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A MULTI-LAYER MATERIAL

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Field of the invention

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The present invention relates to multi-layer materials suitable for forming into flexible containers. Specifically, the present invention relates to multi-layer materials which resist to the aggressive action of products comprising hypochlorite bleach.

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Background of the invention

A wide variety of packaging materials are known. Many of said packaging materials are in the form of materials made of different layers. Said various layers allow to obtain a composite material with a desired combination of properties otherwise not available from a single layer of a single material.

A commercially available and very cost efficient multi-layer material comprises polyethylene terephthalate (=PET) laminated with an adhesive to a

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polyethylene layer. Preferably, said polyethylene layer is made of low density polyethylene (=LDPE). Usually the PET is the outer layer and the LDPE is the inner layer when this multi-layer material is formed into a container, preferably into a flexible sachet or pouch. In a very common execution, sachets or
5 pouches have flat, substantially parallel, opposed rectangular walls completely joined together by heat sealing around their peripheral edges. Specifically, the inner layers of the opposed walls made of LDPE are intimately sealed together. The resulting sachet or pouch is leak tight, and sufficiently resistant to punctures, therefore completely suitable for containing liquid products.

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We found that such a container degrades when it contains a liquid product comprising a hypochlorite bleach. Indeed, the migration of said hypochlorite bleach, or components of said bleach, through said LDPE layer towards the outside of said container is not prevented, specifically towards the adhesive
15 layer of said container. Consequently, said adhesive between the LDPE layer and the outer PET layer is exposed to said bleach or said bleach component(s). As a result, said adhesive may be decomposed, whereby losing its bonding properties. Therefore, the PET layer may de-laminate partially or completely from the LDPE layer. Eventually, the containment properties of
20 said container are degraded, if not completely lost.

It is therefore an object of the present invention to provide a multi-layer material, whose containment properties when formed into a container do not degrade, when said container contains a liquid product comprising a
25 hypochlorite bleach.

Summary of the invention

30 The present invention is a multi-layer material for containing liquid products comprising hypochlorite bleach. This multi-layer material comprises an inner layer, a layer of adhesive and an outer layer. Said inner layer is made of a heat sealable polyolefin, and said outer layer is made of a printable plastic material. Said multi-layer material further comprises a means which prevents
35 that said multi-layer material degrades with the aggressive action of said hypochlorite bleach or components of said bleach. Preferably, said multi-layer

material according to the present invention comprises a barrier layer and/or a bleach resistant adhesive layer.

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Detailed description of the invention

In the following, "aggressive" describes the decomposing action exerted by at least a component of said hypochlorite bleach onto a layer of the multi-layer material according to the present invention, like the adhesive layer.
10 Furthermore, in the following, "degradation" is the result of the aggressive action of at least a component of said hypochlorite bleach onto a layer of the multi-layer material according to the present invention, like the de-lamination of the outer layer from the inner layer. A "degradation of the package" may also mean that the package loses its leak tightness caused by the aggressive
15 action of said hypochlorite bleach.

The multi-layer material according to the present invention comprises an outer layer, an inner layer and an adhesive layer. The outer layer should be suitable for printing. Indeed, said outer layer is the outermost layer of said multi-layer
20 material when said multi-layer material is formed into a container. Therefore, suitable materials for the outer layer are printable plastic materials, like polypropylene (=PP), polyethylene terephthalate (=PET), polyamide, polystyrene, ethyl vinyl alcohol (=EVOH), polycarbonate, polyvinyl chloride (=PVC) or cellophane. Preferred printable plastic material for said outer layer
25 is PP or PET.

To facilitate the printing process and/or to ensure an adequate bonding of the inks of the printing on the plastic surface, the surface of the printable plastic is usually varnished with electrostatic coatings or Corona-treated. Both the
30 electrostatic coating and the Corona treatment are methods which are able to orient the electrical charges on the exterior surface of the layer. The orientation of the electrical charges give rise to attractive electrostatic forces for the subsequent adhesion of the inks. Specifically, the electrostatic coating is the application of a solution containing metal ions on the exterior surface of
35 the outer layer. Whereas, the Corona treatment is an electrostatic method also acting on the exterior surface of the outer layer.

Said inner layer is made of a heat sealable polyolefin. A heat sealable polyolefin facilitates the forming of a container. Indeed, to form a container it is sufficient to seal together said inner layer of a first sheet to said inner layer of a second sheet with a heat sealing process, both sheets being made of the multi-layer material according to the present invention. Preferably, said heat sealable polyolefin is polyethylene, more preferably polyethylene of low density (=LDPE) or linear low density polyethylene (=LLDPE). As a preferred option, ethyl vinyl acetate (=EVA) is added to said inner layer to lower the melting point and facilitate consequently the heat sealing process. Preferably, said inner layer made of LDPE or LLDPE has a density of at least 0.9 g/cm³ (gram per cubic centimeter), more preferably in the range of 0.910 g/cm³ to 0.925 g/cm³. The thickness of said inner layer is preferably above 80 µm, more preferably between 95 µm and 105 µm.

A third layer herein is an adhesive layer. Said adhesive layer attaches said outer layer with said inner layer. Preferably, said adhesive layer may attach said outer layer to said inner layer through a lamination process. We found that said adhesive layers in the sachets of the prior art are sensitive to the hypochlorite bleach or component(s) of said hypochlorite bleach which is able to migrate through said inner layer. Said adhesive layer, exposed to the aggressive action of said hypochlorite bleach component(s), decomposes. Consequently, the outer layer de-laminates from the inner layer. Therefore, the multi-layer material according to the present invention further comprises a means which prevents that said multi-layer material degrades with the aggressive action of said hypochlorite bleach or components of said hypochlorite bleach.

A means which prevents that said multi-layer material degrades with the aggressive action of said hypochlorite bleach or components of said bleach according to the present invention is an adhesive resistant to hypochlorite bleach. Preferably, said bleach resistant adhesive is made of polyurethane, more preferably, of a two component polyurethane. These adhesive made of polyurethane exhibit a good balance between performance and cost. The two-component polyurethane adhesive comprises as a first component a mixture of polyurethan, polyester and other minor ingredients. The second component comprises isocyanate as co-reactant. This co-reactant acts as a catalyst when mixed with the first component of the two-component polyurethan adhesive.

Said mixing of said co-reactant with said first component improves the bonding properties of said adhesive via a controlled cross-linking of the polymeric structure. Furthermore, the mixture of said co-reactant with said first component improves the flexibility of the adhesive layer, reducing the possibility of breakings in the adhesive layer itself.

Preferably, said first component is first mixed together with said second component of said two-component polyurethan adhesive before applying it onto said multi-layer material. Once applied onto said multi-layer material, such adhesives require usually at least 10 days aging for proper reticulation and polymerization of the adhesive's components before said multi-layer material is further processed and formed into a container. An example of a commercially available adhesive, which we found to be suitable, is ET-691 produced by Morton GmbH, Beim Struckenberge 11, D-28239 Bremen, Germany. We found that this adhesive is sufficiently resistant to the aggressive action of the hypochlorite bleach component(s) to be used in the multi-layer material according to the present invention.

We found that the adhesive's resistance to the aggressive action of said hypochlorite bleach or component(s) of said bleach may be further increased when the adhesive is applied above a threshold surface density. The surface density of said adhesive is the quantity of adhesive over a unit surface, hereinafter expressed in g/m^2 (gram of adhesive per square meter of plastic layer). Consequently, said surface density defines also the thickness of said adhesive layer. Said threshold surface density of said adhesive depends principally on the type of the adhesive itself and from the diffusivity of said hypochlorite bleach components of said product through said inner layer. As an example, using a polyurethane adhesive, an inner layer having a thickness of about $100\ \mu\text{m}$ and having a product comprising hypochlorite bleach with an available chlorine concentration of up to about $150\ \text{g/l}$ (gram per liter), we determined a threshold surface density of at least $2.5\ \text{g/m}^2$, more preferably of about $4\ \text{g/m}^2$.

This threshold surface density has been determined experimentally. In practice, several multi-layer materials with adhesive layers of different surface densities have been immersed in a product comprising the hypochlorite bleach. After 3 weeks, the multi-layer material with the adhesive layer of

lowest surface density showing no delamination, determines said threshold surface density of said adhesive layer. Consequently, as a preferred option to further improve the resistance of said multi-layer material to hypochlorite bleach, said adhesive layer may be applied above said threshold surface density.

Furthermore, we found that another improvement decreasing the adhesive's sensitivity to the aggressive action of said hypochlorite bleach or component(s) of said bleach is to achieve an uniform distribution of said adhesive. Hereinafter, a uniform distribution means that the thickness of the layer is constant with an allowed deviation of less than 50%, more preferably of about 10 %. The uniformity of said adhesive layer may be experimentally determined. A possible way is to cut said multi-layer material through its thickness to obtain a cross sectional cut of said multi-layer material along its thickness. Said cross sectional cut can then be analysed by an optical microscopy. On the contrary, confocal laser microscopy allows to analyse the same cross sectional cut without previously cutting said multi-layer material through its thickness.

A layer of adhesive usually has some imperfections, like cracks, voids and undesirable porosity, where the bonding properties may be easily broken via mechanical or chemical stresses. We found that thin layers of adhesive are more subject to lose their bonding properties than thicker layers. Indeed, the substrates of adhesive in the thinner layer having imperfections may not be sufficiently counterbalanced by the surrounding substrates without imperfections. On the contrary, thicker layers have better chances to counterbalance said imperfections in their greater substrates, i.e. thinner layers of adhesive are more susceptible to lose their bonding properties than thicker layers. Therefore, as another preferred execution to further improve the resistance of said multi-layer material to said hypochlorite bleach, said adhesive layer is uniformly distributed in said multi-layer material.

As another alternative means which prevents that said multi-layer material degrades with the aggressive action of the hypochlorite bleach or components of said bleach is a barrier layer. Said barrier layer is located between said inner layer and said adhesive layer. Preferably, said barrier layer is made of a polyolefin material whose density and thickness is sufficient to prevent the

migration of bleach through said barrier layer towards said adhesive layer. Preferably, said barrier layer is made of polyethylene of medium density (=MDPE) or high density (=HDPE), or of ethyl vinyl alcohol (=EVOH), or of mixtures thereof. Preferably, said barrier layer made has a density of above
5 0.9 g/cm³, more preferably in the range between 0.926 g/cm³ to 0.97 g/cm³, most preferably between 0.926 g/cm³ and 0.965g/cm³. Preferably, the thickness of said barrier layer is between 5 µm and 95 µm, more preferably between 30 µm and 60 µm. We have found that said multi-layer material comprising said barrier layer according to the present invention reduces the
10 migration of the contained hypochlorite bleach or bleach component(s) towards said adhesive layer .

Preferably, said barrier layer is co-extruded with said inner layer, forming a co-extruded layer. Then said outer layer is attached onto said co-extruded layer
15 by said adhesive layer. Indeed, the opposite side made of said inner layer is more adequate for heat sealing in respect to said barrier layer, since a lower sealing energy is necessary for said inner layer. To further improve the resistance of said multi-layer material to said hypochlorite bleach, said adhesive layer may be a adhesive layer resistant to said hypochlorite bleach
20 as described above, and/or said adhesive is applied above said threshold surface density as described above, and/or said adhesive is uniformly distributed as described above.

As described before, said barrier layer is located between said inner layer and
25 said adhesive layer of said multi-layer material to protect said adhesive layer. Specifically, said barrier layer protects said adhesive layer when said multi-layer material is formed into a container containing a product comprising a hypochlorite bleach. Indeed, we found that the hypochlorite bleach or component(s) of the bleach comprised in said product are able to migrate
30 through said inner layer made of LDPE as described above. On the contrary, said barrier layer is able to substantially reduce the migration towards said adhesive layer. Otherwise, without said barrier layer said adhesive layer would be exposed to great amounts of aggressive hypochlorite bleach/ hypochlorite bleach component(s) which are able to decompose said adhesive, and
35 eventually destroy at least partially the bonding properties of said adhesive. Consequently, said outer layer would de-laminate from said co-extruded barrier-inner layer. The corresponding container may lose, for example, its

leak tightness in a few days. Therefore, said barrier layer is able to substantially increase the resistance of said multi-layer material to said hypochlorite bleach.

- 5 As another preferred option according to the present invention, said barrier material may be sandwiched between said inner layer and an intermediate layer. Said intermediate layer is preferably made of low density polyolefin. Preferably, said intermediate layer is made of the same material as said inner layer. This intermediate layer further increases the thickness and the barrier
10 properties of the inner layer and the barrier layer of said multi-layer material in a cost efficient manner. The thickness of said intermediate layer is between 5 μm and 50 μm , more preferably between 20 μm and 40 μm .

- 15 In another preferred option, the wall thickness of the inner layer made of LDPE is increased. In this manner, the permeability of the inner layer to hypochlorite bleach can be further reduced, such to achieve a permeability below the threshold limit for the degradation of the adhesive layer. Preferably, the thickness of said LDPE layer is above 100 μm , and more preferably between 150 μm and 200 μm .

- 20 Said multi-layer material of the present invention is flexible. This means that said multi-layer material can be sufficiently bent without causing any permanent cracking into said multi-layer material itself. Nevertheless, we found that the multi-layer material according to the present invention is more
25 resistant to wrinkles and punctures than the multi-layer material of the prior art without said barrier layer. Furthermore, we found that the water permeability of said multi-layer material according to the present invention is reduced with respect to the multi-layer material of the prior art without said barrier layer. Therefore, said multi-layer material according to the present invention
30 provides better containment properties for liquid products in respect to the multi-layer material of the prior art without said barrier layer.

- When said multi-layer material according to the present invention is formed into a container, said container is able to contain a liquid product comprising
35 hypochlorite bleach. Preferably, said hypochlorite bleach has an available chlorine concentration of up to 150 g/l, most preferably a hypochlorite bleach with an available chlorine concentration in the range between 25 g/l to 50 g/l.

Preferably, said liquid product may be a detergent composition. Said detergent composition may be used for the cleaning of laundry, dish or hard surfaces.

5 The multi-layer of the present invention may be formed into a container. Said container is formed through heat sealing. Preferably, the forming into a container made of said multi-layer material according to the present invention comprises the following steps:

10 A) co-extruding said barrier layer with said inner layer, or as an option, co-extruding said barrier layer between said inner layer and said intermediate layer;

15 B) laminating said co-extruded layer of A) with an outer layer by interposing an adhesive layer between said outer layer and said co-extruded layer of A) to form the multi-layer material according to the present invention;

C) after at least 10 days of aging of B), said multi-layer material according to the present invention is cut into a sheet of desired dimensions;

20 D) at least two said sheets of equal dimensions are opposed against each other in such a manner that said inner layers contact each other;

25 E) said sheets of D) are formed into a sachet or pouch by heat sealing said sheets together along their peripheral edges, apart along a filling portion of said peripheral edges, so to allow the filling of said sachet or pouch;

F) said open sachet or pouch is filled with a liquid product comprising hypochlorite bleach;

30 G) said sachet or pouch is closed completely by heat sealing along said filling portion.

**Claims :**

1. A multi-layer material for containing a liquid product comprising a hypochlorite bleach, said multi-layer material comprising an inner layer, a layer of adhesive and an outer layer, said inner layer being made of a heat sealable polyolefin, and said outer layer being made of a printable material, characterized in that said multi-layer material further comprises a means which prevents that said multi-layer material degrades with the aggressive action of said hypochlorite bleach or components of said bleach.
2. A multi-layer material according to claim 1 characterized in that said means comprises a barrier layer which is made of a polyolefin material whose density and thickness is sufficient to reduce the migration of said hypochlorite bleach through said barrier layer towards said adhesive layer, and said barrier layer is located between said inner layer and said adhesive layer.
3. A multi-layer material according to claim 2 characterized in that said barrier layer is made a material selected from the group consisting of medium or high density polyethylene, ethyl vinyl alcohol and mixtures thereof.
4. A multi-layer material according to any of claims 2 and 3 characterized in that said barrier layer has a thickness of between 5 μm and 95 μm .
5. A multi-layer material according to any of the preceding claims characterized in that said means comprises said adhesive layer which is made of an adhesive resistant to hypochlorite bleach.
6. A multi-layer material according to claim 5 characterized in that said adhesive resistant to hypochlorite bleach is a two-component polyurethane adhesive.
7. A multi-layer material according to any of the preceding claims characterized in that said adhesive is uniformly distributed in said adhesive layer.



8. A multi-layer material according to any of the preceding claims characterized in that said adhesive is applied above the threshold surface density of 2.5 g/m².
- 5 9. A multi-layer material according to any of the claims 2 to 8 characterized in that said multi-layer material further comprises one or more intermediate layers made of polyolefin, and said intermediate layer being located between said adhesive layer and said barrier layer.
- 10 10. A multi-layer material according to any of the preceding claims characterized in that said outer layer is made of printable plastics.
11. A multi-layer material according to claim 9 characterized in that said printable plastics is selected from a group consisting of polyethylene terephthalate, polypropylene, polyamide, polystyrene, ethyl vinyl alcohol, polycarbonate, polyvinyl chloride and cellophane.
- 15 12. A multi-layer material according to any of the preceding claims characterized in that said inner layer is made of low density polyethylene.
- 20 13. A multi-layer material according to any of the preceding claims characterized in that said hypochlorite bleach has an available chlorine concentration up to 150 g/l, preferably in the range of 25 g/l to 50 g/l.
- 25 14. A flexible container made of the multi-layer material according to any of the preceding claims characterized in that said container comprises at least two sheets of said multi-layer material, said sheets heat sealed together along their peripheral edges.
- 30 15. A flexible container according to claim 14 characterized in that said container is filled with a product comprising a hypochlorite bleach.
- 35 16. A flexible container according to any of claims 14 and 15 characterized in that said hypochlorite bleach has an available chlorine concentration of up to 150 g/l, preferably in the range of 25 g/l to 50 g/l.