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(54) BARRIER PAPER OR BOARD

(57) A process for improving the barrier properties of a barrier layer in a pulp-based substrate layer having a barrier layer, comprising the steps of providing a pulp-based substrate layer having a layer of an aqueous barrier composition applied to it, and then drying the pulp-based substrate layer having a layer of aqueous barrier composition applied to it to form a pulp-based substrate layer having a barrier layer, such that the moisture content of the pulp-based substrate layer having a barrier layer is below 2.5 % by weight, preferably below 2 % by weight, based on the weight of the pulp-based substrate layer having a barrier layer.

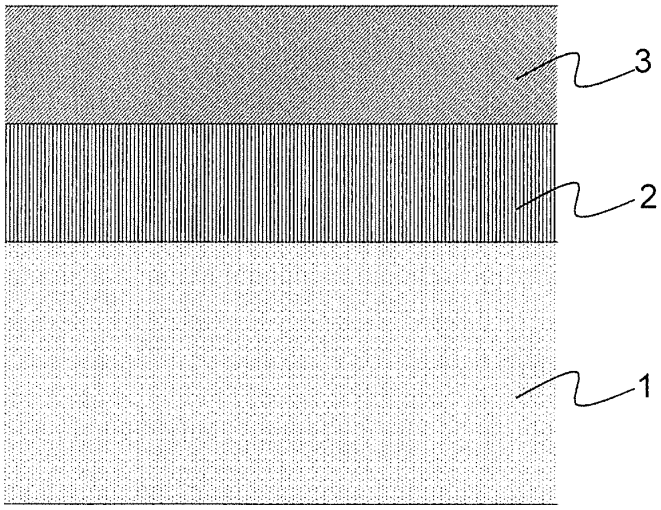

FIG. 1

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Description

TECHNICAL FIELD

[0001] The present invention relates to pulp-based substrate layers having barrier properties and methods of obtaining such pulp-based substrate layers, in particular pulp-based substrate layers such as paper or paperboard having barrier properties.

PRIOR ART

[0002] Paper has been used for packaging applications from many decades. In the past, due to the lack of inherent barrier properties, paper has been used mostly as the print carrier in laminate and/or composite packaging solutions, where it is combined with other materials exhibiting barrier functionality, such as plastic films and/or aluminium layers. The plastic films can be either made from a single material or may be multilayer films that incorporate multiple layers of different polymers, and such plastic films can be applied via extrusion coating or via a lamination process. Aluminium layers can either be applied either as thin sheets of aluminium or may be applied via known deposition techniques such as atomic layer deposition. Also, combinations of plastic films and aluminium layers are known in the field of packaging.

[0003] In recent years, it has become possible to produce papers that have barrier properties that can compete with polymer films, while remaining recyclable.

[0004] Such barrier properties can be achieved via coating the paper with relatively low amounts of one or more dispersions, specifically one or more solutions, of a barrier compound, thereby reducing or replacing plastic film-based materials or metal layers in the end product. Furthermore, due to the light and thin nature of the layers formed upon drying of these waterborne dispersions or solutions, the barrier papers can be repulped and recycled as paper.

[0005] Nevertheless, cost pressure in the packaging field demands for ever improved performing barrier papers, in which improved barrier properties must be achieved at the same or even lower cost.

[0006] EP 1 395 705 B1 discloses a process comprising forming a composite, multilayer free flowing curtain, the curtain having a solids content of at least 45 weight percent, and contacting the curtain with a continuous web substrate of base paper or base board. No overdrying is described.

[0007] EP 1 666 637 A1 discloses a gas-barrier composite plastic film or sheet which is obtained by coating at least one side of a plastic film or sheet made of at least one plastic selected from the group consisting of polyolefins, polyesters, polyamides and polystyrenes with a coating material composition with a gas-barrier property at a coating weight so as to give a dry coat layer thickness of 0.1 to 100 μm. No overdrying is described.

[0008] WO2012/175621 A1 discloses a method for producing coated vacuum metallized substrates with good vapour and oxygen barrier properties in which a liquid coating material is dried but does not disclose a drying step for the barrier composition in which the barrier composition is dried to a moisture of less than 2.5%.

[0009] WO2010/042162 A1 discloses a method for producing multilayer coatings for paper based substrates with good barrier properties in which a liquid coating composition is dried but does not disclose a drying step for the barrier composition in which the barrier composition is dried to a moisture of less than 2.5%.

[0010] WO2009/112255 A1 discloses a method for manufacturing packaging laminates and containers made from those by applying a liquid film coating of a liquid gas barrier composition and subsequently drying it, but does not disclose a drying step for the barrier composition in which the barrier composition is dried to a moisture of less than 2.5%.

SUMMARY OF THE INVENTION

[0011] The present invention provides a process that allows achieving improved barrier properties, such as WVTR (Water Vapour Transmission Rate) or OTR (Oxygen Transmission Rate), in pulp based substrates without having to increase the amount of barrier compound in the barrier composition that is applied to the substrate and/or without having to add further barrier layers to the substrate. This allows achieving improved barrier properties without an increase in material cost.

[0012] It is an object of the present invention to provide a process for improving the barrier properties of a barrier layer comprised in a pulp-based substrate layer having a barrier layer, comprising the steps of

a) providing a pulp-based substrate layer having a layer of an aqueous barrier composition applied to it, wherein said barrier composition comprises a barrier compound,

b) drying the pulp-based substrate layer having a layer of an aqueous barrier composition applied to it to form a pulp-based substrate layer having a barrier layer, such that the moisture content of the pulp-based substrate layer having a barrier layer is below 2.5 % by weight, preferably below 2 % by weight, preferably below 1.5 % by weight, based on the weight of the pulp-based substrate layer having a barrier layer.

[0013] It is a further object of the present invention to provide a packaging material comprising at least one pulp-based substrate layer having, in this order,

optionally, a primer layer adjacent to the pulp-based substrate layer,
a first barrier layer adjacent to the pulp-based substrate layer, wherein the first barrier layer is obtainable according to the process of the first object of the invention,
optionally a sealing layer such as a heat- or cold- sealing layer adjacent to the first barrier layer, wherein the combined amount of the first barrier layer ranges from 4 gsm to 11 gsm, preferably from 4 to 6 gsm, and wherein the packaging material exhibits a WVTR at tropical conditions (38°C, 90% RH) of 1 1 to 5 g/(m2.d), and wherein the pulp-based substrate layer does not contain a metal layer.

[0014] In the context of the present invention, all values for MVTR are determined and measured at tropical conditions (38°C, 90% RH) according to ASTM F1249 and all OTR values are determined and measured at normal conditions (23°C, 50% RH) according to ASTM D3985, unless stated otherwise.

[0015] Further embodiments of the invention are laid down in the dependent claims and the specification.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Preferred embodiments of the invention are described in the following with reference to the drawings, which are for the purpose of illustrating the present preferred embodiments of the invention and not for the purpose of limiting the same. In the drawings,

Fig. 1 shows a cross-section a packaging material according to one embodiment of the present invention, where a first barrier layer (2) and a second barrier (3) are arranged on top of a pulp-based substrate (1) and are adjacent to each other.

Fig. 2 shows a cross-section a packaging material according to one embodiment of the present invention, where a first barrier layer (2) and a second barrier (3) are arranged on top of a pulp-based substrate (1), where an inorganic barrier layer (4) is in between the first barrier layer (2) and a second barrier (3) and adjacent to said barrier layers (2,3).

Fig. 3 shows a cross-section a packaging material according to one embodiment of the present invention, where a first barrier layer (2) and a second barrier (3) are arranged on top of a pulp-based substrate (1), where a primer layer (5) is in between the pulp-based substrate (1) and a first barrier (2) and adjacent to each of them.

Fig. 4 shows a cross-section a packaging material according to one embodiment of the present invention, where a first barrier layer (2) and a second barrier (3) are arranged on top of a pulp-based substrate (1), where an inorganic barrier layer (4) is in between the first barrier layer (2) and a second barrier (3) and adjacent to said barrier layers (2,3) and where a primer layer (5) is in between the pulp-based substrate (1) and a first barrier (2) and adjacent to each of them.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0017] It is an object of the present invention to provide a process for improving the barrier properties of either a barrier layer comprised in a pulp-based substrate layer having a barrier layer, or of a barrier layer in a packaging material comprising a pulp-based substrate layer having a barrier layer, comprising the steps of

a) providing a pulp-based substrate layer having a layer of an aqueous barrier composition applied to it, wherein said barrier composition comprises a barrier compound,
b) drying the pulp-based substrate layer having a layer of an aqueous barrier composition applied to it to form a pulp-based substrate layer having a barrier layer, such that the moisture content of the pulp-based substrate layer having a barrier layer is below 2.5 % by weight, preferably below 2 % by weight, based on the weight of the pulp-based substrate layer having a barrier layer.

[0018] In the context of the present invention, the term "improving a barrier property" means that a barrier property of a layer with respect to at least one substance, such as for example water vapour or oxygen, is modified such as to allow for less diffusion of said substance across the layer. Specifically, in the case of water vapour and oxygen, such an improvement is expressed by lower numerical values in water vapour transmission rate and oxygen transmission rate, respectively.

[0019] It has been found that when a pulp-based substrate layer having a layer of an aqueous barrier composition applied to it is dried to a lower moisture content than would usually be required for mere drying and formation of a barrier

film, the barrier properties of the resulting pulp-based substrate layer having a barrier layer are significantly improved.

[0020] The pulp-based substrate layer that are used in the process according to the present invention may be based on any type of pulp that is sourced from a plant such as for example softwood or hardwood. Exemplary types of pulp that may be comprised in the pulp-based substrate layer are chemical pulps such as kraft or sulphite pulps or are chemi-thermomechanical pulps.

[0021] In a preferred embodiment, the pulp-based substrate layer comprises both hardwood and softwood chemical pulp.

[0022] The process of the invention includes a step of providing a pulp-based substrate layer having a layer of an aqueous barrier composition applied to it. The layer of an aqueous barrier composition can be applied via known techniques that may be used to apply a liquid coating, such as for example blade coating, rod coating, curtain coating, reverse gravure coating, gravure coating, spray coating, dip coating or air knife coating.

[0023] The aqueous barrier composition may be applied to the pulp-based substrate layer either in-line at the time of the production of the pulp-based substrate layer on a paper machine or off-line after the pulp-based substrate layer, which may or may not already have a primer layer, has been produced, on a separate coating apparatus. In the case where the pulp-based substrate layer includes more than one barrier layer, the barrier layers may be formed either by subsequently running the pulp-based substrate layer through multiple coating apparatuses or by repeatedly running the pulp-based substrate layer through a same coating apparatus.

[0024] The coating apparatus is equipped with a coating unit which applies the aqueous barrier composition to the pulp-based substrate layer and with a drying unit which dries the pulp-based substrate layer and the aqueous barrier composition applied. The coating unit may be a blade coating, rod coating, curtain coating, reverse gravure coating, gravure coating, spray coating, dip coating, or air knife coating unit.

[0025] The aqueous barrier composition may be applied to the pulp-based substrate layer in the form of a liquid dispersion, specifically as a liquid solution, which may preferably have a solids content of up to 55% by weight, wherein the solids content may be more preferably between 5% by weight and 55% by weight, based on the weight of the aqueous barrier composition.

[0026] The pulp-based substrate layer may have any form or shape.

[0027] In one embodiment, the pulp-based substrate layer is in the form of a flat web, for example of paper or paperboard. This is mostly, but not necessarily, the case when the aqueous barrier composition is applied to the pulp-based substrate layer in a paper machine, which paper machine forms the pulp-based substrate layer as paper or paperboard and applies the aqueous barrier composition in-line. Alternatively, the aqueous barrier composition is applied to the pulp-based substrate layer in the form of a flat web in a coating apparatus comprising at least one coating unit, configured to apply the aqueous barrier composition, and a drying unit, configured to dry the pulp-based substrate layer having the aqueous barrier composition applied to it to the required moisture content. In order to coat flat web shaped pulp-based substrate layers, the coating unit is preferably a blade coating unit, rod coating unit, curtain coating unit, reverse gravure coating unit, gravure coating unit, spray coating unit or air knife coating unit.

[0028] In another embodiment, the pulp-based substrate layer such as paper or paperboard is not in the form of a flat web, but is formed to a desired three-dimensional shape, such as for example a cup, a tray or a bottle. In this case, the aqueous barrier composition is applied to the pulp-based substrate layer in a coating apparatus comprising at least one coating unit, configured to apply the aqueous barrier composition, and a drying unit, configured to dry the pulp-based substrate layer having the aqueous barrier composition applied to it to the required moisture content. In order to coat three-dimensional shaped pulp-based substrate layers, the coating unit is preferably a spray coating unit, a dipping coating unit or a curtain coating unit.

[0029] In a preferred embodiment, the aqueous barrier composition may be applied to the pulp-based substrate layer on one side or both sides of the pulp-based substrate layer.

[0030] The pulp-based substrate layer can be freely chosen in terms of base weight, provided the pulp-based substrate layer can be provided pin-hole free in order to avoid holes in the barrier layer. In the case the pulp-based substrate layer is a paper, the base weight may be preferably above 15 gsm and below 225 gsm, more preferably of 40 to 120 gsm, whereas in the case the pulp-based substrate layer is a paperboard, the base weight may be preferably above 225 gsm.

[0031] It is understood that the pulp-based substrate layer may be pre-coated or pre-treated prior to being provided in the process according to the invention in ways known in particular in the art of paper and/or paperboard production. For example, the pulp-based substrate layer may be calendared, pressed, smoothened or otherwise mechanically pre-treated prior to step a) and/or the pulp-based substrate layer may be provided with an internal or external sizing or a print coat or otherwise pre-treated prior to step a). As such, the term pulp-based substrate layer includes what is known as "base papers" in the packaging paper field.

[0032] In a preferred embodiment, the aqueous barrier composition may be applied to the pulp-based substrate layer such as to arrive at a barrier layer having a grammage of from 0.5 gsm to 15 gsm, preferably from 2 to 12 gsm, more preferably from 4 to 11 gsm or from 4 to 10 gsm, Alternatively, the barrier layer may also have a grammage of from 9 gsm to 11 gsm.

[0033] In the process according to the present invention, the drying of the pulp-based substrate layer having a layer of aqueous barrier composition applied to it to form a pulp-based substrate layer having a barrier layer is carried out such that the moisture content of the pulp-based substrate layer having a barrier layer is below 2.5 % by weight or of from 0.5 to 2.5 % by weight, preferably below 2 % by weight or of from 0.5 to 2 % by weight, more preferably below 1.5 % by weight or of from 0.5 to 1.5 % by weight, based on the weight of the pulp-based substrate layer having a barrier layer.

[0034] It is understood that before drying, the moisture content of the pulp-based substrate layer having the aqueous barrier composition applied to it is in excess of 2.5 % by weight, or in excess of 5 % by weight based on the weight of the pulp-based substrate layer and the aqueous barrier composition applied to it. It was determined that the pulp-based substrate layer having the aqueous barrier composition applied to it usually has, due to the amount of water added by way of the aqueous barrier composition, a moisture content of about 9% by weight when the pulp-based substrate layer is a paper via appropriate measurements or calculations. When it is a paperboard, due to the higher grammage, the moisture content will be lower but in any case in excess of 2.5 % by weight.

[0035] The moisture content may be measured either in-line in the paper machine via a calibrated moisture content measuring apparatus configured to correlate the measured moisture content to the moisture content as measured according to the Tappi T412 standard; or it may be measured off-line by sampling and measuring the moisture content according to Tappi T412. It is understood that the person of ordinary skill in the art will be able to correlate the in-line measured moisture content to the moisture content according to a Tappi 412 in order to calibrate the in-line moisture content measuring apparatus.

[0036] In the process according to the present invention, the moisture content of pulp-based substrate layer and the layer barrier layer is below 2.5 % by weight, preferably below 2 % by weight, more preferably below 1.5 % by weight, based on the weight of the pulp-based substrate layer. The moisture content may be determined according to Tappi T412. It is understood that due to the differential water retention properties between the pulp-based substrate layer and the aqueous barrier composition, the measured moisture content is the sum of the individual fractions of moisture content contained in the pulp-based substrate layer and the barrier layer, respectively, at the time of measurement and it is not easily possible to attribute accurately the fraction of the overall moisture content originating from the pulp-based substrate layer or the aqueous barrier composition. It has however been found that when the overall measured moisture content of the pulp-based substrate layer and the barrier layer is below the above given thresholds, the barrier properties of the pulp-based substrate layer having a barrier layer are improved when compared to barrier properties of a pulp-based substrate layer having a barrier layer that has been dried to a more conventional moisture content above the above given thresholds.

[0037] In the pulp-based substrate layer having a barrier layer, obtained via the process according to the invention, a WVTR at tropical conditions (38°C, 90% RH) of less than 10 g/(m2.day), and preferably of less than 5 g/(m2.day) and more preferably of between 1 and 5 g/(m2.day) when measured according to ASTM F1249 may be achieved with a barrier layer having a thickness of about 5 microns or less, or between 1 to 5 microns, which is an unexpectedly low WVTR for a thickness of about 5 microns or less. A OTR (23°C, 50% RH) of less than 0.2 cc/(m2.day), more specifically of between 0.05 and 0.1 cc/(m2.day) may be achieved with a barrier layer having a thickness of about 1 micron or less when measured according to ASTM D3985, which is an unexpectedly low OTR for a thickness of about 5 microns or less.

[0038] The above barrier properties are achieved without including a metal or inorganic layer in the pulp-based substrate layer having a barrier layer. However, it may desirable to even further improve the overall barrier properties of the pulp-based substrate layer having a barrier layer, obtained via the process according to the invention, by the addition of a metal layer, a non-metallic inorganic layer, or both.

[0039] The aqueous barrier composition comprises a barrier compound, preferably in the form of an aqueous dispersion, specifically in the form of an aqueous solution, of a barrier compound. The barrier compound may be any one compound, in particular an organic compound, that is able to improve the barrier properties such as for example OTR or WVTR of the pulp-based substrate layer when formed into a layer on the pulp-based substrate layer. Suitable barrier compounds may be chosen from polymers barrier compounds that may be man-made or natural such as for example polyesters, polyolefins or polyamides. In particular, the man-made polymer barrier compounds may be chosen among PVDC, PE, PP, PET, PA, PVOH, EVOH, PVC, PVA, PLA, PHA, styrene acrylate and styrene butadiene, nanocellulose, cellulose nanocrystals or cellulose nanofibrils. In another embodiment, the aqueous barrier composition further comprises, in addition to the above-mentioned polymers compounds, one or more inorganic barrier compounds. The inorganic barrier compounds may be chosen from mineral barrier compounds such as nanopigments, which are preferably plateled-shaped, such as for example nanoclays. In the case where inorganic barrier compounds are comprised in the aqueous barrier composition, the aqueous barrier composition is preferably an aqueous solution of a barrier compound such as a watersoluble polymer compound, where the inorganic barrier compound is dispersed in.

[0040] The aqueous barrier composition may in a preferred embodiment further include a wax. In a preferred embodiment, when a wax is comprised in the aqueous barrier composition, the aqueous barrier composition may preferably be in the form of an aqueous latex, such as for example a styrene butadiene latex or styrene acrylic latex. Waxes are not soluble in an aqueous environment such as aqueous solutions or water. It is understood that the wax suitable for

the aqueous barrier composition can be man-made or a natural wax, for example man-made wax such as polyethylene wax or alkane wax or for example natural wax such as a wax ester.

[0041] The aqueous barrier composition may be in the form of an aqueous dispersion of a barrier compound. It is understood that "a barrier compound" means one or more barrier compounds, i.e. one single barrier compound or a combination of two or more different barrier compounds. In a preferred embodiment the aqueous dispersion of a barrier compound may comprise one barrier compound or more barrier compounds such as for example two different man-made and/or natural polymer compounds. An example of an aqueous dispersion of a barrier compound is an aqueous dispersion of PVDC. Other examples are aqueous dispersions of styrene butadiene, styrene acrylic, polyethylene co-polymer or polyvinylacetate. It is understood that the term aqueous dispersion of a barrier compound also encompasses, without being limited to, an aqueous latex of a barrier compound. Examples of an aqueous latex of a barrier compound are latex of styrene butadiene or latex of styrene acrylic.

[0042] In an embodiment of the process according to the invention, after the drying step b), the process further comprises the step c) of moisturizing the pulp-based substrate layer having a barrier layer, such that the moisture content of the pulp-based substrate layer having a barrier layer is 3.5 % by weight or more, or between 3.5% and 6% by weight, based on the weight of the pulp-based substrate layer and the barrier layer. This might be necessary under certain circumstances if the pulp-based substrate layer having a barrier layer is subsequently converted or printed immediately downstream of the paper machine or at a later stage since a moisture content of less than 3% by weight leads to increased brittleness and loss of flexibility in the pulp-based substrate layer. Increasing the moisture content above 3 % by weight improves the flexibility of the pulp-based substrate layer. Furthermore, moisturizing reduces curl and removes static charges from the pulp-based substrate layer. Moisturizing may be achieved by applying steam, water mist, water or an aqueous coating, preferably on the reverse side of the pulp-based substrate layer, i.e. the side of the pulp-based substrate layer opposite to the side having the barrier layer. It has been observed that that even though the moisturizing step increases moisture content after drying in step b., it does not negatively affect the barrier properties of the pulp-based substrate layer having a barrier layer. In some instances, after the drying step b), the moisture content of the pulp-based substrate layer having a barrier layer may further be increased to 4.5 % by weight or more, or between 4.5% and 6% by weight, based on the weight of the pulp-based substrate layer and the barrier layer.

[0043] Optionally, the moisturizing step may be followed by a further drying step to adjust the moisture content to a predetermined moisture content above 3 % by weight, preferably to 3% by weight to 5% by weight. Particularly but not exclusively, when the remoistening is done via the application of a further coating layer or of water (pure or otherwise) on the reverse side of the pulp-based substrate layer, drying is preferred in order to avoid blocking, wrinkling or opposite curl.

[0044] In a preferred embodiment of the process according to the present invention, drying the pulp-based substrate layer having a layer of aqueous barrier composition applied to it to form a pulp-based substrate layer having a barrier layer is achieved by exposing the pulp-based substrate layer having a layer of aqueous barrier composition to heat, radiation or underpressure, or a combination of two or more thereof. Heat may be applied for example via hot air or steam, radiation may be in the form of infrared radiation or microwave radiation. It is understood that the same options may be employed in the further drying step after the moisturizing step.

[0045] In a preferred embodiment of the process according to the present invention, drying the pulp-based substrate layer having a layer of aqueous barrier composition applied to it to form a pulp-based substrate layer having a barrier layer is achieved by heating the pulp-based substrate layer having a layer of aqueous barrier composition to a temperature of at least 100°C, preferably at least 115°C, more preferably at least 130°C. This may be done at ambient pressure, i.e. without control of pressure, or at underpressure, i.e. control of pressure such that the pressure is below ambient pressure. In the case where underpressure is used, the drying time at the same drying temperature can be further reduced as compared to the case where drying is carried out at ambient pressure and/or the drying temperature at the same drying time can be further reduced as compared to the case where drying is carried out at ambient pressure. Since the pulp-based substrate layer can be heated in excess of 100°C, it means that the substrate does not suffer from thermal shrinkage as most polymer films such as for example PET, PE or PP, commonly used in barrier film packaging.

[0046] In a preferred embodiment of the process according to the present invention, the pulp-based substrate layer having a layer of an aqueous barrier composition further comprises an intermediate layer positioned between the layer of a barrier composition and the pulp-based substrate layer. In a preferred embodiment, the intermediate layer positioned between the layer of a barrier composition and the pulp-based substrate layer is a primer layer, which primer layer is preferably chosen such as to smoothen and close the surface on the side of the pulp-based substrate layer to which the aqueous barrier composition is to be applied. In the case where an aqueous barrier composition is to be applied on the opposite side as well, a primer layer may or may not be present on that side, and if so, positioned between the respective layer of a barrier composition and the pulp-based substrate layer.

[0047] In a preferred embodiment of the process according to the present invention, in step a), the pulp-based substrate layer having a layer of an aqueous barrier composition applied to it has an intermediate layer such as a primer layer positioned between the pulp-based substrate layer and the layer of the aqueous barrier composition. The intermediate

layer such as a primer layer may smoothen the underlying pulp-based substrate layer, close any pores or pinholes, and provide flexibility that allows for easier converting. As such the intermediate layer or primer layer may have any composition, provided it can achieve at least one of the above functions, and may for example, comprise starch in either unmodified or modified form, man-made polymer dispersions, or even barrier compounds.

[0048] In a preferred embodiment of the process according to the present invention, the pulp-based substrate layer having a barrier layer further comprises an inorganic barrier layer or a metal barrier layer, wherein the inorganic barrier layer or a metal barrier layer may be adjacent to the barrier layer. The inorganic barrier layer or a metal barrier layer is preferably deposited via techniques known as thin-film deposition techniques. In a preferred embodiment of the process according to the present invention, the inorganic barrier layer or a metal barrier layer is deposited via either chemical deposition, such as atomic layer deposition, or physical deposition. It is understood that the inorganic barrier layer or metal barrier layer may only be applied once the pulp-based substrate layer having a barrier layer has been formed or before the aqueous barrier composition is applied to the pulp-based substrate layer. It is not possible to apply the inorganic barrier layer via thin-film deposition to the undried aqueous barrier composition.

[0049] In a preferred embodiment of the process according to the present invention, after step c), the process further comprises the step d) of applying an inorganic barrier layer or a metal barrier layer to the barrier layer via thin-film deposition.

[0050] In the case where a metal barrier layer is deposited, the metal is preferably aluminium. In a preferred embodiment of the process according to the present invention, the metal barrier layer is of aluminium.

[0051] In the case where an inorganic barrier layer is deposited, the inorganic barrier is preferably chosen from metal oxides such as aluminium oxide or silica, e.g. Al_xO_y or SiO_x.

[0052] When the inorganic barrier layer or a metal barrier layer surface is deposited, the surface on which it is deposited on may or may not have been surface treated before the deposition of the inorganic barrier layer or a metal barrier layer. Exemplary surface treatments are plasma treatment or corona treatment.

[0053] In a preferred embodiment of the process according to the present invention, the inorganic barrier layer or the metal barrier layer is adjacent to and deposited directly onto the barrier layer.

[0054] In a preferred embodiment of the process according to the present invention, after step d), the process further comprises the step e) of applying a further layer of aqueous barrier composition to the inorganic barrier layer or a metal barrier layer and drying the resulting stack of layers having the further layer of aqueous barrier composition applied to it to form a further barrier layer such that the moisture content of the resulting stack of layers having a further barrier layer is below 2.5 % by weight, preferably below 2 % by weight, based on the weight of the resulting stack of layers having a barrier layer. The aqueous barrier composition and the further aqueous barrier composition may have the same composition or may have different compositions.

[0055] It is understood that the pulp-based substrate layer having a barrier layer may further be coated with a functional layer such as for example a sealing layer which further may or may not be a printable layer.

[0056] It is a further object of the present invention to provide a packaging material comprising at least one pulp-based substrate layer having a barrier layer obtained by the process as described above, for example a wrapping paper for perishable goods such as snacks, candy, nuts, cereals, chocolate, frozen confectionery, toffee, potato chips, dried fruit, cakes, tea leaves, whole bean or ground coffee, pepper, spices, cured meats, dairy products, fresh food such as vegetables, fruit and meat, dry pet food, tobacco, dehydrated foods, non-foods such as vitamins or minerals, household or personal care products, for example, wherein the pulp-based substrate layer does not contain a metal layer.

[0057] It is a further object of the present invention to provide a packaging material comprising at least one pulp-based substrate layer having, in this order,

optionally, a primer layer adjacent to the pulp-based substrate layer,
a first barrier layer adjacent to the pulp-based substrate layer or the primer layer, wherein the first barrier layer is obtainable according to the process of claim 1,
optionally a sealing layer such as a heat- or cold- sealing layer adjacent to the first barrier layer, wherein the amount of the first barrier layer ranges from 4 gsm to 11 gsm, preferably from 4 to 6 gsm, and wherein the packaging material exhibits a WVTR at tropical conditions (38°C, 90% RH) of 1to 5 g/(m2.d), and wherein the pulp-based substrate layer does not contain a metal layer.

[0058] In a preferred embodiment of the packaging material according to the present invention, the packaging material comprises at least one pulp-based substrate layer having, in this order,

a primer layer adjacent to the pulp-based substrate layer,
a first barrier layer adjacent to the primer layer,
an inorganic barrier layer adjacent to the first barrier layer, where the inorganic barrier layer is deposited via thin-film deposition,

a second barrier layer adjacent to the inorganic barrier layer,
optionally a sealing layer such as a heat- or cold- sealing layer adjacent to the second barrier layer, wherein the combined amount of the first barrier layer and the second barrier layer ranges from 4 gsm to 11 gsm, preferably from 4 to 6 gsm, and wherein the packaging material exhibits a WVTR at tropical conditions (38°C, 90% RH) of 1 to 5 g/(m2.d), and and wherein the pulp-based substrate layer does not contain a metal layer. In a preferred embodiment, the first and second barrier layer have the same composition, and preferably comprise PVDC or a nanopigment. It is expected that PVDC will be phased out to be replaced in the coming years with other barrier compounds having the same or better barrier properties and that are more environmentally friendly.

[0059] In a preferred embodiment of the packaging material, the packaging material comprises at least one pulp-based substrate layer having, in this order,

a barrier layer adjacent to the pulp-based substrate layer, wherein the first barrier layer is obtainable according to the process of claim 1,
optionally a sealing layer such as a heat- or cold- sealing layer adjacent to the second barrier layer, wherein the combined amount of the first barrier layer and the second barrier layer ranges from 4 gsm to 11 gsm, preferably from 4 to 6 gsm, and wherein the packaging material exhibits a WVTR at tropical conditions (38°C, 90% RH) of 1 to 5 g/(m2.d) and wherein the pulp-based substrate layer does not contain a metal layer.

[0060] In a preferred embodiment of the packaging material, the packaging material comprises at least one pulp-based substrate layer having, in this order,

a primer layer adjacent to the pulp-based substrate layer,
a barrier layer adjacent to the primer layer, wherein the first barrier layer is obtainable according to the process of claim 1,
optionally a sealing layer such as a heat- or cold- sealing layer adjacent to the second barrier layer, wherein the combined amount of the first barrier layer and the second barrier layer ranges from 4 gsm to 11 gsm, preferably from 4 to 6 gsm, and wherein the packaging material exhibits a WVTR at tropical conditions (38°C, 90% RH) of 1 to 5 g/(m2.d) and wherein the pulp-based substrate layer does not contain a metal layer.

[0061] It is understood that in the above packaging materials, the respective barrier layers are preferably obtained by applying an aqueous barrier composition to either the pulp-based substrate layer, the primer layer or the inorganic barrier layer as may be the case and then drying the resulting stack of layers having the aqueous barrier composition applied to it such as to form a stack of layers having a barrier layer and such that the moisture content of the resulting stack of layers having a barrier layer is below 2.5 % by weight, preferably below 2 % by weight, based on the weight of the stack of layers having a barrier layer. For the avoidance of doubt, the stack of layers includes the pulp-based substrate layer.

EXPERIMENTAL DATA

Comparative Example 1

[0062] A base paper of 70 gsm was coated with an aqueous dispersion of PVDC such as to achieve a coat weight of 10 +/- 1 gsm and dried until a moisture content of 3% was reached. In general, a person of ordinary skill in the art will know how to achieve a given coat weight when provided with an aqueous barrier composition having a certain solids content of barrier compound by applying the appropriate amount of barrier composition to the base paper.
[0063] The resulting barrier paper exhibited a WVTR at tropical conditions (38°C, 90% RH) of about 3 to 5 g/(m2.d), when measured according to ASTM F1249 and OTR at normal conditions (23°C,50%RH) of higher than 5 cc/(m2.d.).

Example 1

[0064] A base paper of 70 gsm was coated with an aqueous dispersion of PVDC such as to achieve a coat weight of 10 +/- 1 gsm and dried until a moisture content of 1.7% was reached.
[0065] The resulting barrier paper exhibited a WVTR at tropical conditions (38°C, 90% RH) of about 1.5 to 2.5 g/(m2.d), when measured according to ASTM F1249 and a OTR at normal conditions (23°C,50%RH) of between 0.5-2.5 cc/(m2.d.).

Comparative Example 2

[0066] A base paper of 80 gsm was coated with an aqueous dispersion of SBR (styrenebutadiene rubber) and wax

latex mixture such as to achieve a coat weight of 6 +/- 1 gsm and dried until a moisture content of 2.8 % was reached.
[0067] The resulting barrier paper exhibited a WVTR at tropical conditions (38°C, 90% RH) of about 28 to 40 g/(m2.d), when measured according to ASTM F1249.

Example 2

[0068] A base paper of 80 gsm was coated with an aqueous dispersion of SBR and wax latex mixture such as to achieve a coat weight of 6 +/- 1 gsm and dried until a moisture content of 1.8% was reached.
[0069] The resulting barrier paper exhibited a WVTR at tropical conditions (38°C, 90% RH) of about 3 g/(m2.d), when measured according to ASTM F1249.

Comparative Example 3

[0070] A base paper of 80 gsm was coated with an aqueous solution of polyvinyl alcohol such as to achieve a coat weight of 3 +/- 1 gsm and dried until a moisture content of 3.2% was reached.
[0071] The resulting barrier paper exhibited a WVTR at ambient conditions (23°C, 50% RH) of about 2.5 g/(m2.d), when measured according to ASTM F1249.

Example 3

[0072] A base paper of 80 gsm was coated with a aqueous solution of polyvinyl alcohol such as to achieve a coat weight of 3 +/- 1 gsm and dried until a moisture content of 3.2% was reached.
[0073] The resulting barrier paper exhibited a WVTR at ambient conditions (23°C, 50% RH) of about 1 g/(m2.d), when measured according to ASTM F1249.

Comparative Example 4

[0074] A base paper of 80 gsm was first coated with an aqueous solution of predominantly polyvinyl alcohol such as to achieve a coat weight of 2 +/- 1 gsm and dried until a moisture content of 3.4% was reached. Then, a second coating with an aqueous dispersion of SBR and wax latex mixture such as to achieve a coat weight of 7 +/- 1 gsm and dried until a moisture content of 3.5% was reached.
[0075] The resulting barrier paper exhibited a WVTR at tropical conditions (38°C, 90% RH) of about 18 to 23 g/(m2.d), when measured according to ASTM F1249.
[0076] The resulting barrier paper exhibited a OTR (23°C, 50% RH) of above 3 cc/(m2.d).

Example 4

[0077] A base paper of 80 gsm was first coated with an aqueous solution of predominantly polyvinyl alcohol such as to achieve a coat weight of 2 +/- 1 gsm and dried until a moisture content of 2.0% was reached. Then, a second coating with an aqueous dispersion of SBR and wax latex mixture such as to achieve a coat weight of 7 +/- 1 gsm and dried until a moisture content of 1.4% was reached.
[0078] The resulting barrier paper exhibited a WVTR at tropical conditions (38°C, 90% RH) of about 2.5 g/(m2.d), when measured according to ASTM F1249.
[0079] The resulting barrier paper exhibited a OTR (23°C, 50% RH) of about 0.1 cc/(m2.d).

Example 5

[0080] A base paper of 100 gsm having a moisture content of about 4 % by weight was coated with an aqueous barrier composition comprising about 50 % by weight of a barrier compound and about 50 % by weight of water. The aqueous barrier composition was applied to the base paper at a wet coating weight of about 20 gsm to achieve a barrier layer having a dry coating weight of about 10 gsm, and the base paper having the aqueous barrier composition applied to it was then dried to a moisture content of about 2 % by weight, to form a base paper having barrier layer. After the drying, the base paper having barrier layer was re-moisturized to a moisture content of about 4.5 % by weight. The detailed amounts used can be found in Table 1.

Table 1

	Basepaper	Coating	Drying	Remoistening
water (gsm)	4.0	14.0	2.2	5.0
solid (gsm)	96.0	106.0	106.0	106
Total (gsm)	100.0	120.0	108.2	111.0
Moisture content(% by weight)	4.0	11.7	2.0	4.5

LIST OF REFERENCE SIGNS

[0081]

1 pulp-based substrate
2 first barrier layer
3 second barrier layer
4 inorganic barrier layer
5 primer layer

Claims

1. A process for improving the barrier properties of a barrier layer comprised in a pulp-based substrate layer having a barrier layer, comprising the steps of

a) providing a pulp-based substrate layer having a layer of an aqueous barrier composition applied to it, wherein said barrier composition comprises a barrier compound,
b) drying the pulp-based substrate layer having a layer of aqueous barrier composition applied to it to form a pulp-based substrate layer having a barrier layer, such that the moisture content of the pulp-based substrate layer having a barrier layer is below 2.5 % by weight, preferably below 2 % by weight, based on the weight of the pulp-based substrate layer having a barrier layer.

2. The process according to claim 1, wherein the pulp-based substrate layer is a paper or paperboard layer.

3. The process according to claim 1 or 2, wherein the aqueous barrier composition comprises a barrier compound in the form of an aqueous dispersion of a barrier compound or specifically an aqueous solution of a barrier compound.

4. The process according to any of claims 1 to 3, wherein the aqueous barrier composition comprises a moisture vapour barrier compound, an oxygen barrier compound, or both.

5. The process according to any of claims 1 to 4, wherein after step b), the process further comprises the step c) of moisturizing the pulp-based substrate layer having a barrier layer, such that the moisture content of the pulp-based substrate layer having a barrier layer is 3.5 % by weight or more, based on the weight of the pulp-based substrate layer having a barrier layer.

6. The process according to any of claims 1 or 2, wherein the aqueous barrier composition comprises a polymer barrier compound and an inorganic barrier compound.

7. The process according to any of claims 1 to 6, wherein drying the pulp-based substrate layer having a layer of aqueous barrier composition applied to it to form a pulp-based substrate layer having a barrier layer is achieved by exposing the pulp-based substrate layer having a layer of aqueous barrier composition to heat, radiation or under-pressure, or a combination of two or more thereof.

8. The process according to claim 7, wherein drying the pulp-based substrate layer having a layer of aqueous barrier composition applied to it to form a pulp-based substrate layer having a barrier layer is achieved by heating the pulp-based substrate layer having a layer of aqueous barrier composition to a temperature of at least 100°C, preferably at least 115°C, more preferably at least 130°C.

9. The process according to any one of claims 1 to 8, wherein in step a), the pulp-based substrate layer having a layer of an aqueous barrier composition applied to it has a primer layer positioned between the pulp-based substrate layer and the layer of the aqueous barrier composition.

10. The process according to any of claims 6 to 9, wherein after step c), or to any of claims 1 to 5, wherein after step b), the process further comprises the step d) of applying an inorganic barrier layer or a metal barrier layer to the barrier layer via thin-film deposition.

11. The process according to claim 10, wherein after step d), the process further comprises the step e) of applying a further layer of aqueous barrier composition to the inorganic barrier layer or a metal barrier layer and drying resulting stack of layers having the further layer of aqueous barrier composition applied to it to form a further barrier layer such that the moisture content of the resulting stack of layers having a further barrier layer is below 2.5 % by weight, preferably below 2 % by weight, based on the weight of the resulting stack of layers having a further barrier layer.

12. A packaging material comprising at least one pulp-based substrate layer having, in this order,

optionally, a primer layer adjacent to the pulp-based substrate layer,
a first barrier layer adjacent to the pulp-based substrate layer or the primer layer, wherein the first barrier layer is obtainable according to the process of claim 1,
optionally a sealing layer such as a heat- or cold- sealing layer adjacent to the first barrier layer, wherein the amount of the first barrier layer ranges from 4 gsm to 11 gsm, preferably from 4 to 6 gsm, and wherein the packaging material exhibits a WVTR at tropical conditions (38°C, 90% RH) of 1 to 5 g/(m^2.d), and
wherein the pulp-based substrate layer does not contain a metal layer.

13. The packaging material according to any one of claims 12, wherein the packaging material is a wrapping paper or a food tray.

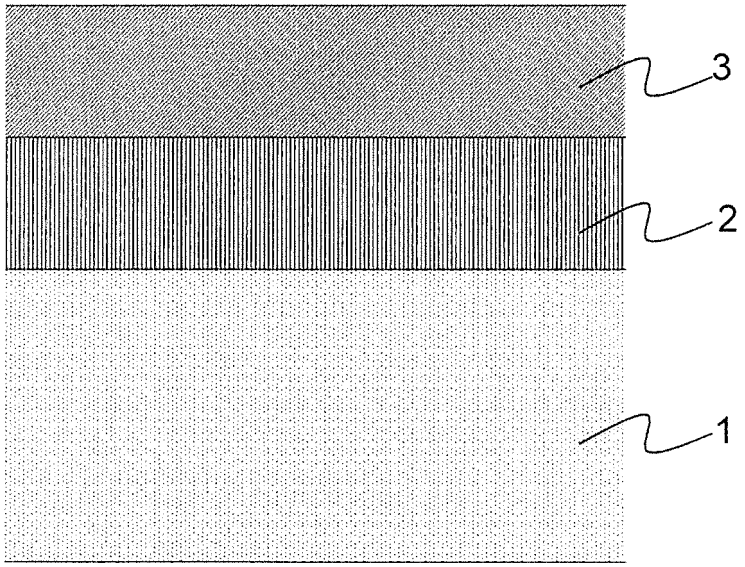

FIG. 1

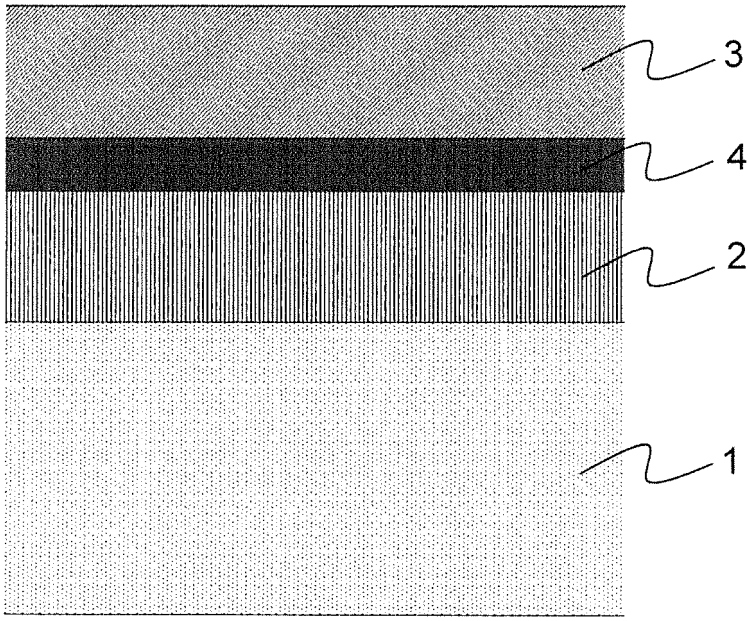

FIG. 2

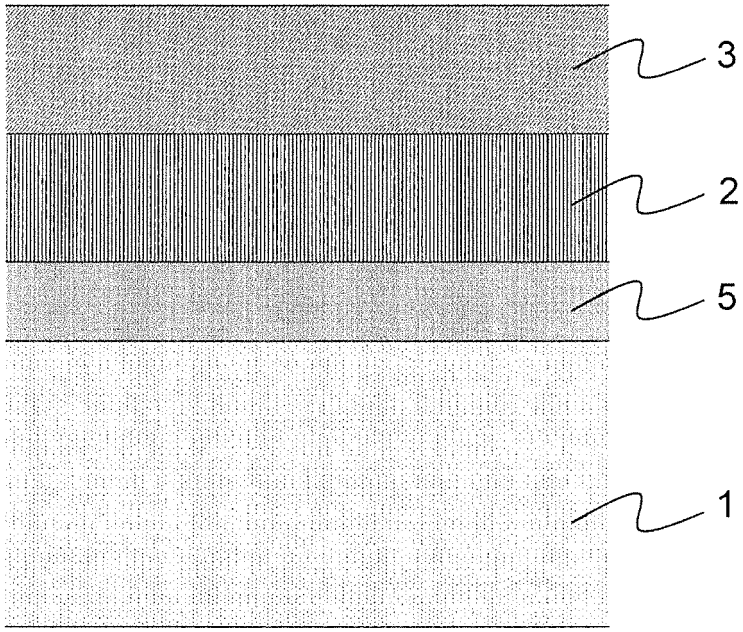

FIG. 3

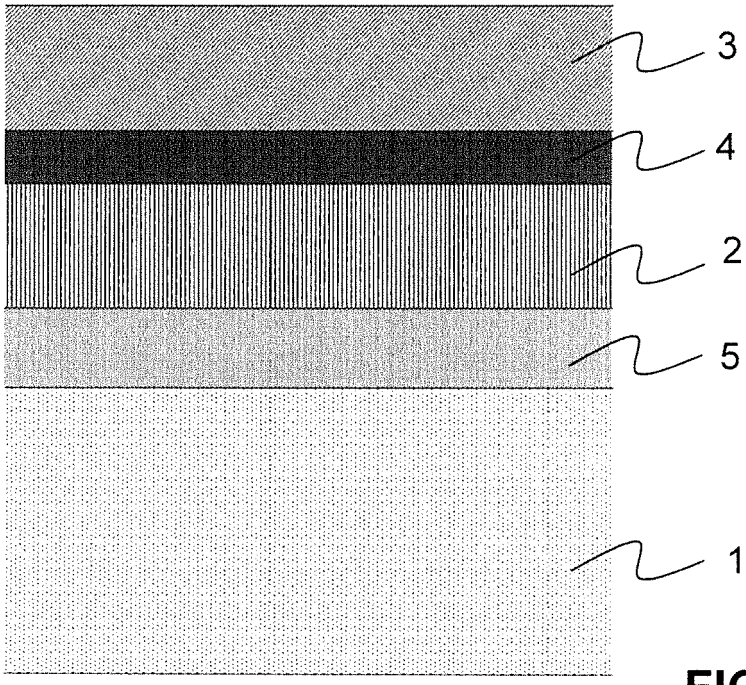

FIG. 4

REFERENCES CITED IN THE DESCRIPTION

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