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(54) **LOW MOISTURE VAPOR TRANSMISSION RATE PACKAGING MATERIAL**

(57) The present invention relates to a food packaging material and a method of manufacturing a food packaging material. The food packaging material of the present invention comprises a paper substrate having a first side and a second side, the second side being opposite to the first side, wherein the paper substrate is coated on at least the first or the second side with a coating comprising wax and a copolymer selected from styrene butadiene copolymer and/or styrene acrylic copolymer.

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Description

TECHNICAL FIELD

[0001] The present invention relates to a food packaging material and a method of manufacturing a food packaging material.

BACKGROUND ART

[0002] Conventional food containers such as pet food containers are often made with plastic films and/or with papers containing fluorochemicals. Thanks to this structure, conventional pet food containers have a good grease barrier, low moisture vapor transmission rate (MVTR) and suitable mechanical properties for the purpose of storing, e.g., pet food.

[0003] However, there are food safety and environmental concerns regarding fluorochemicals, which are being banned in most countries. Plastic content in packaging is also linked to increasing environmental concerns, as they are not fully recyclable.

[0004] Packaging material that is envisioned for the use in pet food containers must satisfy specific requirements. Pet food typically includes high amounts of oil and fats, therefore the packaging material for pet food typically needs to be greaseproof. If the packaging material does not show satisfactory greaseproof properties, grease will penetrate through the packaging material, and grease stains will appear on the outer surface of the container. Furthermore, through grease leaking the packaging material may lose its structural integrity and the risk of breakage of the container will increase.

[0005] Furthermore, the packaging material used in pet food containers should have suitable mechanical properties for converting, i.e. for producing pet food containers. Moreover, it is important that the packaging material is able to withstand handling and holding heavy loads. A standard weight of pet food units may be as high as up to 12 Kg or even more. Thus, a packaging material for pet food should be able to resist a high load. An optimal tensile, stiffness and tear resistance is therefore required, along with the optimal grease resistance properties.

[0006] The packaging material should also be fabricated from materials that are safe for food contact and ideally be recyclable.

[0007] Fluorofree paper-based packaging material for the pet food market are often not satisfactory from the viewpoints mentioned above, because their grease barrier level in the absence of fluorochemicals is too low both at the surface and at the core of the packaging material. Generally, such fluorofree packaging materials use a laminate film, which often contains plastic, to increase the surface grease barrier. However, the use of laminated film reduces the recycling yield of the packaging, the biopolymer content, and does not improve the grease resistance of the core of the material. Furthermore, lamination needs to be performed offline and the production costs thereof are higher than those of a method that can be fully performed on the paper machine.

[0008] In addition, packaging materials not comprising plastic films and/or papers containing fluorochemicals are generally insufficient in controlling the moisture content of packed products such as food. However, in food packaging, moisture control can be critical to maintain food quality, and ensure food safety as well as shelf life. Accordingly, in addition to addressing the problems mentioned above there is a need for a packaging material extending the shelf life of moisture sensitive food products.

TECHNICAL PROBLEM

[0009] There is a demand for a packaging material that is suitable for food and that is able to control moisture of moisture sensitive products. An indication of the permeability of water vapor through a substance is the moisture vapor transmission rate (MVTR). A low MVTR indicates an improved vapor barrier. To be specific, there is a demand for a food packaging material that has a low MVTR.

[0010] Ideally, the packaging material is at the same time substantially free from fluorochemicals such as per- and polyfluoroalkyl substances (PFAS), has good grease-proof properties and maintains optimal mechanical strength such that it can withhold heavy weight.

[0011] Furthermore, there is a demand for this packaging material to be manufacturable with food safe and recyclable materials. That is, conventional packaging materials comprising plastic films, a high amount of coating and/or fluorochemicals may give low MVTR but recyclability would be affected. Accordingly, there is demand for a packaging material providing satisfactory moisture barrier properties while being recyclable.

SUMMARY OF THE INVENTION

[0012] The present invention is aimed at solving above problems of the prior art by providing a food packaging material comprising a paper substrate having a first side and a second side, the second side being opposite to the first side, wherein

the paper substrate is coated on at least the first or the second side with a coating comprising wax and a copolymer selected from styrene butadiene copolymer and/or styrene acrylic copolymer.

[0013] Further, the present invention relates to a method of manufacturing the food packaging material, wherein the coating is applied to the paper substrate preferably by direct gravure or using a single rod or by curtain coating or by spray coating or size press coating or air knife coating or flexography coating.

[0014] It has been found that coating of a paper substrate with a coating comprising both wax and a copolymer selected from at least one of the group consisting of a styrene butadiene copolymer and a styrene acrylic copolymer allows to obtain a food packaging material having low MVTR thereby extending the shelf life of moisture sensitive food products.

[0015] Furthermore, the inventors of the present invention have found that the combination of wax and styrene copolymer according to the invention allows to provide a packaging material having satisfactory moisture barrier properties even when the coating is present only at relatively low amounts. This allows to provide a packaging material having satisfactory moisture barrier properties and being recyclable.

[0016] Without wishing to be bound by any theory, the combination of a wax with a styrene copolymer according to the invention appears to result in a particular suitable interaction within the coating that improves moisture barrier properties. The long aliphatic hydrocarbon chains in the wax likely interact well with the hydrophobic parts in the copolymers. Moreover, the hydrocarbon chains of the wax are more flexible in their configurations and can fold more easily than, for example, styrene copolymers, which have more bulky phenyl groups on their backbones. The hydrocarbon chains of the wax may thus fill gaps in the pore structures of the paper substrate that have been left unblocked by the copolymer due to its rather ridged structure. As the hydrocarbon chains of the wax are water-repellent, moisture barrier properties may be improved.

[0017] In addition, improved grease barrier properties may be obtained by pre-coating the paper substrate with a grease barrier precursor prior to the coating. The food packaging material according to the present invention further allows to obtain optimal mechanical properties. These objects of the present invention are achieved without introducing plastic films and/or papers containing fluorochemicals, thus the invention results in a product that is safe for food contact and has a lower environmental impact (that is, a higher recyclability).

[0018] The food packaging material of the present invention thus may form a food packaging extending shelf life of moisture sensitive food products having optimal mechanical properties without introducing plastic films and/or papers containing fluorochemicals.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

Figure 1 is a schematic illustration of an embodiment of the present invention.

Figure 2 is a schematic illustration of a preferred embodiment of the present invention in which the coating layer further comprises a filler.

Figure 3 is a schematic illustration of a preferred embodiment of the present invention in which the food packaging material further comprises an additional coating layer coated on the coating layer.

Figure 4 is a schematic illustration of a preferred embodiment of the present invention in which the food packaging material further comprises a printing layer.

Figure 5 is a schematic illustration of a preferred embodiment of the present invention in which the food packaging material further comprises an additional coating layer coated on the coating layer and a printing layer.

DETAILED DESCRIPTION OF THE INVENTION

Definitions

[0020] In the present invention, the term "average" denotes mean average, unless stated otherwise.

[0021] In the present invention, references to amounts "by weight" are intended to be synonymous with "by mass". Further, as used herein, the term weight percent (wt.%) refers to a percentage amount by weight.

[0022] In the present invention, the term "polymer" denotes a compound comprising at least ten repeating units such as, for example, a homopolymer, a copolymer, a graft copolymer, a branch copolymer or a block copolymer.

[0023] In the context of the present invention, the term "biodegradable" is generally defined in line with EN13432. The term "biodegradable" when applied to a material or a product means that the material or the entire product will biodegrade. By "biodegrade" it is meant that the chemical structure or the material breaks down under the action of microorganisms. More specifically, a material or a product is considered "biodegradable" if at least 90 wt.% of the material is converted into CO_2 under the action of microorganisms in less than 6 months as measured by the laboratory test method EN 14046, thereby meeting the requirement for biodegradability according to EN 13432.

[0024] The term "compostable" is generally defined in line with EN13432. In the context of the present invention, a material is "compostable" when it comprises a maximum of 10 wt.% and preferably of 5 wt.% of non-biodegradable components, thereby meeting EN13432. The term "compostable" when applied to a material or a product means that the material, or the entire product, will both biodegrade and disintegrate. By the term "disintegrates" it is meant that the material, or the product made from it, will physically fall apart into fine visually indistinguishable fragments, at the end of a typical composting cycle.

[0025] An "industrial compostable" material may be compostable as described above in an industrial setting: The material may disintegrate and biodegrade at temperatures between 55 °C to 60 °C in less than 6 months. In detail, disintegration in an industrial setup may take less than 3 months, while biodegradation may take less than 6 months. If a material is described as "home compostable," it is compostable as described above under conditions present in a domestic composter setting: The material may disintegrate and biodegrade at temperatures below 55 °C, preferably at temperatures between 10 to 45 °C and most preferably between 25 to 30 °C in less than 12 months. In detail, disintegration may take less than 6 months, while biodegradation may take less than 12 months in a domestic composter setting.

[0026] Where the present description refers to "preferred" embodiments/features, combinations of these preferred embodiments/features shall also be deemed as disclosed as long as this combination is technically meaningful.

[0027] Hereinafter, the use of the term "comprising" should be understood as disclosing in a non-limited way, that is to say that additional components or steps can be present or implemented, as long as this is technically meaningful. For a more restricted embodiment, the terms "consisting of" will be used and have to be understood as disclosing in a limited way, that is to say without any additional component or step.

Packaging material

[0028] The present invention relates to a food packaging material comprising a paper substrate having a first side and a second side, the second side being opposite to the first side, wherein the paper substrate is coated on at least the first or the second side with a coating comprising wax and a copolymer selected from styrene butadiene copolymer and/or styrene acrylic copolymer.

[0029] With reference to Figure 1, the packaging material (1) of the present invention comprises a paper substrate (10) having a first side and a second side, the second side being opposite to the first side, which optionally is pre-coated on at least the first or the second side with a grease barrier precursor (12), the paper substrate (10) being coated on a first side with a coating (11) comprising wax and a copolymer (13) selected from styrene butadiene copolymer and/or styrene acrylic copolymer.

Paper substrate

[0030] The term "paper substrate" as used herein refers to planar element such as a sheet of paper having a first side and a second side, the second side being opposite to the first side.

[0031] The paper substrate of the present invention refers to a base paper before coating and the optional pre-coating described below.

[0032] In the present invention, the paper substrate is preferably a cellulose fiber base sheet.

[0033] The term "fiber" as used herein refers to a material form characterized by an extremely high ratio of length to diameter. Generally, cellulose fibers have a very broad range of diameters and length based on fiber type and source of fiber. The average length of a wood pulp fiber as preferably used in the present invention is typically in the range of between from 0.3 mm to 3.5 mm, preferably from 0.3 mm to 3.0 mm, more preferably from 0.8 mm to 2.5 mm and even more preferably from 1.0 mm to 2.0 mm. The diameter of a wood pulp fiber is typically in the range of from 10 μm to 40 pm, preferably from 15 μm to 35 μm and more preferably from 20 μm to 30 μm. The aspect ratio (ratio of fiber length to fiber diameter) of a wood pulp fiber is therefore typically in the range of from 7.5 to 350, preferably from 7.5 to 300, more preferably from 10 to 200 and even more preferably from 20 to 150. The terms "fiber" and "filament" can be used interchangeably for the purposes of the present invention unless otherwise specifically indicated.

[0034] The term "cellulose fiber base sheet" refers to a non-woven fiber base sheet having a structure of individual fibers which are interlaid, but not in an identifiable manner as in a woven or knitted fabric, wherein the non-woven fiber base sheet is derived or prepared from cellulose fibers. A cellulose fiber is a fiber comprised substantially of cellulose. Non-woven materials can be formed from many processes such as, for example, spin laying, carding, air laying and water laying processes. The basis weight of non-woven materials such as a cellulose fiber base sheet is usually expressed in weight per unit area, for example in grams per square meter (gsm = g/m^2) or ounces per square foot (osf).

[0035] The cellulose fiber base sheet used in the present invention is preferably a wet-laid paper sheet. Cellulose fiber base sheets be used in embodiments of the present invention are preferably cellulose fibers from natural sources (for example, native cellulose fibers).

[0036] The term "native cellulose fibers" refers to cellulose fibers from natural sources such as woody plants including

deciduous and coniferous trees or non-woody plants including cotton, flax, esparto grass, kenaf, sisal, abaca, milkweed, straw, jute, hemp and bagasse. Preferably, the native cellulosic fibers used in the present invention are derived from woody plants. Suitable fibers are, for example, Eucalyptus fibers, Birch fibers or other annual plant fibers. The native cellulosic fibers form a crystalline material comprising a crystallized fraction with the crystalline form of Cellulose I comprising all-parallel-oriented cellulose chains.

[0037] Preferably, the cellulose fiber base sheet is a wood pulp paper sheet. The paper substrate used in the present invention preferably comprises natural hardwood fibers, more preferably eucalyptus fibers. Preferably, the paper substrate comprises hardwood fibers in an amount of 20 wt.% or more, preferably 30 wt.% or more, more preferably 40 wt.% or more, and even more preferably 50 wt.% or more relative to the total amount of fibers in the cellulose fiber base sheet.

[0038] Further, the paper substrate used in the present invention preferably comprises natural softwood fibers, preferably in an amount of 10 wt.% or more, preferably 20 wt.% or more, more preferably 30 wt.% or more, and preferably 70 wt.% or less, more preferably 60 wt.% or less, further preferably 50 wt.% or less relative to the total amount of fibers in the cellulose fiber base sheet.

[0039] In a preferred embodiment of the present invention, the paper substrate is made of natural cellulosic fibers, from the viewpoint of biodegradability. It is particularly preferable that the paper substrate is more than 98% biodegradable, preferably more than 99% biodegradable, and most preferably 100% biodegradable. The paper substrate therefore preferably contains no more than 5 wt.% of non-biodegradable material or material of undetermined compostability in order to meet the requirements of the EN 13432 standard. Most preferably, any additives added to the paper substrate are compostable. The paper substrate preferably comprises at least 50 wt.% of cellulosic fibers, preferably at least 60 wt.% of cellulosic fibers, more preferably at least 85 wt.% of cellulosic fibers, and even more preferably at least 90 wt.% of cellulosic fibers. In a more preferable embodiment, at least 95 wt.% and most preferably 100 wt.% of the fibers in the paper substrate are natural cellulosic fibers.

[0040] The diameter of the cellulose fibers is preferably 10 μm to 40 μm, more preferably from 15 μm to 35 μm and even more preferably from 20 μm to 30 μm. The length of the cellulose fibers is preferably 0.3 mm to 3.5 mm, more preferably from 0.3 mm to 3.0 mm, even more preferably from 0.8 mm to 2.5 mm and most preferably from 1.0 mm to 2.0 mm. Therefore, the average aspect ratio (ratio between the length and the diameter of the cellulose fibers) is preferably 7.5 to 350, more preferably from 7.5 to 300, even more preferably from 10 to 200 and most preferably from 20 to 150.

[0041] The paper substrate typically has an average thickness of from 30 μm to 150 pm, preferably from 40 μm to 120 pm, even more preferably from 45 μm to 80 μm and most preferably about 65 μm from the viewpoint of achieving excellent mechanical reinforcement properties.

[0042] Typically, the paper substrate will not have fillers. In particular, a total amount of titanium dioxide, calcium carbonate, and clay in the paper substrate is preferably not more than 5 wt.%, more preferably not more than 2 wt.%, even more preferably not more than 1 wt.%. More preferably, a total amount of fillers in the paper substrate is not more than 2 wt.%, more preferably not more than 1 wt.%, even more preferably not more than 0.5 wt.%.

[0043] Preferably, the cellulosic fibers described above are obtained by refining a pulp to have a desired refining degree (defined herein as Schopper Riegler number, ° SR). More preferably, the cellulosic fibers are refined to 55° SR or more, preferably to 60° SR or more, more preferably to 65° SR or more, and to 100° SR or less, preferably to 95° SR or less, more preferably to 90° SR or less, even more preferably 80° SR or less as measured according to ISO 5267.

[0044] The paper substrate preferably has an air transmittance of 10 ml/min or more, preferably 20 ml/min or more, more preferably 25 ml/min or more, even more preferably 30 ml/min or more, and 80 ml/min or less, preferably 75 ml/min or less, more preferably 70 ml/min or less as determined according to ISO 5636-3.

[0045] When the refining degree and air transmittance of the paper substrate is within the above ranges, good barrier and mechanical properties can be achieved in the final packaging material. In particular, this refining degree and air transmittance may be achieved by adjusting the refining of the pulp when producing the paper substrate. A too low air transmittance, such as below 20 ml/min, or a too high refining degree, such as above 100 °SR, indicates a high refining of the paper and may reduce the mechanical properties. The inventors of the present invention have found that a good balance in terms of mechanical properties and greaseproof performance may be achieved when controlling the refining such that the refining degree/air transmittance is within the ranges described above.

[0046] The paper substrate preferably has a Hagerty porosity greater than 10 000 sec/100 cm^3, preferably greater than 20 000 sec/100 cm^3, more preferably greater than 30 000 sec/100 cm^3, and even more preferably greater than 50 000 sec/100 cm^3. Moreover, the paper substrate preferably has a Hagerty porosity lower than 10 000 000 sec/100 cm^3. The Hagerty porosity is determined according to ISO 5636-5 for example on a PROFILE/PlusO Roughness & Porosity Automated Test System(by Technidyne). The inventors of the present invention observed that MVTR is low, when the coating according to the invention is coated on a base paper having a high Hagerty porosity. When the Hagerty porosity of the paper substrate is within the above limits, the MVTR of the final packaging material is further decreased.

[0047] Preferably, the paper substrate has a basis weight of 30 g/m^2 or more, preferably 35 g/m^2 or more, and even more preferably 40 g/m^2 or more. Moreover, the paper substrate preferably has a basis weight of 200 g/m^2 or less, preferably 180

g/m^2 or less, more preferably 160 g/m^2 or less, and even more preferably 150 g/m^2 or less. Preferably, the paper substrate has a basis weight of 30 to 200 g/m^2, more preferably of 40 to 200 g/m^2; or preferably, the paper substrate has a basis weight of 30 to 150 g/m^2, more preferably of 40 to 150 g/m^2. When the grammage of the paper substrate is within the above limits, the mechanical properties of the final packaging material are improved.

[0048] In a preferred embodiment, the paper substrate is calendered and/or supercalendered. To be specific, the paper substrate may be calendered, supercalendered or the paper substrate is both calendered and supercalendered. More preferably, the paper substrate is calendered and/or supercalendered prior to coating the base paper with the composition according to the invention. Even more preferably, the paper substrate is calendered and/or supercalendered after the optional pre-coating described below.

[0049] A preferred step of calendering the base paper in a method of manufacturing the packaging material according to the present invention is described below. A calendered and/or supercalendered paper substrate may be advantageous in terms of improving the edge wicking (described below) of the packaging material and thus improving its grease resistance properties. For example, a calendering step may help to achieve a denser packaging material, which may increase the grease barrier of the core material without negatively affecting the mechanical properties for converting. Further, a calendering step may improve the printability of the material.

[0050] Preferably, before coating or optional pre-coating of the base paper, the paper substrate has a Sheffield surface smoothness/roughness of less than 600 Sheffield Units (SU), preferably less than 400 SU, more preferably less than 350 SU, even more preferably less than 300 SU. Moreover, the paper substrate preferably has a Sheffield surface smoothness/roughness of more than 100 SU. The Sheffield surface smoothness/roughness is determined according to Tappi T538 standard.

[0051] In a preferred embodiment, the packaging material of the present invention may comprise a paper substrate which is pre-coated with a composition comprising a grease barrier precursor. The term "pre-coated paper substrate" as used herein refers to a base paper which is pre-coated with said composition. The term "pre-coated with a composition" as used herein denotes that the composition penetrates the cavities within the paper substrate along at least a portion of the thickness of the paper substrate. Preferably, the composition penetrates the cavities within the paper substrate along the whole thickness thereof. Preferably, the composition pre-coats the paper substrate across its whole surface. The composition comprising a grease barrier precursor may also additionally cover a surface of the paper substrate. For an efficient coating, the optional pre-coating is preferably performed prior to calendering and/or supercalendering the paper substrate as described above.

[0052] In the context of the preferred embodiment of the present invention, the term "grease barrier precursor" refers to compounds which are able to increase the grease resistance of a material containing them as compared to the same material that does not contain them. For example, grease barrier precursors as described herein may increase the grease resistance of the paper substrate pre-coated with a composition containing them as compared to the base paper substrate before pre-coating. For example, the grease barrier precursor may be a compound that, when used in a composition that pre-coats the paper substrate, decreases the edge wicking of the pre-coated paper substrate by at least 10%, preferably at least 20%, even more preferably at least 30% as compared to the non-pre-coated paper substrate, wherein the edge wicking is determined as follows.

(i) Two 10 x 10 cm samples per test paper were cut. CD (cross direction) and MD (machine direction) were marked.
(ii) The papers were rolled to form a tube, held in place with a paper clip or staple. The paper at the bottom of the tube must not be overlapped to avoid capillary rise of the RP2 sauce between two layers of paper.
(iii) 10 ml of colored RP2 solution (red dyed synthetic oil provided by Ralston-Purina) were added to a Petri dish under fume hood.
(iv) The paper tube was positioned standing vertically on the Petri dish in such a way that the bottom edge touched the bottom of the Petri dish. The start of the contact time with the RP2 liquid was noted.
(v) The tube on the Petri dish was left in a fume hood at room temperature for 24 hours.
(vi) After 24 hours, the paper sample was removed and pressed between two waterleaves (1 back-forth, standard roll 3 or 10 kg) .
(vii) The maximum total height reached by the RP2 simulant was measured on two samples, starting from the bottom of the paper.

[0053] In the preferred embodiment relating to a pre-coated paper substrate, the grease barrier precursor is selected from at least one of the group consisting of polysaccharides such as starch, a starch derivative, carboxymethyl cellulose, carboxyethyl cellulose, chitosan, alginate, dextrin, ethylene vinyl alcohol copolymer, polyvinyl alcohol and a mixture thereof. More preferably, the grease barrier precursor is starch, a starch derivative such as cationic, anionic and nonionic starch, carboxymethyl cellulose, carboxyethyl cellulose, chitosan, alginate, dextrin, or a mixture thereof. Most preferably, the grease barrier precursor is cationic starch, anionic starch, carboxymethyl cellulose or a mixture thereof.

[0054] In the present invention, the term "cationic starch" denotes starch which contains groups that are positively

charged at pH 7, wherein said groups may be one or more selected from amine groups, ammonium groups, imino groups, or phosphonium groups. In the present invention, "anionic starch" denotes starch which contains groups that are negatively charged at pH 7, wherein said groups may be for example carboxylic groups. In the context of the present invention, cationic starch and anionic starch are particularly preferable as grease barrier precursor from the viewpoint of improving both the mechanical properties to fit pet-food converting requirements, as well as to improve the grease barrier at the core of the material.

[0055] Advantageously, the preferred embodiment of pre-coating the base paper with the composition comprising the grease barrier precursor is useful in reducing the penetration of the coating layer as described below. This may help minimizing the surface defects of the coating layer and thus reducing the formation of weak points through which grease may pass. Preferably, the grease barrier precursor is present in an amount of less than 14 wt.%, preferably less than 10 wt.%, more preferably less than 5 wt.%, and even more preferably less than 3 wt.% relative to the paper substrate. Moreover, the grease barrier precursor is present in an amount of more than 1 wt.%, and preferably more than 2 wt.% relative to the paper substrate.

[0056] In a further preferred embodiment, the pre-coated paper substrate represents 50 wt.% or more, preferably 60 wt.% or more, more preferably 70 wt.% or more of the total weight of the packaging material. Further, the pre-coated paper substrate preferably represents 99 wt.% or less, preferably 95 wt.% or less, more preferably 90 wt.% or less of the total weight of the packaging material.

Coating

[0057] The packaging material of the present invention comprises a paper substrate that is coated on at least the first or the second side with a coating (hereinafter also referred to as coating layer). The coating is coated on at least the first or the second side of the paper substrate described above and comprises a wax and a copolymer as described below.

[0058] Preferably, the coating is coated on the entire surface of at least the first or the second side. Further, in a preferred embodiment, the coating is coated onto the first side but not onto the second side of the paper substrate.

[0059] The coating layer in the packaging material of the present invention allows to minimize defects of the surface of the paper substrate and to ensure a low MVTR as described below in further detail as well as high grease barrier resistance.

[0060] Preferably, the coating comprising the wax and the copolymer is present in an amount of at most 25 wt.%, more preferably at most 20 wt.%, and even more preferably of at most 15 wt.%, based on the paper substrate and the coating. Preferably, the coating comprising the wax and the copolymer is present in an amount of at least 1 wt.%, more preferably at least 5 wt.%, based on the paper substrate and the coating. An amount of the coating within the above ranges is advantageous in that it improves recyclability of the packaging material, while still ensuring good barrier properties and low MVTR.

[0061] The basis weight of the coating layer is preferably 4.0 g/m^2 or more, preferably 4.5 g/m^2 or more, more preferably 5.0 g/m^2 or more, more preferably 5.5 g/m^2 or more, and 25 g/m^2 or less, preferably 20 g/m^2 or less, more preferably 15 g/m^2 or less. A weight per unit area within the above ranges is advantageous in that it improves barrier properties and low MVTR of the packaging material, while still ensuring a good recyclability and without incurring in a blocking effect.

[0062] In the present invention, the coating comprises a wax. The term "wax" as used herein has its ordinary meaning to those skilled in the art. That is, the term "wax" refers to organic compounds characterised in that they comprise acid esters having long aliphatic hydrocarbon chains. The total amount of wax in the coating layer may preferably be 10 to 40 wt.%, more preferably 15-35 wt.% relative to the total amount of the coating.

[0063] The wax may be a natural wax, a synthetic wax or a mixture thereof. Natural waxes may comprise unsaturated bonds and various functional groups such as fatty acids, primary and secondary alcohols, ketones, aldehydes and fatty acid esters. Natural waxes include waxes derived from beeswax, epicuticular waxes of plants such as carnauba wax, jojoba oil, candelilla wax, rice bran oil and ouricury wax. Synthetic waxes may comprise long-chain aliphatic hydrocarbons (alkanes or paraffins), preferably synthetic waxes do not comprise functional groups. Synthetic waxes include paraffin wax.

[0064] The wax according to the present invention is preferably at least one selected from at least one of the group consisting of beeswax, carnauba wax or paraffin wax. More preferably, the wax is paraffin wax.

[0065] In the present invention, the coating further comprises a copolymer selected from at least one of the group consisting of a styrene butadiene copolymer and styrene acrylic copolymer. The total amount of a copolymer selected from styrene butadiene copolymer and styrene acrylic copolymer in the coating layer may preferably be 60 to 90 wt.%, and more preferably 65 to 85 wt.% relative to the total amount of the coating.

[0066] The styrene butadiene copolymer is a polymer derived from polymerization of a styrene monomer and a butadiene monomer. Preferably, the styrene butadiene copolymer is at least one selected from a styrene butadiene rubber latex and a styrene butadiene rubber obtained from emulsion polymerization or solution polymerization.

[0067] The styrene acrylic copolymer is a polymer derived from polymerization of a styrene monomer with an acrylic

ester monomer and/or an acrylic acid monomer. Preferably, the styrene acrylic copolymer is a water-based styrene acrylic emulsion polymer obtained from emulsion polymerization.

[0068] In an embodiment of the invention, the coating may comprise one or more additional polymers selected from polyvinyl alcohol, starch, polyurethane, ethylene vinyl-acetate copolymer, styrene (meth)acrylic acid copolymer, and poly (meth)acrylic acid. That is, the coating layer may comprise one or more polymers. When the coating layer comprises more than one polymer, it may be described herein as comprising a "polymer blend". The total amount of the polymer blend in the coating layer may be 1 to 15 wt.% or more, and more preferably 2 to 10 wt.% or more relative to the total amount of the coating. Further, the amount of the polymer blend in the coating layer may be 2 to 30 wt.% or less, and more preferably 4 to 20 wt.% or less relative to the total amount of the coating.

[0069] In a preferred embodiment, the coating layer may further comprise a filler selected from calcium carbonate, clay, talc and a mixture thereof. More preferably, the filler is calcium carbonate. When a filler is present, the amount of filler may be 1 wt.% or more, preferably 5 wt.% or more, more preferably 10 wt.% or more, even more preferably 20 wt.% or more relative to the total amount of coating layer components. Further, when present, the amount of filler may be 60 wt.% or less, preferably 55 wt.% or less, more preferably 50 wt.% or less, even more preferably 45 wt.% or less relative to the total amount of coating layer components. The inclusion of a filler in the coating layer may be advantageous in that it improves drying and reduces the foaming of the coating layer, without negatively affecting the barrier properties.

[0070] Figure 2 is a schematic illustration of a preferred embodiment in which a filler is comprised in the coating layer. As shown in Figure 2, in such an embodiment the packaging material (2) comprises a paper substrate (20) which optionally is pre-coated with a grease barrier precursor (22), the paper substrate (20) being coated on a first side with a coating (21) comprising a filler (24) in addition to a wax and a copolymer (23) selected from styrene butadiene copolymer and/or styrene acrylic copolymer.

[0071] The coating layer of the packaging material of the present invention may comprise additional components, such as defoamers, thickeners such as carboxymethyl cellulose, and/or crosslinking agents such as glyoxal-based compounds.

[0072] In a preferred embodiment of the present invention, the packaging material may further comprise an additional coating layer coated onto the coating layer that comprises a wax and a copolymer as described below. In the context of the present invention, when an additional coating layer is present, the coating layer that is coated on the paper substrate may be referred to as the "first coating layer" and the additional coating layer may be referred to as the "second coating layer".

[0073] Figure 3 is a schematic illustration of a preferred embodiment in which a second coating layer is present and coated onto the first coating layer. As shown in Figure 3, the packaging material (3) of such an embodiment comprises a paper substrate (30), which optionally is pre-coated with a grease barrier precursor (32), the paper substrate (30) being coated on a first side with a first coating (31) comprising wax and a copolymer (33) selected from styrene butadiene copolymer and/or styrene acrylic copolymer, and the first coating (31) being coated with a second coating (34) comprising wax and a copolymer (35) selected from styrene butadiene copolymer and/or styrene acrylic copolymer.

[0074] When a second coating layer is present according to the preferred embodiment of the present invention, the polymer(s), the optional filler and the optional additional components comprised in said second coating layer may be the same or different as the polymer(s) described above that may be comprised in the first coating layer. That is, the composition of the second coating layer and that of the first coating layer may be the same or different from each other. The presence of a second coating layer may be advantageous in terms of further improving MVTR and grease barrier properties of the final packaging material.

[0075] In the preferred embodiment of the present invention, the second coating layer preferably represents at most 12.5 wt.%, preferably 10 wt.%, based on the paper substrate and the coating. Preferably, the total amount of all coating layers in the packaging material is at most 25 wt.%, more preferably at most 20 wt.%, and at least 1 wt.%, more preferably at least 5 wt.%, based on the paper substrate and the coating. The basis weight of the second coating layer is preferably 8 g/m^2 or less; more preferably 7 g/m^2 or less.

[0076] Preferably, basis weight of all coating layers in the packaging material is 4.0 g/m^2 or more, preferably 4.5 g/m^2 or more, more preferably 5.0 g/m^2 or more, more preferably 5.5 g/m^2 or more, and 25 g/m^2 or less, preferably 20 g/m^2 or less, more preferably 15 g/m^2 or less. A weight per unit area within the above ranges is preferable from the viewpoint of MVTR, barrier properties of packaging material, while still ensuring a good recyclability and without incurring in a blocking effect.

[0077] In particular, using a first coating layer and a second coating layer according to the preferred embodiment of the present invention may further improve MVTR and grease barrier properties as compared to using one single coating layer with the same basis weight. Without wishing to be bound to any theory, it is believed that the reason for this may be that using two lighter coating layers instead of one single heavier coating layer may allow to coat surface effects that may appear on the first single coating layer and compensate for the weak points therein, through which grease may pass. With two layers, the probability of such defects may be decreased. These effects may be observed even when the first and second coating layer have the same composition, but have been deposited in two consecutive coating steps.

[0078] In a further preferred embodiment, in the packaging material of the present invention the coating is applied on a first side of the paper substrate, and the packaging material further comprises a printing layer applied on the second side of

the paper substrate. Specifically, the coating is preferably applied on the first side of the paper substrate but not on the second side, and a printing layer is applied on the second side of the paper substrate. Preferably, the printing layer is applied on the entire surface of the second side of the paper substrate.

[0079] Figure 4 illustrates a preferred embodiment of the present invention in which a printing layer is present. As shown in Figure 4, the packaging material (4) comprises a paper substrate (40), which optionally is pre-coated with a grease barrier precursor (42), the paper substrate (40) being coated on a first side with a first coating (41) comprising wax and a copolymer (43) selected from styrene butadiene copolymer and/or styrene acrylic copolymer, and the paper substrate (40) being coated on a second side with a printing layer (44).

[0080] Further, as shown in Figure 5, in a preferred embodiment, the packaging material (5) may comprise, in addition to the printing layer (56) coated onto a second side of the paper substrate (50), also an additional coating layer (54) coated onto the coating layer (51), which is in turn coated onto a first side of the paper substrate (50). The coating layers (51, 54) each independently comprise wax and a copolymer (53, 55) selected from styrene butadiene copolymer and/or styrene acrylic copolymer. That is, the preferred embodiment described above in which an additional coating layer is present may further comprise a printing layer. The properties and components of the additional coating layer are as described above for the embodiment comprising an additional coating layer. Further, the additional coating layer may also comprise a filler as described above.

[0081] In the further preferred embodiment, the printing layer preferably comprises a binder selected from styrene butadiene-based binders (such as Styronal D 517 F produced by BASF, or L7066 from EOC), styrene acrylic-based binders (such as Acronal S360D from BASF), or starch, or starch derivative, or carboxymethyl cellulose, or a mixture thereof. The amount of binder in the printing layer is preferably 10 wt.% or more, more preferably 15 wt.% or more, further preferably 20 wt.% or more and 60 wt.% or less, preferably 50 wt.% or less, more preferably 40 wt.% or less with respect to the total amount of components in the printing layer.

[0082] In the further preferred embodiment, the printing layer preferably comprises a filler selected from calcium carbonate, clay, talc and a mixture thereof. The amount of filler in the printing layer is preferably 40 wt.% or more, more preferably 50 wt.% or more, further preferably 60 wt.% or more and 90 wt.% or less, preferably 85 wt.% or less, more preferably 80 wt.% or less with respect to the total amount of components in the printing layer.

[0083] In the further preferred embodiment, the printing layer may comprise further additives such as defoaming agents, dispersant, lubricant, crosslinker, thickener, pH modifier and gloss-imparting agents.

[0084] When present, the printing layer may represent 1 wt.% or more, preferably 2 wt.% or more, more preferably 4 wt.% or more, and 12 wt.% or less, preferably 10 wt.% or less, further preferably 8 wt.% or less of the total weight of the packaging material.

[0085] When a printing layer is present, its basis weight may be 1 g/m^2 or more, preferably 2 g/m^2 or more, more preferably 3 g/m^2 or more, and 10 g/m^2 or less, preferably 8 g/m^2 or less, more preferably 6 g/m^2 or less.

[0086] One objective of the present invention is providing a packaging material having an optimal balance between mechanical properties, MVTR and grease barrier properties while reducing the amount of per- and polyfluoroalkyl substances in the packaging material, which are conventionally used to improve the grease barrier properties.

[0087] In particular, the total amount of fluorine-containing organic substances (including per- and polyfluoroalkyl substances) in the packaging material of the present invention does not exceed 20 ppm, preferably 15 ppm, more preferably 10 ppm, and most preferably 5 ppm, based on the total weight of the packaging material.

[0088] In a further preferred embodiment, the total amount of elemental fluorine in the packaging material, namely the fluor content, does therefore not exceed 100 ppm, preferably does not exceed 90 ppm, and more preferably does not exceed 80 ppm, based on the total weight of the packaging material. To be specific, the packaging material according to this preferred embodiment has a fluor content of less than 100 ppm, preferably of less than 90 ppm, and more preferably of less than 80 ppm

[0089] In the present invention, preferably the amount of standard sizing agents is limited. Examples of sizing agents are alkyl ketene dimers, soap rosin, anionic rosin and cationic rosin.

[0090] It has been found that keeping the amount of such sizing agents below a certain limit helps the penetration of the grease barrier precursor into the paper substrate. This results in an improvement of the grease barrier properties of the paper substrate, which can be achieved without using per- and polyfluoroalkyl substances. When these sizing agents are present in a high amount in the paper substrate, they may interfere with the penetration of the grease barrier precursor into the paper and affect the grease barrier performance. More specifically, in the present invention the total amount of alkyl ketene dimers, soap rosin, anionic rosin and cationic rosin in the paper substrate is preferably less than 2.0 wt.%, more preferably less than 1.5 wt.%, more preferably less than 1.0 wt.%, and even more preferably less than 0.5 wt.% based on the total weight of the paper substrate. More preferably, the total amount of sizing agents in the paper substrate is less than 2.0 wt.%, preferably less than 1.5 wt.%, more preferably less than 1.0 wt.%, and even more preferably less than 0.5 wt.% based on the total weight of the paper substrate.

[0091] Further, in the present invention it is preferable that the amount of wet strength agents is also limited. Examples of wet strength agents are polyamidoamine-epichlorohydrin resin, polyethylene imine, urea formaldehyde, and melamine

formaldehyde resins. Preferably, in the present invention the total amount of polyamidoamine-epichlorohydrin resin, polyethylene imine, urea formaldehyde, and melamine formaldehyde resins in the paper substrate is less than 0.5 wt.%, more preferably less than 0.35 wt.%, even more preferably less than 0.2 wt.% based on the total weight of the paper substrate. More preferably, the total amount of wet strength agents in the paper substrate is less than 0.5 wt.%, preferably less than 0.35 wt.%, more preferably less than 0.2 wt.% based on the total weight of the paper substrate.

[0092] In a more preferred embodiment, the total amount of alkyl ketene dimers, soap rosin, anionic rosin, cationic rosin, polyamidoamine-epichlorohydrin resin, polyethylene imine, urea formaldehyde, and melamine formaldehyde resins is less than 0.5 wt.%, preferably less than 0.35 wt.%, more preferably less than 0.2 wt.% based on the total weight of the paper substrate.

[0093] In a more preferred embodiment, the total amount of sizing agents and wet strength agents is less than 0.5 wt.%, preferably less than 0.35 wt.%, more preferably less than 0.2 wt.% based on the total weight of the paper substrate.

[0094] In a preferred embodiment, the amount of polyethylene and polypropylene is less than 0.5 wt.%, preferably less than 0.3 wt.%, more preferably less than 0.2 wt.% based on the total weight of the packaging material.

[0095] Preferably, the amount of plastic film in the packaging material is less than 0.5 wt.%, preferably less than 0.3 wt.%, more preferably less than 0.2 wt.% based on the total weight of the packaging material.

Physical and mechanical properties

[0096] The basis weight of the packaging material according to the present invention is preferably 40 g/m^2 or more, more preferably 50 g/m^2 or more, further preferably 60 g/m^2 or more, even more preferably 70 g/m^2 or more, and preferably 130 g/m^2 or less, more preferably 120 g/m^2 or less, further preferably 110 g/m^2 or less, even more preferably 100 g/m^2 or less.

[0097] The Sheffield surface smoothness/roughness of the packaging material according to the present invention is preferably less than 200 SU, more preferably less than 150 SU, and even more preferably less than 100 SU, when determined according to the Tappi T538 standard as described above.

[0098] The thickness of the packaging material according to the present invention is preferably 50 μm or more, preferably 55 μm or more, more preferably 60 μm or more, even more preferably 70 μm or more, and 120 μm or less, preferably 110 μm or less, more preferably 100 μm or less, even more preferably 95 μm or less.

[0099] A tensile strength in the machine direction (MD) of the packaging material of the present invention as determined by ISO 1924 is 1 kN/m or more, preferably 2 kN/m or more, more preferably 3 kN/m or more, further preferably 3.5 kN/m or more, and 12 kN/m or less, preferably 10 kN/m or less, further preferably 8 kN/m or less.

[0100] A tensile strength in the cross direction (CD) of the packaging material of the present invention as determined by ISO 1924 is preferably 0.5 kN/m or more, more preferably 1 kN/m or more, even more preferably 1.5 kN/m or more, and 8 kN/m or less, more preferably 7 kN/m or less, even more preferably 6 kN/m or less.

Recyclability

[0101] Preferably, the packaging material of the present invention is recyclable by repulping and recoverable according to EN13430 at at least 85 wt.%. The term "repulping" describes a process whereby a material that has previously undergone or has been formed by at least one pulping step is subjected to a further pulping step. The term "recyclable by repulping" describes a material which can be at least partially recovered and converted into a new material or object during a repulping step. Said material may be waste product. The term "recyclable" is generally described in line with EN13430. The expression "recyclable by repulping and recoverable according to EN13430 at at least 85%" therefore describes a material, which has been formed by or otherwise undergone at least one pulping step, and from which, upon subjecting it to a further pulping step, at least 85 wt.% of the material can be recovered. In a more preferred embodiment, the packaging material is recyclable by repulping and recoverable according to EN13430 at at least 90 wt.%, and even more preferably at at least 95 wt. %.

Compliance with standards for food contact

[0102] The packaging material of the present invention is a food packaging material, which means that it is suitable as packaging material for food. Preferably, the packaging material of the present invention is a pet food packaging material.

[0103] In one embodiment, the packaging material is food contact approved according to any of EU 1935/2004, BfR 36, FDA 21 CFA §176-170 & 176-180.

Barrier properties

[0104] In the present invention, the packaging material comprises a paper substrate that is coated on at least the first or the second side with a coating. The coating layer in the packaging material comprises a wax and a copolymer as described

above and allows to minimize defects of the surface of the paper substrate and to ensure a low MVTR thereby achieving very good vapor barrier properties and to ensure a high grease barrier resistance.

[0105] In a preferred embodiment, the packaging material has a moisture vapor transmission rate (MVTR) of less than 75 g/m^2/24h, preferably of less than 50 g/m^2/24h, more preferably of less than 25 g/m^2/24h or less, determined at 85% RH and 23 °C. MVTR is determined according to ISO 2528.

[0106] The MVTR is an indication of the permeability of water vapor through a substance. A low MVTR indicates an improved vapor barrier. In food packaging, moisture control is critical to maintain food quality, and ensure food safety as well as shelf life. MVTR generally decreases with increasing thickness of a barrier coating layer, and increases with increasing temperature. The food packaging material according to the present invention, however, shows improved MVTR (to be specific, lower MVTR) compared to other materials comprising a coating layer not comprising a wax and a copolymer as described above. The packaging material of the present invention therefore is able to control moisture of packed products thereby extending the shelf life of moisture sensitive food products.

[0107] In another preferred embodiment, the packaging material has a Cobb at 30 minutes measured according to TAPPI 441 of less than 10 g/m^2, preferably less than 8 g/m^2, more preferably less than 5 g/m^2. The Cobb value is an indication of the amount of water that is taken up by a defined area of paper sample through one-sided contact with water, within a certain amount of time (60 seconds according to ISO 535). A higher Cobb value indicates a higher water pick-up and therefore a lower barrier activity.

[0108] Preferably, the packaging material is grease-proof according to TAPPI T454. In one embodiment, the packaging material is greaseproof as determined according to TAPPI T454 with 30 seconds without grease leakage, preferably with 60 seconds without leakage, more preferably with 180 seconds without leakage, more preferably with 300 seconds without leakage, more preferably with 600 seconds without leakage, and even more preferably with 1800 seconds without leakage.

Food packaging

[0109] The food packaging material of the present invention may form a food packaging. As the food packaging is formed by the packaging material described above, a food packaging is provided that has low MVTR thereby extending the shelf life of moisture sensitive food products while maintaining optimal mechanical properties without introducing plastic films and/or papers containing fluorochemicals. The food packaging of the invention is thus safe for food contact and has a lower environmental impact (that is, a higher recyclability).

Method for producing a packaging material

[0110] Preferably, the packaging material of the present invention described above is obtainable by the method for producing a packaging material according to the present invention and described herein.

[0111] A method of manufacturing the food packaging material of the present invention includes a step of applying the coating layer as described above. At industrial scale, the coating is applied by direct gravure or using a single rod or by curtain coating or by spray coating or size press coating or air knife coating or flexography coating to the paper substrate described above.

[0112] To be specific, the coating layer comprising wax and a copolymer selected from styrene butadiene copolymer and/or styrene acrylic copolymer according to the present invention is applied to the paper substrate by at least one selected from direct gravure, using a single rod, curtain coating, spray coating, size press coating, air knife coating and flexography coating.

[0113] The coating layer may be applied at a speed of 50 m/min or more, preferably 60 m/min or more, more preferably 80 m/min or more, even more preferably 100 m/min or more, and 1000 m/min or less, preferably 900 m/min or less, more preferably 800 m/min or less.

[0114] Preferably, the coating is applied on the entire surface of at least the first or the second side. Further, in a preferred embodiment, the coating is applied only on the first side but not on the second side of the paper substrate.

[0115] In the method according to the invention, the components of the coating layer may be dispersed or dissolved in a liquid medium. The liquid medium used to disperse or dissolve the components of the coating layer is preferably water.

[0116] The step of applying the coating layer may be performed by applying a composition comprising the components of the coating layer as described above. To be specific, the components of the coating comprise the wax and the copolymer selected from styrene butadiene copolymer and/or styrene acrylic copolymer as described above. In addition the coating may comprise one or more additional polymers, fillers, defoamers, thickeners and any component as described above for the coating layer of the packaging material of the present invention.

[0117] A method of manufacturing the food packaging material according to the present invention may further comprise the steps of:

(i) providing a paper substrate having a first side and a second side, the second side being opposite to the first side;
(ii) optionally pre-coating the paper substrate with a composition comprising a grease barrier precursor as described above; and
(iii) applying a coating layer comprising wax and a copolymer selected from styrene butadiene copolymer and/or styrene acrylic copolymer on at least the first or the second side of the optionally pre-coated paper substrate.

[0118] The method of the present invention includes an optional step (ii) of pre-coating the paper substrate with a composition comprising a grease barrier precursor. The grease barrier precursor comprised in the composition used in step (ii) may be as described above for the grease barrier precursor in the packaging material of the present invention.

[0119] In the method of the present invention, the composition used for the pre-coating step is preferably a composition in which the grease barrier precursor as described above is dispersed or dissolved in a liquid medium. The liquid medium used to disperse or dissolve the grease barrier precursor may be an aqueous medium and is preferably water.

[0120] The pre-coating may be performed by any means known in the art and is preferably carried out by size press. For example, the pre-coating may be performed by a two-step method including a step of adding in wet-end a composition comprising a grease barrier precursor, and a step of further pre-coating the paper substrate by size press with a composition comprising a grease barrier precursor which may be the same or different as the one used in wet end. For example, the grease barrier precursor added in wet-end may be cationic starch and/or carboxymethyl cellulose, and the grease barrier precursor added by size press may be anionic starch. Advantageously, the pre-coating with the composition comprising the grease barrier precursor may be performed online on the paper machine without a converting step.

[0121] The method according to the present invention may include a step (ii') of calendering the optionally pre-coated paper substrate after step (ii) and/or a step (iii') of calendering the optionally pre-coated paper substrate coated with the coating layer after step (iii).

[0122] Including a calendering step (ii') and/or (iii') may be advantageous in terms of improving the edge wicking of the packaging material and thus improving its grease resistance properties. For example, a calendering step may help to achieve a denser packaging material, which may increase the grease barrier of the core material without negatively affecting the mechanical properties for converting. Further, a calendering step may improve the printability of the material.

[0123] The optional calendering step (ii') and/or (iii') may be carried out by a soft calender, hard calender, shoe calender or supercalender. The number of calendering nip could be from 1 to 16. This step is preferably carried out by a soft calender with 4 nip, online on the paper machine.

[0124] The method according to the present invention may include a step (iv) of applying an additional coating layer on the coating layer obtained in step (iii) and optionally calendered in step (iii'). The additional coating layer may be as described above for the additional coating layer of the packaging material of the present invention. As described above, the additional coating layer may be referred to as the "second coating layer" and the coating layer on which the additional coating layer is applied may be referred to as the "first coating layer".

[0125] The step (iv) of applying said second coating layer may be carried out in the same way as described above for the step (iii) of applying the coating layer onto the optionally pre-coated paper substrate.

[0126] Preferably, before the application of the second coating layer in step (iv), a step (iii") of drying the first coating layer obtained in step (iii) is performed. A step (iv') of drying the second coating layer after step (iv) may also be carried out.

[0127] The advantages of applying a second coating layer are as described above for the second coating layer of the packaging material of the present invention. Such advantages may be observed even when the second coating layer optionally added with step (iv) has the same composition as the first coating layer applied with step (iii).

[0128] The method according to the present invention may further include a step (v) of applying a printing layer onto the second side of the optionally pre-coated paper substrate. The printing layer may be as described above. The step (v) may be carried out by any method known in the art for the application of printing layer on paper-based packaging materials and may be preferably applied by blade coating, liquid application system or gravure coating.

EXAMPLES

[0129] The following base papers (properties shown in Table 1) were used as paper substrates and coated with the coating compositions shown below in Table 2 to manufacture packaging materials. Unless explicitly stated, the samples of the examples described below are laboratory tests.

Paper substrate 1

[0130] Base paper comprising 55% short fibers (hardwood) and 45% long fibers (softwood), sized with 1.2% alkyl ketene dimer (AKD) and calendered. The fibres were refined at 55-60° SR.

Paper substrate 2

[0131] Base paper comprising 64% short fibers (hardwood) and 36% long fibers (softwood), calendered and sized with 0.3 AKD. The fibers were refined at 30-40° SR to provide a more open paper.

Paper substrate 3

[0132] Base paper comprising 15% short fibers (hardwood) and 85% long fibers (softwood) and 0.8 wt.% TiO_2 relative to the overall amount of fibers, pre-coated with 1.5 wt.% starch and then calendered without sizing. The fibers were refined at 60-70° SR.

Paper substrate 4

[0133] Base paper comprising 33% short fibers (hardwood), 67% long fibers (softwood) and 1.7 wt.% TiO_2 relative to the overall amount of fibers. The fibres are refined at 50-55° SR. The paper is then supercalendered.

Paper substrate 5

[0134] Base paper comprising 20% short fibers (hardwood) and 80% long fibers (softwood). The fibres are refined at 55-60° SR.

Table 1: Properties of paper substrates

Paper Substrate	Basis weight [g/m^2]	Paper density [kg/m^3]	Hagerty* porosity [sec]
1	52	968	34,800
2	44	690	290
3	66	928	8,300,000
4	65	1120	7,800
5	65	1120	73,900
*The Hagerty porosity was measured on PROFILE/PlusO Roughness & Porosity Automated Test System by Technidyne according to ISO 5636-5.			

Table 2: Coating compositions

Coating Composition	Product name	Chemical composition
A	EXCEVAL AQ 4104 [1]	polyvinyl alcohol (90 parts)
	Aquapel J220[2]	alkyl ketene dimer (5 parts)
	Kymène [3]	polyamide-epichlorohydrin (5 parts)
B	GENFLO 5086[4]	styrene butadiene
C	COAT 252 ECO[5]	styrene butadiene + wax
D	Joncryl HPB 1634[6]	styrene acrylic emulsion (partly based on renewal resources) + wax
E	WOKOSEAL 1512[7]	styrene butadiene-based latex + wax
F	Joncryl HPB1631-A[8]	styrene acrylic emulsion + wax
Supplier: [1] Kuraray; [2,3] Solenis; [4] OMNOVA; [5] CHT; [6,8] BASF; [7] MUNZING		

Example 1

[0135] A coating was applied on the first side of Paper Substrate 1 at a coat weight shown below in Table 3 by using a hand coater. Coating Compositions A, B, C, D and E were used for the application of the first coating layer to manufacture

Packaging Materials 1-A, 1-B, 1-C, 1-D and 1-E.

[0136] Packaging Material 1-AA was manufactured by applying a coating of Coating Composition A on the first side of Paper Substrate 1. After drying the first coating layer, a second coating of Coating Composition A was applied on the first coating layer. Both coating layers were applied at a coat weight shown below in Table 3 by using a hand coater.

[0137] The MVTR value of the samples prepared in Example 1 was determined as described above and the results are also shown in Table 3.

Table 3: Packging Material 1

Packaging Material	Coat weight [g/m^2]	MVTR [g/m^2/24]
1-A	5.5	356
1-AA	4.0 + 1.8	248
1-B	6.2	216
1-C	6.0	36
1-D	6.0	25
1-E	6.0	18.5

[0138] As can be seen in Table 3, the MVTR is very high for the Packaging Material 1-A, which contains no styrene copolymer or wax in the coating. Although an improvement in moisture barrier properties is observed for sample 1-AA having two coating layers, without a styrene copolymer or wax in the coating, the MVTR is only slightly reduced. MVTR is also high for Packaging Material 1-B, which contains a styrene copolymer but no wax in the coating.

[0139] The Packaging Materials 1-C, 1-D and 1-E, which contain wax and a styrene copolymer, however, have a very low MVTR. The packaging materials according to the present invention thus provide satisfactory moisture barrier properties while being recyclable. As discussed above, the addition of wax to the styrene copolymer results in a particular suitable interaction within the coating that improves moisture barrier properties.

Example 2

[0140] A coating was applied on the first side of Paper Substrate 2 at a coat weight shown below in Table 4 by using a hand coater. Coating Compositions A, B, C and D were used for the application of the first coating layer to manufacture Packaging Materials 2-A, 2-B, 2-C and 2-D.

[0141] The MVTR value of the samples prepared in Example 2 was determined as described above and the results are also shown in Table 4.

Table 4: Packaging Material 2

Packaging Material	Coat weight [g/m^2]	MVTR [g/m^2/24]
2-A	5.7	422
2-B	6.1	159
2-C	6.3	33
2-D	5.7	56

[0142] As can be seen in Table 4, the MVTRs of the samples of Example 2 are overall higher when compared to those of Example 1 shown in Table 3. This results from Paper Substrate 2 having a more open structure and a significantly lower Hagerty porosity when compared to Paper Substrate 1.

[0143] As further shown in Table 4, the MVTR is very high for Packaging Material 4-A, which contains no styrene copolymer or wax in the coating. Packaging Material 4-B, which contains a styrene copolymer but no wax in the coating, still has a high MVTR.

[0144] Despite the open structure of Paper Substrate 2, the Packaging Materials 4-C and 4-D containing wax and a styrene copolymer in the coating provide satisfactory moisture barrier properties.

Example 3

[0145] A coating was applied on the first side of Paper Substrate 3 at a coat weight and by a method shown below in Table

6. Coating Compositions A, B, D and F were used for the application of the first coating layer to manufacture Packaging Materials 3-A, 3-B, 3-D and 3-F_a to 3-F_d. Materials 3-F_a to 3-F_d are obtained by machine trials.

[0146] Packaging Material 3-AA was manufactured by applying a coating of Coating Composition A on the first side of Paper Substrate 3. After drying the first coating layer, a second coating of Coating Composition A was applied on the first coating layer. Both coatings were applied at a coat weight shown below in Table 5 by using a hand coater.

[0147] The MVTR value of the samples prepared in Example 3 was determined as described above and the results are also shown in Table 5.

Table 5: Packaging Material 3

Packaging Material	Coating method	Coat weight [g/m^2]	MVTR [g/m^2/24]
3-A	hand coater	5.7	341
3-AA	hand coater	4.3 + 2.0	222
3-B	hand coater	6.2	320
3-D	hand coater	6.3	28
3-F_a	drawdown rod	13.0	22
3-F_b	single rod - 2nd station	7.0	25
3-F_c	direct gravure	11.0	23
3-F_d	rod - 10mm	8.0	15

[0148] As can be seen in Table 5, the MVTR is very high for the Packaging Material 3-A, which contains no styrene copolymer or wax in the coating. Even with two coating layers, the MVTR of Material 3-AA is only slightly reduced in the absence of a styrene copolymer or wax. MVTR is also very high for Packaging Material 3-B, which contains no wax in the coating.

[0149] As further shown in Table 4, the Packaging Materials 3-D and 3-F_a to 3-F_d, which contain wax and a styrene copolymer according to the invention in the coating have a very low MVTR. Example 3 thus confirms that satisfactory moisture barrier properties of the recyclable packaging materials according to the present invention can be obtained not only in laboratory tests but also by machine trials.

Example 4

[0150] All materials of Example 4 are obtained by machine trials.

[0151] Coating Composition F was used for the application of a coating on the first side of Paper Substrates 4 and 5 at a coat weight and by a method shown below in Table 6 to manufacture Packaging Materials 4-F and 5-F.

[0152] The MVTR value of the Packaging Materials 4-F and 5-F was determined as described above and the results are shown in Table 6 compared to those of 3-F_b and 3-F_d.

Table 6: Comparison of different F-coated paper substrates

Packaging Material	Paper Substrate	Coating method	Coat weight [g/m^2]	MVTR [g/m^2/24]
4-F	5	direct gravure	9.0	61
5-F	6	single rod - 2nd station	10.0	12
3-F_b	4	single rod - 2nd station	7.0	25
3-F_d	4	rod - 10mm	8.0	15

[0153] As can be seen in Table 6, all packaging materials according to the present invention provide satisfactory moisture barrier properties while being recyclable. As discussed above, Paper Substrate 4 has a lower Hagerty porosity. Hence the MVTR of Packaging Material 4-F is higher than for the other samples.

Example 5

[0154] Table 7 shows a comparison of the Packaging Materials 1-D, 2-D and 3-D described above.

Table 7: Comparison of different D-coated paper substrates

Packaging Material	Paper Substrate	Coating method	Coat weight [g/m^2]	MVTR [g/m^2/24]
1-D	1	hand coater	6.0	25
2-D	2	hand coater	5.7	56
3-D	3	hand coater	6.3	28

[0155] As shown in Table 8, Packaging Materials 1-D and 3-D, comprising base papers having a Hagerty porosity of greater 10 000 sec, have lower MVTRs, that is further improved moisture barrier properties, compared to Material 2-D.

Claims

1. A food packaging material comprising:
a paper substrate having a first side and a second side, the second side being opposite to the first side,
wherein the paper substrate is coated on at least the first or the second side with a coating comprising wax and a copolymer selected from styrene butadiene copolymer and/or styrene acrylic copolymer.

2. Food packaging material of claim 1, having a moisture vapor transmission rate, MVTR, of less than 75 g/m^2/24h, preferably of less than 50 g/m^2/24h, more preferably of less than 25 g/m^2/24h, determined at 85% RH and 23 °C.

3. Food packaging material according to any of the preceding claims, wherein the paper substrate has a Hagerty porosity greater than 10 000 sec/100 cm^3, preferably greater than 20 000 sec/100 cm^3, more preferably greater than 30 000 sec/100 cm^3, even more preferably greater than 50 000 sec/100 cm^3.

4. Food packaging material according to any of the preceding claims, wherein paper substrate has a basis weight of 30 to 200 g/m^2, preferably of 30 to 150 g/m^2, more preferably of 40 to 150 g/m^2.

5. Food packaging material according to any of the preceding claims, wherein the coating comprising the wax and the copolymer is present in an amount of at most 25 wt.%, preferably of at most 20 wt.%, more preferably of at most 15 wt.%, based on the paper substrate and the coating.

6. Food packaging material according to any of the preceding claims, wherein the paper substrate is calendered and/or supercalendered.

7. Food packaging material according to any of the preceding claims, wherein the paper substrate prior to coating has a Sheffield surface smoothness/roughness of less than 600 Sheffield Units (SU) preferably less than 400 SU, more preferably less than 350 SU, even more preferably less than 300 SU, determined according to Tappi T538 standard.

8. Food packaging material according to any of the preceding claims, wherein the paper substrate is made of natural cellulosic fibers, preferably comprising at least 50 wt.% of cellulosic fibers, preferably at least 60 wt.% of cellulosic fibers, more preferably at least 85 wt.% of cellulosic fibers, and even more preferably at least 90 wt.% of cellulosic fibers.

9. Food packaging material according to claim 8, wherein said cellulosic fibers are refined to 55 °SR (Schopper Riegler) or more, preferably to 60° SR or more, more preferably to 65° SR or more.

10. Food packaging material according to any of the preceding claims, having a fluor content of less than 100 ppm, preferably of less than 90 ppm, more preferably of less than 80 ppm.

11. Food packaging material according to any of the preceding claims, being recyclable by repulping and recoverable according to EN13430 at at least 85 wt.%, preferably at at least 90 wt.%, more preferably at at least 95 wt.%.

12. Food packaging material according to any of the preceding claims, having a Cobb at 30 minutes measured according to TAPPI 441 of less than 10 g/m^2, preferably less than 8 g/m^2, more preferably less than 5 g/m^2.

13. Food packaging material according to any of the preceding claims, wherein the paper substrate is pre-coated on at

least the first or the second side with a grease barrier precursor selected from polysaccharides such as starch, a starch derivative, carboxymethyl cellulose, carboxyethyl cellulose, chitosan, alginate, dextrin, ethylene vinyl alcohol copolymer, polyvinyl alcohol and a mixture thereof; and the coating comprising the wax and the copolymer is coated on at least the first or the second side impregnated with the grease barrier precursor.

14. Food packaging material according to claim 13, wherein the grease barrier precursor is present in an amount of less than 14 wt.%, preferably less than 10 wt.%, more preferably less than 5 wt.%, even more preferably less than 3 wt.% relative to the paper substrate.

15. Food packaging material according to any of the preceding claims, forming a food packaging.

16. Method of manufacturing a food packaging material as defined in claim 1, wherein the coating is applied to the paper substrate by direct gravure or using a single rod or by curtain coating or by spray coating or size press coating or air knife coating or flexography coating.

Figure 1

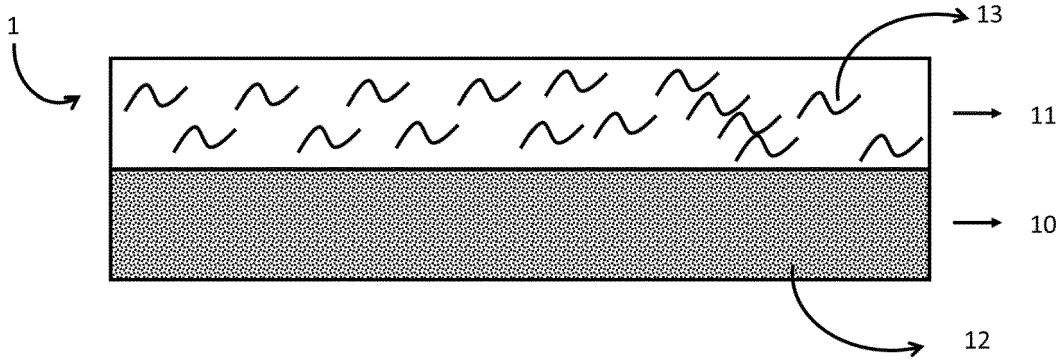


Figure 2

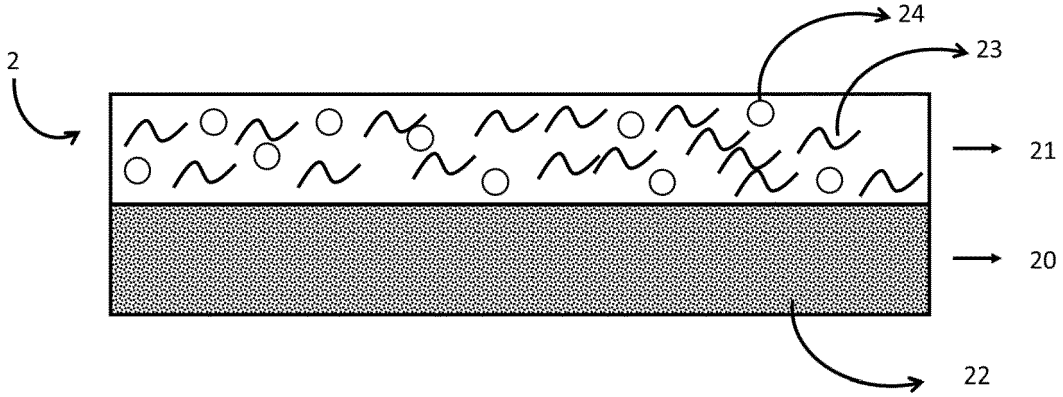


Figure 3

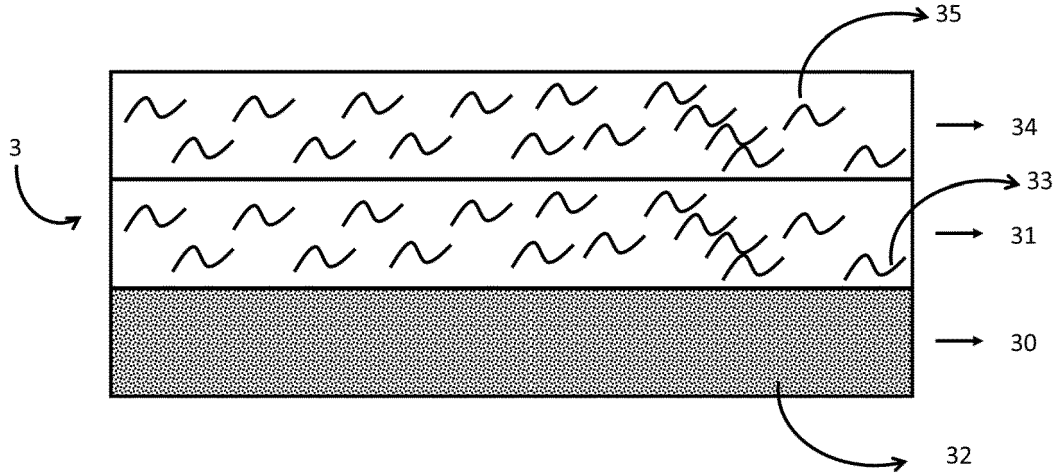


Figure 4

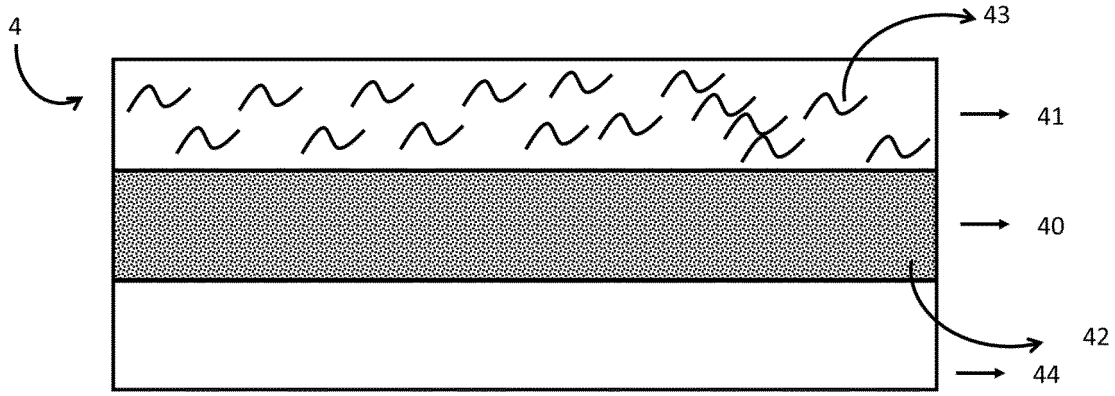
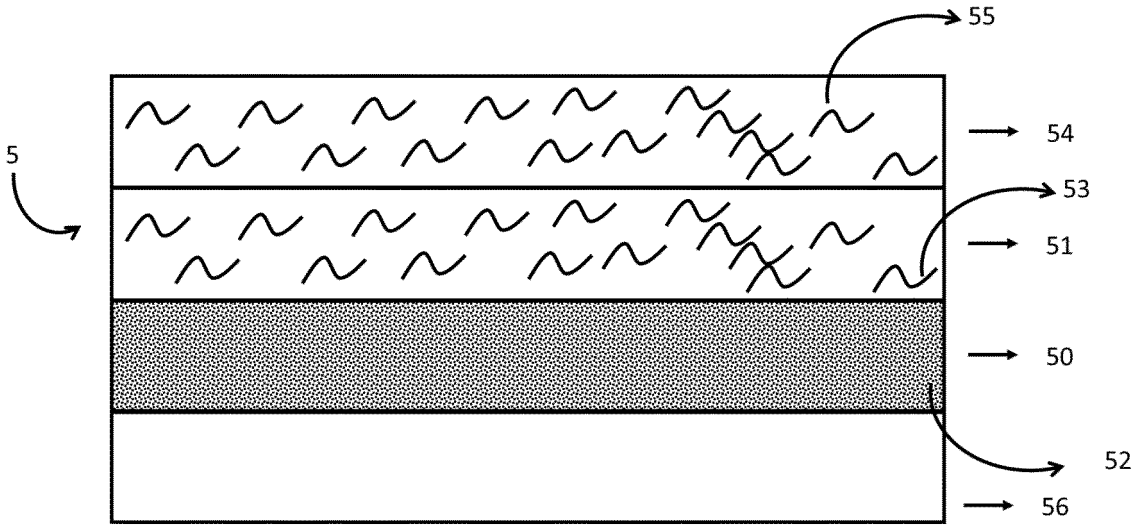


Figure 5



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EUROPEAN SEARCH REPORT

Application Number
EP 24 18 0839

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D21H
B65D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	8 November 2024	Ponsaud, Philippe

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