high degree. In accordance with the present disclosure, the fibrous web is combined with a transparency agent, which can be a bio-based wax or oil. The transparency agent not only increases the barrier characteristics of the paper but also lowers the opacity characteristics of the paper. Ultimately, a paper can be produced that has an opacity of less than about 45%. For instance, the opacity of the paper products can be less than about 40%, such as less than about 38%, such as less than about 35%. The actual opacity can depend upon various factors and is generally greater than 5%, such as greater than about 10%.

[0046] Referring to **FIG. 1,** one embodiment of a low opacity paper or paper product **10** made in accordance with the present disclosure is shown. **FIG. 1** represents a schematic cross-sectional view of the product **10.** As shown, in this embodiment, the low opacity paper **10** includes a paper base sheet **12** which is a fibrous web formed from cellulose fibers. The fibrous web **12**, for instance, can be a wetlaid paper web. In other embodiments, however, the fibrous web **12** can be made using any suitable papermaking technique. The fibrous web **12** includes a first surface opposite a second surface. Applied to the first surface of the fibrous web **12** is a first coating **14** and a second coating **16.** The first coating **14** contains a transparency agent that lowers the opacity of the paper product **10.** The first coating **14** is shown as a separate layer in **FIG. 1** but will also become impregnated into the fibrous web **12** as explained above. As will be described in greater detail below, the first coating **14** can be made from a bio-based oil or wax. In one particular aspect, for instance, the first coating **14** is formed from a coconut-based wax, a soy-based wax, a rice-based wax, and/or a palm-based wax.

[0047] In the embodiment shown in **FIG. 1**, the second or heat-sealable coating **16,** on the other hand, is applied over the first coating **14**. The heat-sealable coating **16** further improves the barrier properties of the overall product. The heat-sealable coating **16** is also heat-sealable and therefore can be used to bond the coated paper to an adjacent coated paper for producing packages or other items where a hollow enclosure is desired.

[0048] The heat-sealable coating **16** can contain, for instance, a plant or animal derived wax alone or in combination with other components, such as a polymer. The polymer combined with the plant or animal derived wax, for instance, can be a polyester polymer, a protein such as casein, a polysaccharide, a polysaccharide ester, a polysaccharide ether, a polysaccharide ether ester, or combinations thereof.

[0049] In one embodiment, which is the subject of claim 2, the transparency agent coating **14** and the heat-sealable coating **16** can be applied to one side of the cellulose layer or to different sides of the cellulose layer. In another embodiment, which is the subject of claim 1, the composition used to form the first coating can be combined with the composition used to form the second coating and applied to the web as a single coating that lowers opacity and provides heat seal properties.

[0050] As shown in **FIG. 1**, the low opacity paper **10** can be made exclusively from a single layer of a fibrous web in combination with the first coating **14** and the second coating **16** (or a single coating that combines the first coating components with the second coating components).

[0051] The coated paper **10** defines an exterior surface **18** as shown in **FIG. 1** that is a heat-sealable surface. The surface **18**, for instance, can be formulated to not be sticky at room temperature. The surface **18** or heat-sealable coating **16** can produce a heat seal at a temperature of greater than about 100°C, such as greater than about 110°C, such as greater than about 120°C, such as greater than about 130°C, such as greater than about 140°C, such as greater than about 150°C, such as greater than about 160°C, such as greater than about 170°C, such as greater than about 180°C, and less than about 250°C, such as less than about 230°C, such as less than about 220°C, such as less than about 210°C, such as less than about 200°C, such as less than about 190°C, such as less than about 180°C. Of particular advantage, the coating displays excellent heat-sealability even at relatively low basis weights.

[0052] The coated paper **10** as shown in **FIG.** 1 can be used to form various different packages using different techniques and processes.

[0053] As described above, in one embodiment, the fibrous web **12** can be a wetlaid paper web formed from cellulose fibers. For example, the fibrous web can be formed from an aqueous suspension of fibers. The cellulose fibers contained in the fibrous web can be pulp fibers including wood pulp fibers, plant waste fibers, or other plant fibers. In forming the fibrous web, the aqueous suspension of fibers can be deposited onto a porous forming surface that allows water to drain thereby forming the fibrous web. As the web is formed and dried, the paper can be calendered.

[0054] In one aspect, the fibrous web is made primarily from plant derived or natural fibers. Natural (plant derived) fibers may be selected from chemical pulp, such as sulphate and sulphite pulp, organosolv pulp, recycled fibers, and/or mechanical pulp including e.g. refiner mechanical pulp (RMP), pressurized refiner mechanical pulp (PRMP), pretreatment refiner chemical alkaline peroxide mechanical pulp (P-RC APMP), thermomechanical pulp (TMP), thermomechanical chemical pulp (TMCP), high-temperature TMP (HT-TMP) RTS-TMP, alkaline peroxide pulp (APP), alkaline peroxide mechanical pulp (APMP), alkaline peroxide thermomechanical pulp (APTMP), Thermopulp, groundwood pulp (GW), stone groundwood pulp (SGW), pressure groundwood pulp (PGW), super pressure groundwood pulp (PGW-S), thermo groundwood pulp (TGW), thermo stone groundwood pulp (TSGW), chemimechanical pulp (CMP), chemirefinermechan-

ical pulp (CRMP), chemithermomechanical pulp (CTMP), high-temperature CTMP (HT-CTMP), sulphite-modified thermomechanical pulp (SMTMP), reject CTMP (CTMPR), groundwood CTMP (G- CTMP), semichemical pulp (SC), neutral sulphite semi chemical pulp (NSSC), high-yield sulphite pulp (HYS), biomechanical pulp (BRMP), pulps produced according to the OPCO process, explosion pulping process, Bi-Vis process, dilution water sulfonation process (DWS), sulfonated long fibres process (SLF), chemically treated long fibres process (CTLF), long fibre CMP process (LFCMP), Kraft wood pulp, mdf-fibers, nanocellulose, and modifications and combinations thereof. The pulp may be a bleached or non-bleached pulp. The pulp may originate from hardwood or softwood, including birch, beech, aspen such as European aspen, alder, eucalyptus, maple, acacia, mixed tropical hardwood, pine such as loblolly pine, fir, hemlock, larch, spruce such as Black spruce or Norway spruce, and mixtures thereof.

[0055] Non-wood plant fibers can also be used, such as seed hair fibers, leaf fibers, and bast fibers. Plant fibers can be provided from e.g. straws of grain crops, wheat straw, reed canary grass, reeds, flax, hemp, kenaf, jute, ramie, seed, sisal, abaca, coir, bamboo, bagasse, cotton kapok, milkweed, pineapple, cotton, rice, reed, esparto grass, Phalaris arundinacea, or combinations thereof.

[0056] The fibrous web can be primarily formed from the cellulose fibers without being combined with other components, such as fillers. For instance, the fibrous web (prior to coating) can contain cellulose fibers in an amount greater than about 90% by weight, such as in an amount greater than about 95% by weight. Particular cellulose fibers well suited to producing the fibrous web include softwood fibers, hardwood fibers, birch fibers, hemp fibers, or mixtures thereof. For example, in one embodiment, the fibrous web can be made exclusively from softwood fibers alone or in combination with hardwood fibers. Alternatively, the fibrous web can be made from a blend of wood pulp fibers, such as softwood fibers, with bast fibers, such as hemp fibers. The cellulose fibers can be selected, for instance, in order to produce a web that can be efficiently drained from aqueous fluids during formation and that can produce a relatively low opacity paper at lower basis weights while still retaining mechanical properties needed for processing and handling.

[0057] Once a suitable fiber furnish is selected for producing the fibrous web, in one aspect, the fibers used to form the web can optionally be fed through a refining process in order to increase freeness as measured by the Schopper Riegler Method for drainability (ISO 5267-1:2000). As used herein, refining the cellulose fibers is different than producing pulp fibers. In pulping, the lignin is removed from the cellulose fibers. During refining, on the other hand, the nap of individual fibrils making up the outer surface or wall of the fiber is raised which is sometimes referred to as defibrillation. Refining is the mechanical and/or chemical action which causes defibrillation.

[0058] In one aspect, in preparing the fibers for producing the fibrous web, the fibers can first go through a suitable pretreatment, such as washing, and can also be chopped especially if using bast fibers. In addition, the fibers can be fed through a hammermill or subjected to various different chemical treatments.

[0059] The cellulose fibers can be mixed with an aqueous solution or solvent which can occur in a refiner, such as a twin screw machine. If desired, wetting agents, acids, or alkalis can also be added in order to soften the cellulose fibers. In addition, one or more alcohols can also be added to the fibers including methyl alcohol, ethyl alcohol, or mixtures thereof.

[0060] The aqueous suspension can be fed to or formed in a refiner and subjected to a mechanical refining action. The consistency of the fibers in the refiner can be from about 1% to about 30% solids content. In the refiner, such as a twin screw refiner, the pulp suspension is subjected to mechanical action that produces the formation of greater fibrils within each fiber.

[0061] It should be understood that any suitable refining device may be used in order to increase the freeness value of the fibers and that a twin screw refiner merely represents one instrument, process or technique that may be used.

[0062] After exiting one or more refiners, in accordance with the present disclosure, the cellulose fibers have a freeness value of greater than about 60° SR, such as greater than about 65° SR, such as greater than about 70° SR. In one aspect, the cellulose fibers have been refined to greater than about 73° SR, such as greater than about 75° SR, such as greater than about 78° SR, such as greater than about 80° SR, such as greater than about 82° SR. The freeness value of the fibers is less than about 95° SR, such as less than about 90° SR, such as less than about 85° SR, such as less than about 80° SR. It was discovered that refining the fibers to the extent described above not only can improve drainage of the web during production but can also lower the opacity characteristics of the paper. Refining the cellulose fibers can also allow for a reduction in the thickness of the sheet while still providing good mechanical properties. Reduction in thickness for a given basis weight, for instance, has been found to unexpectedly improve transparency while still maintaining an excellent balance of mechanical properties. Adjusting the level of refining of the cellulose fibers can also allow for adjustments to the barrier properties of the low opacity paper. For instance, refining of the fibers can be used to adjust air permeability and to develop air barrier properties, water barrier properties, oil barrier properties, or the like.

[0063] Once the cellulose fibers have been refined, the fibers are formed into a web. In one aspect, the basis weight of the web is relatively low. For instance, the basis weight of the fibrous web can be less than about 38 g/m^2, such as less than about 36 g/m^2, such as less than about 34 g/m^2, such as less than about 32 g/m^2, such as less than about 30 g/m^2, such as less than about 28 g/m^2, such as less than about 25 g/m^2, such as less than about 23 g/m^2. The basis weight is generally greater than about 10 g/m^2, such as greater than about 12 g/m^2. In one particular aspect, the basis

weight of the fibrous web is from about 10 g/m^2 to about 24 g/m^2, preferably from about 10 g/m^2 to about 18 g/m^2 including all increments of 1 g/m^2 therebetween.

[0064] In accordance with the present disclosure, two coating compositions or a combined coating composition are applied to the fibrous web. The first coating is applied to the fibrous web in order to lower the opacity of the final product. The second coating, on the other hand, can be a heat-sealable coating for providing the paper product with heat-sealable characteristics. In addition, both coatings can synergistically function together to provide excellent barrier properties. The paper product can have excellent aesthetic and functional qualities that makes the product well suited for packaging applications. In one aspect, the first coating can form a layer on one side of the fibrous web, which will also imply impregnation into the web. The second coating can form a surface layer underlying first coating.

[0065] In accordance with the present disclosure, the first coating comprises a transparency agent. The transparency agent can comprise a bio-based wax or oil. The bio-based wax or oil, for instance, can be derived from animal or plant biomass. In one aspect, the transparency agent can be a bio-based wax derived from at least 80% by weight vegetable oils, such as at least about 90% by weight vegetable oils, such as up to 100% by weight vegetable oils. The bio-based wax can be paraffin-free and can be free of mineral oil saturated hydrocarbons and mineral oil aromatic hydrocarbons. Of particular advantage, the transparency agent can meet all government requirements for food contact and food handling. The coating compositions can meet all of the requirements of FDA 21 CFR § 176.180 which is directed to components of paper and paperboard that are in contact with dry food. Similarly, the transparency agent and the low opacity paper can also meet all of the requirements of European Commission Regulation No. 1935/2004 regarding materials and articles intended to come in contact with food.

[0066] The bio-based wax, in one embodiment, can have a melting point of from about 25°C to about 75°C, including all increments of 1°C therebetween. The melting point of the bio-based wax can be less than about 70°C, such as less than about 65°C, such as less than about 60°C, such as less than about 55°C, such as less than about 50°C, such as less than about 45°C, such as less than about 40°C. The melting point of the bio-based wax can be greater than about 25°C, such as greater than about 30°C, such as greater than about 35°C, such as greater than about 40°C, such as greater than about 45°C, such as greater than about 50°C. A bio-based wax can be selected having a particular melting point that is well suited for a particular application.

[0067] In one particular embodiment, the transparency agent comprises a bio-based wax that is a coconut-based wax, a rice-based wax, a palm-based wax, a soy-based wax or mixtures thereof.

[0068] In one aspect, for instance, the transparency agent is a coconut-based wax or oil. The coconut-based wax can have a melting point of from about 25 degrees C to about 45 degrees C, such as from about 30 degrees C to about 40 degrees C. The coconut-based wax can be applied to the fibrous web as an anionic, aqueous dispersion.

[0069] In another aspect, the transparency agent can be a palm-based wax or oil. The palm-based wax can have a melting point of from about 50 degrees C to about 70 degrees C, such as from about 55 degrees C to about 65 degrees C. The palm-based wax can be applied to the fibrous web as an anionic, aqueous dispersion.

[0070] Alternatively, the transparency agent can be a soy-based wax that may be applied to the fibrous web as an aqueous cationic emulsion having a melting point of from about 55 degrees C to about 80 degrees C, such as from about 63 degrees C to about 72 degrees C.

[0071] In one aspect, the bio-based wax can be water dispersible or water miscible. Thus, the transparency agent can be incorporated into an aqueous composition for application to the fibrous web in producing the low opacity paper.

[0072] The amount of the transparency agent incorporated into the product can depend on various factors. The basis weight (dry) of the transparency agent coating can be from about 0.5 g/m^2 to about 18 g/m^2, including all increments of 0.5 g/m^2 therebetween. For instance, the transparency agent coating can have a basis weight of greater than about 2 g/m^2, such as greater than about 4 g/m^2, such as greater than about 5 g/m^2, such as greater than about 6 g/m^2, such as greater than about 7 g/m^2, such as greater than about 8 g/m^2. The basis weight of the transparency agent coating can be less than about 20 g/m^2, such as less than about 15 g/m^2, such as less than about 12 g/m^2, such as less than about 10 g/m^2, such as less than about 8 g/m^2.

[0073] In one aspect, the transparency agent can be present in the paper product in an amount greater than about 2% by weight, such as in an amount greater than about 3% by weight, such as in an amount greater than about 4% by weight, such as in an amount greater than about 5% by weight, such as in an amount greater than about 10% by weight, such as in an amount greater than about 13% by weight. The transparency agent is present in the paper product generally in an amount less than about 35% by weight, such as in an amount less than about 25% by weight, such as in an amount less than about 20% by weight, such as in an amount less than about 15% by weight, such as in an amount less than about 10% by weight, such as in an amount less than about 8% by weight, such as in an amount less than about 6% by weight.

[0074] The transparency agent can improve various properties and characteristics of the coated paper. For instance, the transparency agent can increase the transparency and/or decrease the opacity of the final product. The transparency agent can also reduce the permeability of the low opacity paper and increase the barrier properties of the paper.

[0075] As described above, the first coating applied to the fibrous web can be covered with a second or heat-sealable

coating or can be combined with a heat-sealable coating composition. The heat-sealable coating can be applied directly to the transparency agent coating and can be applied to the coated paper without any type of adhesive or tie layer between the transparency agent coating and the heat-sealable coating. In fact, the coated paper of the present disclosure can be made without any adhesive layers between any of the coatings or between the fibrous web and the coating.

[0076] Alternatively, the first coating containing the transparency agent can be combined with the heat sealable coating composition and applied to the web as a single coating.

[0077] In another aspect, the heat-sealable (second) coating can be applied to the fibrous web on a side that is the opposite side to the side coated with the first coating containing the transparency agent, so as to provide a first coating on the first surface and a second coating on the second surface of the fibrous web.

[0078] The heat-sealable coating can contain a polymer and various other components. The polymer can be a polymer selected from the group consisting of proteins, polysaccharides, polysaccharide ethers, polysaccharide esters and polysaccharide ether esters. The above polymers can completely replace petroleum-derived heat-sealable polymers used in the past. The polymers above, for instance, can be produced from biomass. Thus, the polymers can be sustainable and environmentally friendly, just like the plant or animal derived wax or oil and exhibit excellent heat-sealable properties.

[0079] The polymer is preferably a protein and/or thermoplastic polymer that improves the heat-sealability.

[0080] The polymer can be a thermoplastic polymer with a melting point in the range of 60 to 200°C, more preferably 100 to 180°C, and most preferably 110 to 180°C. When the heat-sealable coating of the coated paper (paper product) of the present disclosure comprises a thermoplastic polymer having a melting point in the range of 60 to 200°C, the heat-sealability of the coated paper is improved.

[0081] In addition, the polymer is preferably a biomass-based polymer, so that the coated paper is more sustainable and environmentally friendly.

[0082] For example, the polymer can be a polyester polymer that may be selected from the group consisting of polyhydroxyalkanoate, polylactic acid, polyglycolic acid, polybutylene succinate, polycaprolactone, polybutylene adipate terephthalate, and polylactic acid-polyethylene glycol.

[0083] Polyhydroxyalkanoates (PHAs) are polyesters of hydroxyalkanoic acids. Polyhydroxyalkanoates (PHAs) are thermoplastic. They may be homopolyesters or copolyesters and differ in their properties according to their chemical composition, namely the contained hydroxyalkanoic acid(s).

[0084] The PHA may be one or more polyesters selected from the group consisting of poly(3-hydroxypropionate), poly(3-hydroxybutyrate), poly(4-hydroxybutyrate), poly(3-hydroxyvalerate), poly(3-hydroxyhexanoate), poly(3-hydroxyheptanoate), poly(3-hydroxyoctanoate), poly(3-hydroxynonanoate), poly(3-hydroxydecanoate), poly(3-hydroxyundecanoate), poly(3-hydroxydodecanoate), poly(3-hydroxytetradecanoate), poly(3-hydroxypentadecanoate),and poly(3-hydroxyhexadecanoate). The PHA may also be one or more copolyester obtained from copolymerization of two or more hydroxyalkanoic acids. More particularly, the PHA copolyester may be one or more selected from the group consisting of poly(3-hydroxypropionate-co-3-hydroxybutyrate), poly(3-hydroxypropionate-co-4-hydroxybutyrate), poly(3-hydroxybutyrate-co-4-hydroxybutyrate), poly(3-hydroxybutyrate-co-3-hydroxyvalerate), poly(3-hydroxybutyrate-3-hydroxyhexanoate), and poly(3-hydroxybutyrate-co-3-hydroxyvalerate-co-3-hydroxyhexanoate).

[0085] The PHA is preferably one or more polyesters selected from the group consisting of poly(3-hydroxypropionate), poly(3-hydroxybutyrate), poly(4-hydroxybutyrate), poly(3-hydroxyvalerate), poly(3-hydroxybutyrate-co-4-hydroxybutyrate), poly(3-hydroxybutyrate-3-hydroxyhexanoate), and poly(3-hydroxybutyrate-co-3-hydroxyvalerate). The PHA is most preferably poly(3-hydroxybutyrate).

[0086] The polybutylene adipate terephthalate is preferably a block copolymer. The polylactic acid-polyethylene glycol is preferably a block copolymer.

[0087] The polysaccharide may be one or more polymers selected from the group consisting of starch, cellulose, arabinoxylan, chitin, and pectin. The polysaccharide is preferably starch or cellulose, such as a cellulose derivative.

[0088] A plasticizer may be added to the polysaccharide in order to improve the thermoplastic properties of the polysaccharide. Thus, a thermoplastic polysaccharide comprising a polysaccharide and a plasticizer is obtained.

[0089] The plasticizer may be one or more compound(s) selected from the group consisting of polyhydric alcohols, diols, esters of polyhydric alcohols and aliphatic esters of mono-, di- or polycarboxylic acids. The plasticizer is preferably a polyhydric alcohol or a diol and most preferably one or more compound(s) selected from glycerol, glycol, and sorbitol. The glycerin may be vegetable glycerin (VG). Vegetable glycerin is glycerin obtained from plant oils such as soybean oil, coconut oil or palm oil.

[0090] The thermoplastic polysaccharide preferably comprises at least one of starch and cellulose. In other words, the thermoplastic polysaccharide is preferably thermoplastic starch, thermoplastic cellulose or a combination thereof, and more preferably thermoplastic starch. The thermoplastic starch preferably comprises one or more plasticizer selected from the group consisting of glycerol, glycol, and sorbitol.

[0091] In one aspect, the thermoplastic polysaccharide is derived from agricultural waste from corn.

[0092] The polymer used in the present disclosure may also be a polysaccharide ether, a polysaccharide ester or a polysaccharide ether ester.

[0093] The polysaccharide ether is preferably a cellulose ether. The polysaccharide ether is more preferably carboxymethyl cellulose, methyl cellulose, ethyl cellulose, hydroxyethyl cellulose, hydroxypropyl cellulose, ethyl methyl cellulose, and hydroxypropyl methyl cellulose. The polysaccharide ether is most preferably carboxymethyl cellulose, methyl cellulose, and hydroxyethyl cellulose.

[0094] The polysaccharide ester may be a cellulose ester such as cellulose acetate.

[0095] The polysaccharide ether ester may be a cellulose ether ester such as hydroxypropyl methyl cellulose acetate succinate and carboxymethyl cellulose acetate butyrate.

[0096] The polymer is most preferably one or more selected from the group consisting of poly(3-hydroxybutyrate), poly(4-hydroxybutyrate), polylactic acid, polylactic acid-polyethylene glycol block copolymer, polybutylene adipate terephthalate and thermoplastic starch.

[0097] The polymer can also be a protein, especially plant sourced proteins. Such proteins include soybean protein isolate, whey protein isolate, or casein.

[0098] The heat-sealable coating used in the present disclosure may comprise one or more additives. Each additive can be present in the coating in an amount of from about 0.01% by weight to about 7% by weight, such as from about 0.1% by weight to about 3% by weight. The additive may be at least one compound selected from the group consisting of a rheology modifier and a softener.

[0099] The rheology modifier can be one or more compounds selected from the group consisting of cellulose, starch or a derivative thereof. For example, the rheology modifier can be a microcrystalline cellulose and/or a nanocellulose. The rheology modifier is preferably water-soluble or water-dispersible. The rheology modifier is more preferably biomass-based and/or biodegradable. The rheology modifier allows to thicken the emulsion and to improve emulsion stability. Thus, dripping during application of the coating can be avoided.

[0100] The heat-sealable coating of the present disclosure may also contain a softener. The softener may be one or more compound(s) selected from the group consisting of polyhydric alcohols, diols, esters of polyhydric alcohols and aliphatic esters of mono-, di- or polycarboxylic acids. The softener is preferably a polyhydric alcohol or a diol and most preferably one or more compound(s) selected from bio-based glycerin or glycerol, glycol, and sorbitol.

[0101] In one exemplary embodiment, the coating comprises up to 90 wt.-% of the polymer, 0 to 3 wt.-% of rheology modifier, and 0 to 7 wt.-% of softener based on the total weight of the coating.

[0102] The heat-sealable coating used in the present invention can be mixed with the transparency agent in ratio of from about 10 to 90 wt.-% of the wax and about 10 to 90 wt.-% of the polymer and may more preferably comprise 10 to 40 wt.-% of the wax and 60 to 90 wt.-% of the polymer, based on the total weight of the coating mixture. In addition, a paper coated with a coating comprising 10 to 90 wt.-% of the wax and 10 to 90 wt.-% of the polymer, based on the total weight of the coating, combines a paper-like look and feel with a workability and heat-sealability comparable to a plastic film. The heat-sealability of the coated paper can be improved when the coating comprises 10 to 40 wt.-% of the wax and 60 to 90 wt.-% of the polymer, based on the total weight of the coating. In addition, a coated paper with a coating comprises 10 to 40 wt.-% of the wax and 60 to 90 wt.-% of the polymer, based on the total weight of the coating, exhibits improved water-vapor barrier properties. In a particularly preferable embodiment, the coating comprises 20 to 40 wt.-% of the wax and 60 to 80 wt.-% of the polymer, based on the total weight of the coating. In such coating, the best compromise between water vapor barrier properties and heat-sealability is achieved.

[0103] The basis weight of the heat-sealable coating can vary depending upon the particular application and the end use of the coated paper. In general, the basis weight of the heat-sealable coating can be from about 1 g/m^2 to about 20 g/m^2, including all increments of 1 g/m^2 therebetween. For instance, the heat-sealable coating can have a basis weight of greater than about 1 g/m^2, such as greater than about 3 g/m^2. The basis weight of the heat-sealable coating can be less than about 20g/m^2, such as less than about 18 g/m^2, such as less than about 15 g/m^2, such as less than about 13 g/m^2, such as less than about 10 g/m^2, such as less than about 8 g/m^2.

[0104] If the transparent agent coating composition is combined with the heat sealable coating composition and applied as a single coating, the basis weight of the resulting coating can be from about 3 g/m^2 to about 35 g/m^2, including all increments of 1 g/m^2 therebetween. For instance, the combined coating can have a basis weight of greater than about 5 g/m^2, such as greater than about 8 g/m^2. The basis weight of the combined coating can be less than about 30 g/m^2, such as less than about 25 g/m^2, such as less than about 20 g/m^2, such as less than about 18 g/m^2, such as less than about 15 g/m^2.

[0105] The coating compositions can be applied to the fibrous web using any suitable method or technique. For example, in one embodiment, an aqueous composition containing the transparency agent can be applied to the fibrous web using a size press either at the wet end of the papermaking machine or after the web has been dried. Alternatively, however, the fibrous web can be formed and then later coated with a composition containing the transparency agent. Coating can be performed using any suitable method including air knife coating, roll-to-roll coating, blade coating, spray coating, Mayer rod coating, direct gravure printing, offset gravure printing, reverse gravure printing, smooth roll coating, curtain coating, bead coating, slot coating, fill press coating, and the like.

[0106] The heat-sealable coating can be formed by applying a coating composition over the transparency agent coating

by spraying, brushing, or rolling. Upon application to the surface, the surface coating composition undergoes film formation.

[0107] The heat-sealable coating may be formed by coalescence-based film formation. Coalescence-based film formation takes place with polymer particles dispersed in a liquid phase, preferably with latex polymers, and most preferably with water-dispersed polymers selected from the group consisting of polyester, polysaccharide, polysaccharide ester, polysaccharide ether and polysaccharide ether ester in combination with a plant or animal derived wax.

[0108] The heat-sealable coating composition can be an aqueous dispersion or emulsion comprising the wax and/or polymer. The wax is preferably a wax as defined in the first aspect of the present invention. In other words, the wax is preferably a plant wax or an animal wax and is more preferably a plant wax. The wax comprised in the heat-sealable coating compositions is most preferably one or more selected from the group consisting of coconut wax, soy wax, palm wax, rice bran wax, and mixtures thereof. The wax has preferably a dropping point in the range of 60°C to 120°C.

[0109] After application of the first and second coating compositions, the coatings are dried to form a coated paper. In one aspect, the first coating composition can be applied and dried followed by application of the second coating composition followed by drying. Alternatively, the first and second coating compositions can be combined together and then applied to the fibrous web followed by drying.

[0110] Drying may be carried out by blowing hot dry air onto the coating, thus raising the coating temperature to a point where water is evaporated from the coated paper, leaving a relatively dry coated paper. In the drying process, the web temperature, i.e. the temperature of the fibrous web, must be lower than the dropping point of the wax. Thus, the web temperature during drying is preferably less than 120°C. The web temperature of the paper can be determined by means of non-contact temperature measurement using an infrared, non-contact thermometer.

[0111] The coated fibrous web can be calendered without being supercalendered. In one aspect, a plain filigree press may be used for a glazing effect on the surface of the product. The calender rolls, for instance, can include a hard roll opposite a soft roll. The pressure applied to the coated paper can be greater than about 200 kPa (2 bar), such as greater than about 400 kPa (4 bar), such as greater than about 500 kPa (5 bar), and generally less than about 1200 kPa (12 bar), such as less than about 1000 KPa (10 bar), such as less than about 800 kPa (8 bar), such as less than about 700 kPa (7 bar). Calendering can occur at ambient temperature or, alternatively, one or both of the calender rolls can be heated.

[0112] In one aspect, the transparency agent can be applied to the fibrous web and the fibrous web can be calendered. After being calendered, the heat-sealable coating can be applied to the web. Alternatively, the coated fibrous web can be calendered after both coatings have been applied to the web, i.e. after the heat-sealable coating has been applied and formed on the web. In still another embodiment, the coated fibrous web can be calendered multiple times. For instance, in one aspect, the transparency agent can be applied to the fibrous web and the fibrous web can undergo a first calendering process. Next, the heat-sealable coating can be applied and formed on the fibrous web and the coated web can be calendered again.

[0113] In addition to having a relatively low opacity, the coated paper of the present disclosure can have a relatively low thickness. For example, the thickness of the paper can be less than about 80 μm, such as less than about 70 μm, such as less than about 60 μm. The paper generally has a thickness of greater than about 20 μm, such as greater than about 25 μm, such as greater than about 30 μm.

[0114] Low opacity papers made according to the present disclosure not only display low opacity and heat sealability but also display a beneficial blend of other properties. For instance, the low opacity paper can have a Gurley air permeability of less than about 45,200 seconds, such as less than about 20,000 seconds, such as less than about 10,000 seconds, such as less than about 1000 seconds, and generally greater than about 600 seconds.

[0115] The low opacity and heat-sealable paper can also have a water drop resistance greater than 10 min according to TAPPI T 432 cm-09 (2μL of water volume is used in test). The paper product can have a water vapor barrier at 23°C and 50%HR less than 80 g/m^2/day, such as less than 50 g/m^2/day according to ASTM E96/E96M - 15:2014. The low opacity and heat-sealable paper of the present disclosure has numerous uses and applications. For instance, the low opacity and heat-sealable paper can be used as a packaging material. The low opacity and heat-sealable paper, for instance, can be made to be flexible or semirigid making the product well suited for constructing packages.

[0116] In addition to being directed to a low opacity and heat-sealable paper and to products made from the paper, the present disclosure is also directed to a method for producing a low opacity and heat-sealable paper. The method includes forming a fibrous web from a fiber furnish. The fibrous web, for instance, can be a wetlaid web. The fibrous web is then coated with an aqueous composition containing the transparency agent as described above. Any suitable technique can be used to coat the fibrous web. For instance, in one aspect, the fibrous web can be coated using a size press.

[0117] The coating applied to the fibrous web can be dried and then optionally calendered. Next, a second coating can be applied to the fibrous web containing heat-sealable components. The coating can be dried to form the heat-sealable coating and the coated and dried web can optionally be calendered.

[0118] In another aspect, the heat-sealable composition or components can be combined with the transparency agent composition or components and the resulting heat-sealable and transparency composition can be applied to the web to form a single coating that reduces opacity and is heat sealable. The coating can be dried and then optionally calendered.

[0119] According to an embodiment of the present invention the paper product comprises:

i) a paper base sheet which is a fibrous web comprising cellulose fibers, wherein the fibers are refined softwood fibers and the basis weight of the fibrous web is 10 g/m^2 or more and less than 25 g/m^2 and preferably in the range of 10 g/m^2 to 24 g/m^2; and
ii) a coating comprising a transparency agent composition comprising a soy-based wax, and a heat sealable coating composition comprising a polysaccharide; wherein the opacity of the paper product is less than 35%.

[0120] According to an embodiment of the present invention the paper product comprises:

i) a paper base sheet which is a fibrous web comprising cellulose fibers, wherein the fibers are refined softwood fibers and the basis weight of the fibrous web is 10 g/m^2 or more and less than 25 g/m^2 and preferably in the range of 10 g/m^2 to 24 g/m^2; and
ii) a first coating layer of a transparency agent composition comprising a coconut-based wax; and
iii) a second coating layer of a heat-sealable coating composition containing/comprising a casein protein;

wherein the opacity of the paper product is less than 35%, preferably less than 20%.

[0121] The present disclosure may be better understood with reference to the following examples.

Examples

[0122] Low opacity and heat-sealable papers were made in accordance with the present disclosure and tested for various properties. Three different samples were produced.

[0123] Each sample included a fibrous web, also called or base web. The basis weight of the fibrous web in Sample No. 1 was 14 g/m^2 and it had a Schopper-Riegler freeness value of 86° SR. The basis weight of the fibrous web in Sample No. 2 and No. 3 was 22 g/m^2 and it had a Schopper-Riegler freeness value of 82° SR. Each fibrous web was made from pulp fibers, particularly refined softwood fibers.

[0124] Sample No. 1 and Sample No. 2 were coated with a mix of a transparency agent composition comprising a soy-based wax and a heat-sealable coating composition that contained a polysaccharide derived from agricultural corn waste. In Sample Nos. 1 and 2, the heat-sealable and transparency agent coating had a basis weight of 11 g/m^2.

[0125] Sample No. 3 was first coated with transparency agent composition comprising a coconut-based wax and secondly with a heat-sealable coating composition that contained a casein protein, having a sealing temperature between 130 and 220°C. The coating weight of the two layers was 11 g/m^2.

[0126] The coated paper samples were then tested for various properties and the following results were obtained. For each property, the coated paper was tested twice and the results were averaged. The heat-sealability was tested at 160°C by use a heat-sealed laminator, such as YOSAN LM-260. All coated papers have heat-sealable properties.

Property	Test	Fibrous web	Sample No. 1	Fibrous web	Sample No. 2	Sample No. 3
Heat-sealable and wax coating weight [g/m^2]		-	11	-	12	11
Coated paper grammage [g/m^2]		-	25	-	35	34
Thickness 100kPa [μm]	EN ISO 534:201 1	27	38	38	50	41
Gurley permeability [seconds/ 100 ml]	ISO Test 5636:20 03	128	922	987	45200	45200
Tensile MD [cN/30mm]	DIN EN ISO 1924-2:2008	2974	3153	5801	6356	4857
Elongation MD [%]	DIN EN ISO 1924-2:2008	0.8	1.5	1.1	1.9	1.68
Opacity [%]	EN ISO 2471:20 08	21	23	31	32	18
Water vapor transfer rate 23°C 50%HR [g/m^2/day]	ASTM E96/E96 M-15:2014	300	13	295	10	16

(continued)

Property	Test	Fibrous web	Sample No. 1	Fibrous web	Sample No. 2	Sample No. 3
Water drop resistance [min]	TAPPI T 432 cm-09	0.8	>5	0.8	>5	>5

[0127] As shown above, the coated paper samples had very low opacity characteristics while also including excellent mechanical strength properties and barrier properties. The described samples displayed sealable properties at 150°C.

[0128] These and other modifications and variations to the present invention may be practiced by those of ordinary skill in the art. Embodiments of the invention are set forth in the appended claims. In addition, it should be understood that aspects of the various embodiments may be interchanged both in whole or in part.

Claims

1. A paper product comprising:

a fibrous web comprising cellulose fibers, wherein the cellulose fibers have a Schopper-Riegler freeness value in the range of 60° SR to 95° SR as measured according to ISO 5267-1:2000, the fibrous web having a basis weight of less than 38 g/m^2 and defining a first surface and a second surface; and
a coating on the first surface and/or the second surface of the fibrous web, preferably on one of the first surface and the second surface, wherein the coating comprises
a transparency agent, the transparency agent comprising a bio-based wax or oil, and
a heat-sealable composition, the heat-sealable composition comprising a polymer comprising a polyester, a protein, a polysaccharide, a polysaccharide ester, a polysaccharide ether, or a polysaccharide ether ester;
wherein the coating defines an exterior surface (18) of the paper product; and
wherein the paper product displays an opacity of less than about 45%.

2. A paper product comprising:

a fibrous web comprising cellulose fibers, wherein the cellulose fibers have a Schopper-Riegler freeness value in the range of 60° SR to 95° SR as measured according to ISO 5267-1:2000, the fibrous web having a basis weight of less than 38 g/m^2 and defining a first surface and a second surface; and
a first coating comprising a transparency agent, the transparency agent comprising a bio-based wax or oil, and
a second coating comprising a heat-sealable composition, the heat-sealable composition comprising a polymer comprising a polyester, a protein, a polysaccharide, a polysaccharide ester, a polysaccharide ether, or a polysaccharide ether ester;
wherein the paper product displays an opacity of less than about 45%; and
wherein one of the following features (i) or (ii) is satisfied:

(i) the first coating and the second coating are provided in sequence on the same surface, namely, on the first surface and/or on the second surface of the fibrous web;
(ii) the first coating is provided on the first surface and the second coating is provided on the second surface of the fibrous web.

3. A paper product as defined in claim 2, wherein the first coating is provided on the first surface and the second coating is provided on the second surface of the fibrous web.

4. A paper product as defined in any of the preceding claims, wherein the cellulose fibers have a Schopper-Riegler freeness value in the range of 70° SR to 90° SR.

5. A paper product as defined in any of the preceding claims, wherein the fibrous web has a basis weight of less than 24 g/m^2, preferably less than 22 g/m2, more preferably less than 20 g/m^2, and greater than 10 g/m^2.

6. A paper product as defined in any of the preceding claims, wherein the paper product has been calendered, but not supercalendered.

7. A paper product as defined in any of the preceding claims, wherein the bio-based wax or oil is a plant-based wax or oil, which preferably has a melting point of from 25°C to 75°C.

8. A paper product as defined in any of the preceding claims, wherein the bio-based wax or oil is a coconut-based wax, a palm-based wax, a soy-based wax, a rice-based wax, or mixtures thereof.

9. A paper product as defined in any of the preceding claims, wherein the paper product has an opacity of less than 42%, preferably less than 32%.

10. A paper product as defined in any of the preceding claims, wherein the polymer contained in the heat sealable composition comprises a thermoplastic starch.

11. A paper product as defined in any of the preceding claims, wherein the polymer contained in the heat sealable composition comprises a protein, preferably a whey protein, a soy protein, casein, or mixtures thereof.

12. A paper product as defined in any of the preceding claims, wherein the basis weight of the coating containing the heat-sealable composition is from about 1 g/m^2 to about 35 g/m^2, preferably from about 3 g/m^2 to about 25 g/m^2, and more preferably from about 4 g/m^2 to about 20 g/m^2.

13. A paper product as defined in any of the preceding claims, wherein the paper product is free of paraffins, mineral oil, or hydrocarbon oils.

14. A paper product as defined in any of the preceding claims, wherein the fibrous web comprises wood pulp fibers alone or in combination with bast fibers.

15. A paper product as defined in any of the preceding claims, wherein the paper product has a thickness of less than 80 μm, preferably less than 70 μm, more preferably less than 60 μm, and greater than 30 μm.

16. A paper product as defined in any of the preceding claims, wherein the transparency agent is present in the paper product in an amount greater than 2% by weight, preferably in an amount greater than 4% by weight, more preferably in an amount greater than 6% by weight, even more preferably in an amount greater than 8% by weight, and in an amount less than 25% by weight, preferably in an amount less than 20% by weight, more preferably in an amount less than 15% by weight.

17. A paper product as defined in any of the preceding claims, wherein the paper product has an air permeability of less than 45,200 seconds, preferably less than 20,000 seconds, more preferably less than 10,000 seconds, even more preferably less than 1000 seconds, and greater than 600 seconds according to ISO 5636-5:2003.

18. A paper product as defined in any of the preceding claims, wherein the paper product has a water vapor transmission rate at 23°C and 50%HR of less than 80 g/m^2/day, preferably less than 50 g/m^2/day according to ASTM E96/E96M - 15:2014.

19. A paper product as defined in any of the preceding claims, wherein the paper product is a packaging material.

20. A use of a paper product as defined in any of the preceding claims, as a packaging paper for food, cosmetics or pharmaceuticals, or as a packaging of cigarette packs, cigarette cartons, cigars packages, Heat-non-Burn packs and Heat-non-Burn cartons.

21. A method for producing the paper product as defined in claim 1, comprising:

    coating the fibrous web with a mixture of the transparency agent and the heat sealable composition; and optionally calendering the coated fibrous web.

22. A method for producing the paper product as defined in claim 2, comprising:

    coating the fibrous web with an aqueous composition containing the transparency agent; and then coating the fibrous web with the heat-sealable composition; and
    optionally calendering the coated fibrous web.

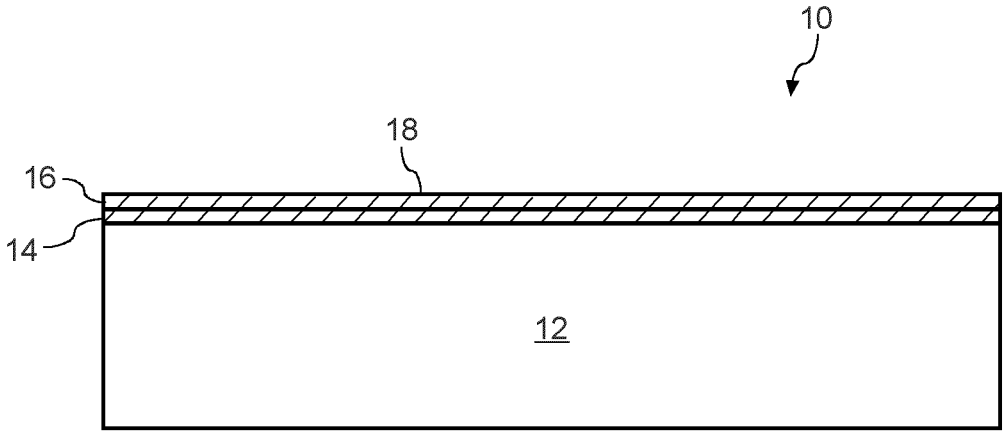

FIG. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 23 17 7036

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Place of search	Date of completion of the search	Examiner
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