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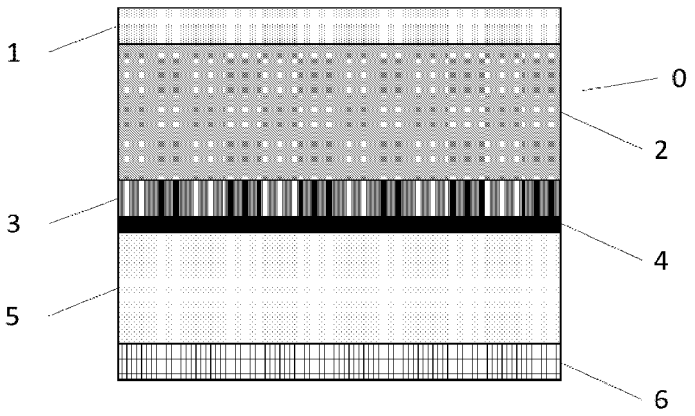
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(54) Title: MULTI-LAYER METALLIZED PAPER-BASED PACKAGING MATERIAL

Figure 1



(57) Abstract: A multi-layer metallized paper-based packaging material comprising, from its outer side to its inner side: an outer side polymeric layer (1); a paper layer (2); an adhesive layer (3); a metallization layer (4); a polymeric film (5); and (6) an inner side polymeric layer; processes for preparing the multi-layer metallized paper-based packaging material.

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MULTI-LAYER METALLIZED PAPER-BASED PACKAGING MATERIAL

Field of the invention

The present invention concerns a packaging paper-based material having high barrier properties to moisture and oxygen, and being recyclable in the recycling paper stream.

Background of the invention

Plastic packaging is used frequently in the economy and in people's daily lives. It has multiple advantages, such as its flexibility and its light weight. Such a weight reduction contributes to fuel saving and C02 reduction during transport, for example. Its barrier properties help to reduce food waste due a positive effect on increasing shelf life. The barrier properties also help to secure food safety.

However, according to the European strategy for plastics in a circular economy, recently published by the European Commission, around 25.8 million tons of plastic waste are generated in Europe every year with less than 30% of such waste being collected for recycling and between 150 000 to 500 000 tons of plastic waste entering the oceans every year.

To ensure that plastic waste is reduced, significant efforts are made in the industry and in commerce. Several supermarkets replace plastic bags by paper based bags, for example. However, replacing plastics with paper in food packaging is not an easy task. A change in packaging material must not compromise consumer safety. The packaging must serve to protect the food, but must also be robust enough to be handled by machines during the production process, and must allow that the food product is presented and protected effectively.

Hence, there is a need for paper based materials with improved barrier properties. There is - in particular - a need for paper based materials with improved barrier properties that minimize plastics content and maximise paper content, to allow for easier sorting and separation of paper-based material during recycling. WO 2000/076862 A9 describes in this respect a laminate structure for packaging applications comprising a paper substrate, and at least one polymer/nanoclay composite layer having clay particles with a thickness ranging from 0.7 to 9 nm applied to said paper substrate with an extrusion or lamination

process. Similarly, WO 2000/077300 A1 and WO 1996/013380 A1 disclose multi-layer packaging materials wherein thick plastic layers are either extruded, co-extruded or laminated to a cellulosic layer. WO 2022/238280 A1 discloses a barrier multi-layer packaging material structure that is recyclable in a paper recycling process, which is metallized for high moisture barrier, and further comprises an additional layer for excellent oxygen barrier and heat seal properties.

However, there is a need in the art to even further improve the barrier and recyclability properties of a paper based packaging material. In particular, there is a need to provide a paper based packaging material that has a high paper fibre content, minimal or no through holes or cracks in any layers, especially the metallization layer, a high WVTR and OTR and that can be made easily at scale.

Summary of the invention

The objective of the present invention is to improve the state of the art and, in particular, to provide a multi-layer packaging material that provides improved barrier properties and may be recycled; and to provide the use of such a multi-layer packaging material to package dry or liquid food products, or to at least to provide a useful alternative to packaging solutions existing in the art.

Consequently, the objectives of the present invention are achieved by the subject matter of the independent claims. The dependent claims further develop the concept of the present invention.

The present inventors propose to solve the above problems by providing a multi-layer metallized paper-based packaging material comprising, from its outer side to its inner side: an outer side polymeric layer; a paper layer; an adhesive layer; a metallization layer; a polymeric film; and an inner side polymeric layer.

The present invention further provides a process for preparing a multi-layer metallized paper-based packaging material comprising: providing a paper layer having an adhesive layer on a second surface thereof and an adhesive layer on a second surface thereof; providing a polymeric film having a metallization layer on a first surface thereof and an inner side polymeric layer on a second surface thereof; and applying the metallization layer to the adhesive layer.

The present invention further provides a process for preparing a multi-layer metallized paper-based packaging material comprising: providing a paper layer having an adhesive layer on a second surface thereof; providing a polymeric film having a metallization layer on a first surface thereof; applying the metallization layer to the adhesive layer; applying an outer side polymeric layer to a first surface of the paper layer; and applying an inner side polymeric layer to a second surface of the polymeric film an inner side polymeric layer.

The present invention further provides a use of a multi-layer packaging material in accordance with the present invention to package dry or liquid food and a food packaging comprising a multi-layer metallized paper-based packaging material in accordance with the present invention.

Brief description of the drawings

Additional features and advantages of the present invention are described in, and will be apparent from, the description of the presently preferred embodiments which are set out below with reference to the drawings in which:

Figure 1 is a schematic representation of the multi-layer metallized paper-based packaging material according to the invention.

Detailed description of the invention

Definitions

As used in this specification, the words "comprises", "comprising", and similar words, are not to be interpreted in an exclusive or exhaustive sense. In other words, they are intended to mean "including, but not limited to".

In the present specification, "optical density" (or "equivalent optical density") of a material is defined as amount of light being reflected from the material, using a reflection densitometer. Optical density is measured by any internationally recognized standard method (e.g. EN ISO 5-2:2009).

In the present specification, "Bekk" smoothness of a material refers to the smoothness of a paper surface, evaluated by measuring the leakage of air applied at a specified pressure between a smooth glass surface and the surface of a paper sample. The time (in seconds) for a fixed volume of air to seep between these surfaces gives the "Bekk" smoothness value. Bekk smoothness is measured by any internationally recognized standard method (e.g. EN ISO 5627).

What is generally meant by "three-dimensional forming" is the application of a process to form a material into a three-dimensional item. Three- dimensional forming processes can comprise for instance deep-drawing, or thermoforming.

In the present application, a "deep-drawing" process is a process by which a material is formed into a shaped mould, by application of a deformation pressure inside said mould, such that the material takes the shape of the mould. During forming in a deep-drawing process, the material can be either deformed and/or stretched.

Thermo-processing of a material refers to the fact that heat is applied to a material in order to transform said material and allow to process it into a pre-determined item or to modify its mechanical properties. For instance, the material can be heated at least in some of its portions, in order to seal said material to another item, or to itself (e.g. to close a sachet made from said material). In another example, heat is applied to said material, e.g. to improve its mechanical resistance to mechanical stress.

Multi-layer metallized paper-based packaging material

The present invention relates to a multi-layer metallized paper-based packaging material 0 of the type shown in Figure 1 comprising, from its outer side to its inner side:

an outer side polymeric layer 1;
a paper layer 2;
an adhesive layer 3;
a metallization layer 4;
a polymeric film 5; and
an inner side polymeric layer 6.

In a preferred embodiment of the invention, the packaging material described therein is used to package edible products. The edible product to be packaged may be a food or beverage product for human or animal consumption in liquid, pasty, gel, granulate, powder, or solid form.

For the purpose of the present invention, the term "paper-based" shall mean that the packaging material may comprise at least 50 weight-%, at least 60 weight-%, at least 70 weight-%, at least 80 weight-%, at least 90 weight-%, at least 95 weight-%, or at least 99 weight-% paper. In preferred embodiments, the packaging material comprises at least 70 weight-%, preferably from about 75 weight-% to about 85 weight-% paper.

The multi-layer metallized paper-based packaging material according to the invention requires packaging forming capabilities, to be able to be processed into a fully formed, filled, and closed package. In a preferred embodiment, the packaging material will be designed for being formed into a package by a folding-gluing process. Such a folding-gluing process allows to form three-dimensional objections (such as boxes and cartons. This process typically involves folding the packaging material along pre-creased lines and applying an adhesive to hold the product in its shape. This process requires the packaging material to be foldable. Alternatively, the material may be designed for being formed into a package by using, for example, a thermoforming process. Such a thermoforming process allows to form three-dimensional objects (such as bottles, cartons, trays, cups, bowls, coffee capsules or pods and the like), and requires the use of heat to form in a shaped mould, the - initially flat - material into a three-dimensional shape. This process requires the application of pressure in addition to heat, for several seconds.

The multi-layer metallized paper-based packaging material in accordance with the present invention preferably achieves an oxygen transmission rate (OTR) of not more than 30 cm^3 / m^2 / day at 23°C and 50% Relative Humidity (RH) and 20.95% oxygen concentration, more preferably of below 10 cm^3 / m^2 / day when measured at 23°C and 50 % Relative Humidity and 20.95% oxygen concentration, and preferably not more than 5 cm^3 / m^2 / day, more preferably not more than 2.5 cm^3 /day/m^2, more preferably not more than 2 cm^3 /day/m^2, and most preferably not more than 1 cm^3 / m^2 / day.

The multi-layer metallized paper-based packaging material in accordance with the present invention may further have a water vapour transmission rate (WVTR) of not more than 1.5 g / d / m^2 when measured at

38°C and 90 % Relative Humidity, preferably not more than 1 g / d / m^2, more preferably not more than 0.8 g / d / m^2, and most preferably not more than 0.5 g / d / m^2.

The paper-based barrier heat resistant packaging material of the invention is recyclable with the paper and carton stream for example. This is due to the fact that the polymer and metal coating can be easily separated from pulp fibres in a recycling process adapted to recycle paper or other cellulosic material (e.g. paperboard).

Outer side polymeric layer

In some embodiments, the outer side polymeric layer comprises a polymer selected from the group consisting of ethylene acrylic and/or methacrylic acid copolymers, propylene acrylic acid copolymers, polyesters, polyolefins, polyvinylidene chloride (PVDC), polybutylene-succinate, thermoplastic starch, or a combination thereof. In preferred embodiments, the outer side polymeric layer comprises a polymer selected from the group consisting of polyethylene and polypropylene, or a combination thereof. In particularly preferred embodiments, the outer side polymeric layer comprises polyethylene.

In some embodiments, the outer side polymeric layer is one that has been applied by a polymer dispersion coating process, a polymer extrusion coating process, or a polymer lamination coating process. In particularly preferred embodiments, the outer side polymeric layer is one that has been applied by a polymer dispersion coating process.

In some embodiments, the outer side polymeric layer has a grammage in the range of from about 1 to about 20 gsm. In some embodiments, the outer side polymeric layer has a grammage in the range of from about 1 to about 10 gsm, preferably about 5 gsm. In other embodiments, wherein the outer side polymeric layer has a grammage in the range of from about 10 to about 20 gsm, preferably about 15 gsm.

In particularly preferred embodiments, the outer side polymeric layer has a grammage in the range of from about 1 to about 10 gsm, preferably about 5 gsm and is one that has been applied by a polymer dispersion coating process. In other particularly preferred embodiments, the outer side polymeric layer has a grammage in the range of from about 10 to about 20 gsm, preferably about 15 gsm and is one that has been applied by a polymer extrusion coating process.

Paper layer

An appropriate paper, especially in terms of thickness and mechanical and chemical stability, shall be selected based typically on the type of product to be packaged, the intended shelf life, and whether the paper material is to be used as primary packaging (i.e. in direct contact with the product), secondary or tertiary packaging.

The paper layer may have a grammage in the range of from about 40 gsm to about 380 gsm. In preferred embodiments, the paper layer may have a grammage in the range of from about 100 gsm to about 300 gsm, preferably from about 160 gsm to about 240 gsm, more preferably from about 180 gsm to about 230 gsm.

In particularly preferred embodiments, the paper layer is around 180 to 230 gsm of a Liquid Packaging Board grade.

Adhesive layer

In preferred embodiments, the adhesive layer comprises a polymer selected from the group consisting of a latex/casein blend, starch, sugar derivatives, cellulose, amino resin, (poly)acrylate, modified polyvinyl alcohol (PVOH), polyvinyl alcohol (PVOH), modified ethylene vinyl alcohol (EVOH), ethylene vinyl alcohol (EVOH), polyvinyl acetate, polyacrylic acid, maleic acid-modified ethylene copolymers, methylcellulose, carboxy-methylcellulose, carboxy-functional polyesters, polyethylene succinate, polybutylene succinate, ionomers or hydrophilic polyurethane, or a combination thereof. In particularly preferred embodiments, the adhesive layer comprises modified polyvinyl alcohol (PVOH), polyvinyl alcohol (PVOH), modified ethylene vinyl alcohol (EVOH), ethylene vinyl alcohol (EVOH), or a combination thereof.

In some embodiments, the adhesive layer may a grammage in the range of from about 1 gsm to about 10 gsm. In preferred embodiments, the adhesive layer has a grammage in the range of from about 1 gsm to about 5 gsm, preferably from about 2 gsm to about 3 gsm.

In addition to providing an adhesion between the paper layer and the metallization layer, the adhesive layer provides an oxygen barrier.

Metallization layer

In the multi-layer metallized paper-based packaging material of the invention, the metallized layer typically has a thickness in the range of from about 1 nm to about 500 nm, preferably of 20 to 400 nm, or even more preferably of 20 to 300 nm. The metallization layer may have a thickness in the range of from about 2 nm to about 200 nm, in the range of from about 6 nm to about 80 nm, or in the range of from about 20 nm to about 50 nm.

It is preferable to maximise the equivalent optical density of the metallization layer. In preferred embodiments, the metallization layer preferably has an equivalent optical density in the range of from more than about 1, more than about 2, more than about 3, or more than about 4. Typically, the metallization layer has an equivalent optical density of from about 1 to about 5, from about 2 to about 5, from about 1.2 to about 3.9, or from about 1.4 to about 3.5.

The metallization layer may comprise any one selected from the group consisting of aluminium, aluminium oxide (AlOx, more precisely AlO_3) or silicon oxide (SiOx), or a combination thereof. In preferred embodiments, the metallized layer is an aluminium layer.

Generally, in the present specification, by "metallized" (or "metallic") layer, it is meant a layer formed from a metal, and by extension a metalloid. Metalloids (like SiOx or AlOx mentioned above) are very close to metals but they differ by some properties to metals - and they are actually not considered as non-metallic elements. In the present specification, it is agreed that such words as "metallized", "pre-metallization", "post-metallization", refer to metallization as such, but also by extension, to metalloidization. The aluminium layer may be applied to the packaging material by chemical deposition or physical vacuum deposition. For example, the aluminium layer may be applied by means of a. An example of a vacuum deposition process is described in Thin Solid Films, Volume 666, 30 November 2018, Pages 6-14. Vacuum deposition is an evaporative process in which aluminium from a solid phase is transferred to the vapour phase and back to the solid phase, gradually building up film thickness. Coatings produced by vacuum deposition have the advantage of good abrasion resistance, impact and temperature

strength, as well as the capability to be deposited on complex surfaces. The range of optical density for the aluminium layer may be in the range of 1.4-3.8, which correlates with a thickness of 30-200 nanometres.

The thickness of the metallization layer may be adjusted appropriately, for example, depending on the intended shelf life, the packaged product and the overall thickness of the packaging material.

During recycling, the metallization layer is separated from the rest of the packaging material due to its very low thickness. Typically, aluminium is separated from the rest of the packaging material during recycling in a hydra-pulper. One major advantage of the present invention is it that despite being deprived of an extruded or laminated polyolefin layer, such as a PE or a PP layer, excellent liquid and gas barrier properties are achieved with the combination of the ultra-thin metal layer which provides a barrier to gases, with the ultra-thin layer of HDPE dispersion coating which provides the barrier to liquids.

Polymeric film

In some embodiments, the polymeric film is very thin. For example, the polymeric film may have a grammage in the range of from about 1 gsm to about 20 gsm, preferably in the range in the range of from about 5 gsm to about 15 gsm, most preferably of about 8 gsm. The polymeric film may have a thickness of from about 2 μm to about 20 μm, preferably of from about 3 μm to about 12 μm, more preferably from about 4 μm to about 8 μm.

The polymeric film may comprise any one selected from the group consisting of polyolefin (e.g. PP or PE), polyester (e.g. PET), biaxially oriented polyamide or polylactic acid, or a combination thereof

The polymeric film may comprise a monoaxially or biaxially oriented film. For example, the polymeric film may comprise any one selected from the group consisting of monoaxially oriented polypropylene (MOPP), biaxially oriented polypropylene (BOPP), biaxially oriented polyester (BOPET), monoaxially oriented polyethylene (MDOPE), biaxially oriented polyamide (BOPA) or biaxially oriented polylactic acid (BOPLA), or a combination thereof. In preferred embodiments, the polymeric film comprises any one selected from the group consisting of monoaxially oriented polypropylene (MOPP), and biaxially oriented polypropylene (BOPP), or a combination thereof.

Inner side polymeric layer

In some embodiments, the inner side polymeric layer comprises a polymer selected from the group consisting of ethylene acrylic and/or methacrylic acid copolymers, propylene acrylic acid copolymers, polyesters, polyolefins, polyvinylidene chloride (PVDC), polybutylene-succinate, thermoplastic starch, or a combination thereof. In preferred embodiments, the inner side polymeric layer comprises a polymer selected from the group consisting of polyethylene and polypropylene, or a combination thereof. In particularly preferred embodiments, the inner side polymeric layer comprises polyethylene.

In some embodiments, the inner side polymeric layer is one that has been applied by a polymer dispersion coating process, a polymer extrusion coating process, or a polymer lamination coating process. In particularly preferred embodiments, the inner side polymeric layer is one that has been applied by a polymer dispersion coating process.

In some embodiments, the inner side polymeric layer has a grammage in the range of from about 1 to about 25 gsm. In some embodiments, the inner side polymeric layer has a grammage in the range of from about 1 to about 10 gsm, preferably about 5 gsm. In other embodiments, wherein the inner side polymeric layer has a grammage in the range of from about 10 to about 20 gsm, preferably about 15 gsm.

In particularly preferred embodiments, the inner side polymeric layer has a grammage in the range of from about 10 to about 25 gsm, preferably about 15 gsm and is one that has been applied by a polymer extrusion coating process.

Process

The present invention provides a process for preparing a multi-layer metallized paper-based packaging material comprising: providing, from an outer side of the multi-layer metallized paper-based packaging material to its inner side,

an outer side polymeric layer;

a paper layer;

an adhesive layer;

a metallization layer;

a polymeric film; and

an inner side polymeric layer.

The chronology in which the layers are deposited may vary according to the particularly manufacturing process used.

For example, in one embodiment the process comprises: providing a paper layer having an adhesive layer on a second surface thereof; providing a polymeric film having a metallization layer on a first surface thereof; and applying the metallization layer to the adhesive layer a paper layer having an adhesive layer on a second surface thereof; providing a polymeric film having a metallization layer on a first surface thereof; and applying the metallization layer to the adhesive layer. The outer side polymeric layer may be added to the first surface of the paper layer before or after applying the metallization layer to the adhesive layer. The inner side polymeric layer may be added to the second surface of the polymeric film before or after applying the metallization layer to the adhesive layer.

In another embodiment, the process comprises: providing a paper layer having a metallization layer on a first surface thereof and an adhesive layer on a second surface thereof; providing a polymeric film; and applying the polymeric layer to the metallization layer. The outer side polymeric layer may be added to the first surface of the paper layer before or after applying the metallization layer to the adhesive layer. The inner side polymeric layer may be added to the second surface of the polymeric film before or after applying the metallization layer to the adhesive layer.

Each of the layers in the process may have any of the features of that layer as defined herein.

Example 1

A multi-layer metallized paper-based packaging material is proposed according to the above principles of the invention. In Example 1, the multi-layer metallized paper-based packaging material comprises, from its outer side to its inner side:

- an outer side polymeric layer having a grammage of about 5 gsm comprised of a polyethylene deposited by a dispersion coating process;
- a paper layer having a grammage of 200 gsm;

- an adhesive oxygen barrier layer having a grammage of from about 2 to about 3 gsm comprising ethylene vinyl alcohol, propylene vinyl alcohol, or a blend thereof;
- a metallization layer having a thickness of about 50 nm comprising vacuum deposited aluminium;
- a polymeric film comprising biaxially oriented polypropylene having a grammage of about 8 gsm; and
- an inner side polymeric layer having a grammage of about 15 gsm comprised of a polyethylene deposited by an extrusion coating process.

The above material is produced as a flat blank sheet, which is then subject to a conventional heat sealing process by pressing said edges one against the other between a pair of sealing jaws. The sealing jaws temperature is set at 180°C, and a sealing pressure of 900 N is applied to said material during 5 seconds.

A multi-layer metallized paper-based packaging material according to Example 1 is proposed to have an 80% paper fibre content, no through holes or cracks in any layers, especially the metallization layer, and a high WVTR and OTR. The multi-layer metallized paper-based packaging material of Example 1 may be made on a large scale with little difficulty.

Example 2

The multi-layer metallized paper-based packaging material of Example 2 is prepared in the same way as Example 1, except that the outer side polymeric layer has a grammage of about 15 gsm and comprised of a polyethylene deposited by an extrusion coating process.

Example 3

The multi-layer metallized paper-based packaging material of Example 3 is prepared in the same way as Example 1, except that the polymeric film comprises monoaxially oriented polypropylene having a grammage of about 8 gsm.

Those skilled in the art will understand that they can freely combine all features of the present invention disclosed herein. In particular, features described for the products of the present invention may be combined with the use of the present invention and vice versa. Further, features described for different embodiments of the present invention may be combined.

Although the invention has been described by way of example, it should be appreciated that variations and modifications may be made without departing from the scope of the invention as defined in the claims.

Furthermore, where known equivalents exist to specific features, such equivalents are incorporated as if specifically referred in this specification. Further advantages and features of the present invention are apparent from the figures and non-limiting examples.

Embodiments

Various preferred features and embodiments of the present invention will now be described with reference to the following numbered paragraphs (paras).

1. A multi-layer metallized paper-based packaging material comprising, from its outer side to its inner side:

an outer side polymeric layer;

a paper layer;

an adhesive layer;

a metallization layer;

a polymeric film; and

an inner side polymeric layer.

2. The multi-layer metallized paper-based packaging material in accordance with para 1, wherein the outer side polymeric layer comprises a heat sealable polymer.

3. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-2, wherein the outer side polymeric layer comprises a polymer selected from the group consisting of ethylene acrylic and/or methacrylic acid copolymers, propylene acrylic acid copolymers, polyesters, polyolefins, polyvinylidene chloride (PVDC), polybutylene-succinate, thermoplastic starch, or a combination thereof.

4. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-3, wherein the outer side polymeric layer comprises a polymer selected from the group consisting of polyethylene and polypropylene, or a combination thereof.

5. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-4, wherein the outer side polymeric layer comprises polyethylene.

6. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-5, wherein the outer side polymeric layer comprises polyethylene applied by a polymer extrusion coating process.

7. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-5, wherein the outer side polymeric layer is one that has been applied by a polymer dispersion coating process.

8. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-5, wherein the outer side polymeric layer is one that has been applied by a polymer lamination coating process.

9. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-8, wherein the outer side polymeric layer has a grammage in the range of from about 1 to about 20 gsm.

10. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-9, wherein the outer side polymeric layer has a grammage in the range of from about 1 to about 10 gsm, preferably about 5 gsm.

11. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-9, wherein the outer side polymeric layer has a grammage in the range of from about 10 to about 20 gsm, preferably about 15 gsm.

12. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-11, wherein the paper layer has a grammage in the range of from about 40 gsm to about 380 gsm.

13. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-12, wherein the paper layer has a grammage in the range of from about 100 gsm to about 300 gsm.

14. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-13, wherein the paper layer has a grammage in the range of from about 160 gsm to about 240 gsm.

15. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-14, wherein the paper layer has a grammage in the range of from about 180 gsm to about 230 gsm.

16. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-15, wherein the adhesive layer comprises a polymer selected from the group consisting of a latex/casein blend, starch, sugar derivatives, cellulose, amino resin, (poly)acrylate, polyvinyl alcohol (PVOH), ethylene vinyl alcohol (EVOH) polyvinyl acetate, polyacrylic acid, maleic acid-modified ethylene copolymers, methylcellulose, carboxy-methylcellulose, carboxy-functional polyesters, polyethylene succinate, polybutylene succinate, ionomers or hydrophilic polyurethane, or a combination thereof.

17. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-16, wherein the adhesive layer comprises modified polyvinyl alcohol (PVOH), polyvinyl alcohol (PVOH), modified ethylene vinyl alcohol (EVOH), ethylene vinyl alcohol (EVOH), or a combination thereof.

18. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-16, wherein the adhesive layer has a grammage in the range of from about 1 gsm to about 5 gsm.

19. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-18, wherein the adhesive layer has a grammage in the range of from about 2 gsm to about 3 gsm.

20. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-19, wherein the metallization layer comprises any one selected from the group consisting of aluminium, aluminium oxide (AlOx) or silicon oxide (SiOx), or a combination thereof.

21. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-20, wherein the metallization layer is one that has been transfer- or vacuum-deposited.

22. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-21, wherein the metallization layer has a thickness in the range of from about 1 nm to about 500 nm.

23. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-22, wherein the metallization layer has a thickness in the range of from about 2 nm to about 200 nm.

24. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-23, wherein the metallization layer has a thickness in the range of from about 6 nm to about 80 nm.

25. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-24, wherein the metallization layer has a thickness in the range of from about 20 nm to about 50 nm.

26. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-25, wherein the metallization layer has an optical density in the range of from about 2 to about 5.

27. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-26, wherein the polymeric film comprises an oriented film.

28. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-27, wherein the polymeric film comprises any one selected from the group consisting of oriented polypropylene (OPP), oriented polyester (OPET), oriented polyethylene (OPE), oriented polyamide (OPA) or oriented polylactic acid (OPLA), or a combination thereof.

29. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-28, wherein the polymeric film comprises any one selected from the group consisting of monoaxially oriented polypropylene (MOPP), biaxially oriented polypropylene (BOPP), biaxially oriented polyester (BOPET), monoaxially oriented polyethylene (MDOPE), biaxially oriented polyamide (BOPA) or biaxially oriented polylactic acid (BOPLA), or a combination thereof.

30. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-29, wherein the polymeric film comprises any one selected from the group consisting of monoaxially oriented polypropylene (MOPP) and biaxially oriented polypropylene (BOPP), or a combination thereof.

31. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-30, wherein the polymeric film has a grammage in the range of from about 1 gsm to about 20 gsm.

32. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-31, wherein the polymeric film has a grammage in the range of from about 5 gsm to about 15 gsm.

33. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-32, wherein the polymeric film has a grammage of about 8 gsm.

34. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-33, wherein the inner side polymeric layer comprises a heat sealable polymer.

35. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-34, wherein the inner side polymeric layer comprises a polymer selected from the group consisting of ethylene acrylic and/or methacrylic acid copolymers, propylene acrylic acid copolymers, polyesters, polyolefins, polyvinylidene chloride (PVDC), polybutylene-succinate, thermoplastic starch, or a combination thereof.

36. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-35, wherein the inner side polymeric layer comprises a polymer selected from the group consisting of polyethylene and polypropylene, or a combination thereof.

37. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-36, wherein the inner side polymeric layer comprises polyethylene.

38. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-37, wherein the inner side polymeric layer comprises polyethylene applied by a polymer extrusion coating process.

39. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-38, wherein the inner side polymeric layer is one that has been applied by a polymer dispersion coating process.

40. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-39, wherein the inner side polymeric layer is one that has been applied by a polymer dispersion coating process.

41. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-40, wherein the inner side polymeric layer has a grammage in the range of from about 1 to about 25 gsm.

42. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-41, wherein the inner side polymeric layer has a grammage in the range of from about 1 to about 10 gsm, preferably about 5 gsm.

43. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-42, wherein the inner side polymeric layer has a grammage in the range of from about 10 to about 25 gsm, preferably about 15 gsm.

44. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-43, wherein the oxygen barrier transfer rate (OTR) is below 10 cm^3 / m^2 / day when measured at 23°C and 50 % Relative Humidity and 20.95% oxygen concentration.

45. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-44, wherein the oxygen barrier transfer rate (OTR) is below 1 cm^3 / m^2 / day when measured at 23°C and 50 % Relative Humidity and 20.95% oxygen concentration.

46. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-45, wherein the moisture barrier transfer rate (WVTR) is below 1.5 g / m^2 / day when measured at 38°C and 90 % Relative Humidity.

47. The multi-layer metallized paper-based packaging material in accordance with any of paras 1-45, wherein the moisture barrier transfer rate (WVTR) is below 0.5 g / m^2 / day when measured at 38°C and 90 % Relative Humidity.

48. A process for preparing a multi-layer metallized paper-based packaging material comprising:

- providing a paper layer having an adhesive layer on a second surface thereof;
- providing a polymeric film having a metallization layer on a first surface thereof; and
- applying the metallization layer to the adhesive layer.

49. The process for preparing a multi-layer metallized paper-based packaging material in accordance with para 48, comprising applying an outer side polymeric layer to a first surface of the paper layer.

50. The process for preparing a multi-layer metallized paper-based packaging material in accordance with para 49, wherein the outer side polymeric layer is applied to the first surface of the paper layer before applying the metallization layer to the adhesive layer.

51. The process for preparing a multi-layer metallized paper-based packaging material in accordance with para 49, wherein the outer side polymeric layer is applied to the first surface of the paper layer after applying the metallization layer to the adhesive layer.

52. The process for preparing a multi-layer metallized paper-based packaging material in accordance with any of paras 48-51, comprising applying an inner side polymeric layer to a second surface of the polymeric film.

53. The process for preparing a multi-layer metallized paper-based packaging material in accordance with para 52, wherein the inner side polymeric layer is applied to the second surface of the polymeric film before applying the metallization layer to the adhesive layer.

54. The process for preparing a multi-layer metallized paper-based packaging material in accordance with para 52 , wherein the inner side polymeric layer is applied to the second surface of the polymeric film after applying the metallization layer to the adhesive layer.

55. The process for preparing a multi-layer metallized paper-based packaging material in accordance with any of paras 48-54, wherein:

the multi-layer metallized paper-based packaging material is as described in any of paras 1-47; and/or

the outer side polymeric layer is as described in any of paras 1-47; and/or

the paper layer is as described in any of paras 1-47; and/or

the adhesive layer is as described in any of paras 1-47; and/or

the metallization layer is as described in any of paras 1-47; and/or

the polymeric film is as described in any of paras 1-47; and/or

the inner side polymeric layer is as described in any of paras 1-47.

Claims

1. A multi-layer metallized paper-based packaging material comprising, from its outer side to its inner side:

an outer side polymeric layer;

a paper layer;

an adhesive layer;

a metallization layer;

a polymeric film; and

an inner side polymeric layer.

2. The multi-layer metallized paper-based packaging material in accordance with claim 1, wherein the outer side polymeric layer has a grammage in the range of from about 10 gsm to about 20 gsm and comprises polyethylene applied by a polymer extrusion coating technique.

3. The multi-layer metallized paper-based packaging material in accordance with claim 1, wherein the outer side polymeric layer has a grammage in the range of from about 1 gsm to about 10 gsm and comprises polyethylene applied by a polymer dispersion coating technique.

4. The multi-layer metallized paper-based packaging material in accordance with any of claims 1-3, wherein the paper layer has a grammage in the range of from about 160 gsm to about 260 gsm, preferably in the range of from about 180 gsm to about 200 gsm.

5. The multi-layer metallized paper-based packaging material in accordance with any of claims 1-4, wherein the adhesive layer has a grammage in the range of from about 1 gsm to about 5 gsm, preferably in the range of from about 2 gsm to about 3 gsm, and comprises modified polyvinyl alcohol (PVOH), polyvinyl alcohol (PVOH), modified ethylene vinyl alcohol (EVOH), ethylene vinyl alcohol (EVOH), or a combination thereof.

6. The multi-layer metallized paper-based packaging material in accordance with any of claims 1-5, wherein the metallization layer comprises any one selected from the group consisting of aluminium,

aluminium oxide (AlOx) or silicon oxide (SiOx), or a combination thereof and the metallization layer has a thickness in the range of from about 6 nm to about 300 nm.

7. The multi-layer metallized paper-based packaging material in accordance with any of claims 1-6, wherein the polymeric film has a grammage in the range of from about 5 gsm to about 15 gsm, preferably about 8 gsm, and comprises oriented polypropylene, such as monoaxially oriented polypropylene (MOPP) and biaxially oriented polypropylene (BOPP),or a combination thereof.

8. The multi-layer metallized paper-based packaging material in accordance with any of claims 1-7, wherein the inner side polymeric layer has a grammage in the range of from about 10 to about 25 gsm, preferably about 15 gsm, and comprises polyethylene applied by a polymer extrusion coating process.

9. The multi-layer metallized paper-based packaging material in accordance with any of claims 1-8, wherein the oxygen barrier transfer rate (OTR) is below 1 cm^3 / m^2 / day when measured at 23°C and 50 % Relative Humidity and 20.95% oxygen concentration.

10. The multi-layer metallized paper-based packaging material in accordance with any of claims 1-9, wherein the moisture barrier transfer rate (WVTR) is below 0.5 g / m^2 / day when measured at 38°C and 90 % Relative Humidity.

11. A process for preparing a multi-layer metallized paper-based packaging material comprising:

- providing a paper layer having an adhesive layer on a second surface thereof and an adhesive layer on a second surface thereof;
- providing a polymeric film having a metallization layer on a first surface thereof and an inner side polymeric layer on a second surface thereof; and
- applying the metallization layer to the adhesive layer.

12. A process for preparing a multi-layer metallized paper-based packaging material comprising:

- providing a paper layer having an adhesive layer on a second surface thereof;
- providing a polymeric film having a metallization layer on a first surface thereof;
- applying the metallization layer to the adhesive layer;
- applying an outer side polymeric layer to a first surface of the paper layer; and

- applying an inner side polymeric layer to a second surface of the polymeric film an inner side polymeric layer.

13. The process for preparing a multi-layer metallized paper-based packaging material in accordance with claim 11 or 12, wherein:

the multi-layer metallized paper-based packaging material is as described in accordance with any of claims 1 to 10; and/or

the outer side polymeric layer is as described in any of claims 1 to 10; and/or

the paper layer is as described in any of claims 1 to 10; and/or

the adhesive layer is as described in any of claims 1 to 10; and/or

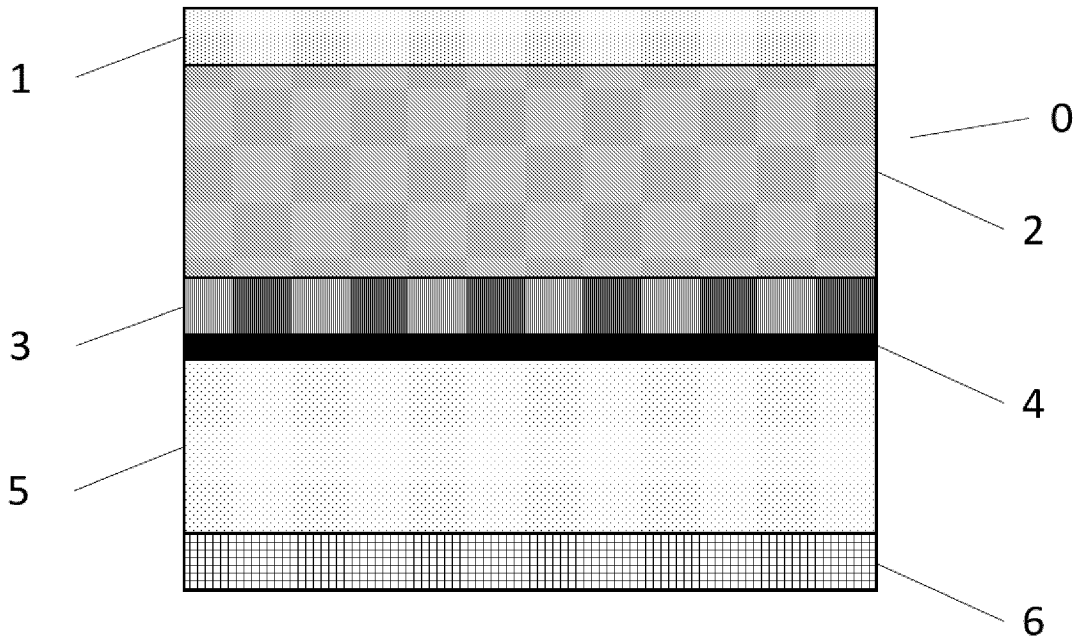
the metallization layer is as described in any of claims 1 to 10; and/or

the polymeric film is as described in any of claims 1 to 10; and/or

the inner side polymeric layer is as described in any of claims 1 to 10.

Drawings

Figure 1



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/071057

A. CLASSIFICATION OF SUBJECT MATTER

INV. B32B15/08 B32B15/085 B32B15/20 B32B27/08 B32B27/10
B32B27/30 B32B27/32 B32B27/34 B32B27/36 B32B27/40
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B32B

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2022/175433 A1 (NESTLE SA [CH]) 25 August 2022 (2022-08-25) claims 1-6; figure 1	1-13
X	WO 2023/285496 A1 (NESTLE SA [CH]) 19 January 2023 (2023-01-19) claims 1-13; figures 1-2	1-13
X	WO 2022/175432 A1 (NESTLE SA [CH]) 25 August 2022 (2022-08-25) claims 1-10; figure 1	1-13

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 August 2024	09/09/2024

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2024/071057

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