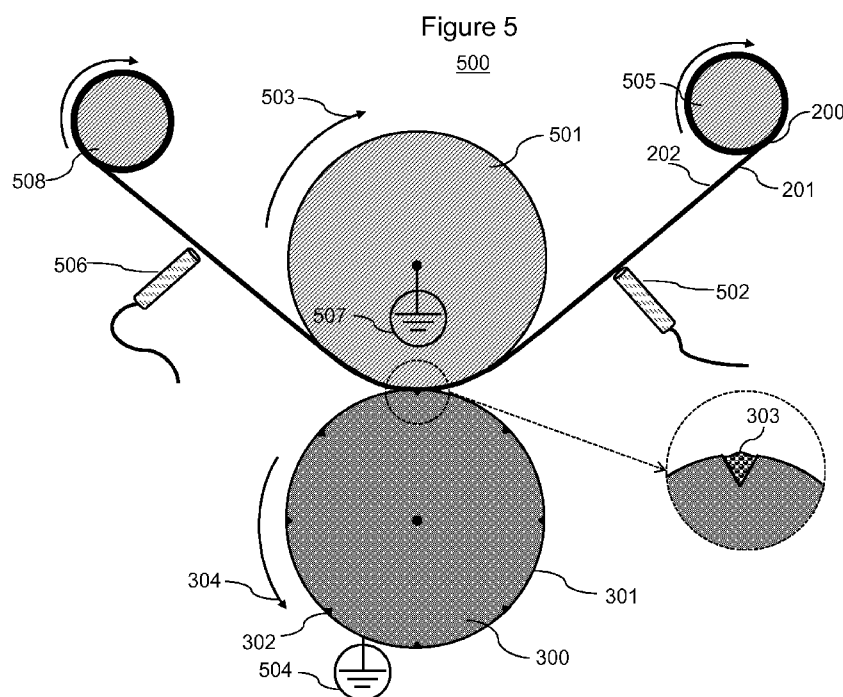




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(57) Abstract: The invention relates to a method (100) comprising, as method steps (101 to 104), • a) providing a sheet like composite (200) comprising, from an outer surface (201) of the sheet like composite to an inner surface (202), • i) a carrier layer (203), • ii) a barrier layer (206), and • iii) an inner polymer layer (208); wherein the sheetlike composite (200) has a first electrical charge; • b) providing a first component (300) comprising a first component surface (301), wherein the first component surface comprises a multitude of recesses (302), wherein the recesses comprise a composition (303) comprising a colourant, wherein the first component (300) moves in a first direction (304), wherein the first component has a second electrical charge; • c) making a first change in the absolute value of the difference between the first electrical charge and the second electrical charge; • d) contacting the outer surface



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(201) of the sheetlike composite with the first component surface (301); and • e) making a further change in the absolute value of the difference between the first electrical charge and the second electrical charge downstream of method step d). The invention further relates to a printed sheetlike composite; to a container precursor and to a container, each comprising the printed sheetlike composite; to an apparatus for printing a sheetlike composite; and to a use of the apparatus for printing a sheetlike composite.

**ELECTROSTATICALLY ASSISTED PRINTING OF A PACKAGING MATERIAL LAMINATE FOR
DIMENSIONALLY STABLE FOOD AND DRINK PRODUCT CONTAINERS COMPRISING THE FOLDED
PACKAGING MATERIAL LAMINATE WITH CHARGING AND DISCHARGING**

The present invention relates to the technical field of dimensionally stable food and drink
product containers made from packaging material laminate, wherein these containers comprise
the packaging material laminate in folded form. More particularly, the present invention relates
to a method comprising, as method steps,

- a) providing a sheetlike composite comprising, as mutually superposed layers, from
an outer surface of the sheetlike composite to an inner surface of the sheetlike
composite,
 - i) a carrier layer,
 - ii) a barrier layer, and
 - iii) an inner polymer layer,wherein the sheetlike composite has a first electrical charge;
- b) providing a first component comprising a first component surface,
wherein the first component surface comprises a multitude of recesses,
wherein the recesses comprise a composition comprising a colourant,
wherein the first component moves in a first direction,
wherein the first component has a second electrical charge;
- c) making a first change in the absolute value of the difference between the first
electrical charge and the second electrical charge;
- d) contacting the outer surface of the sheetlike composite with the first component
surface; and
- e) making a further change in the absolute value of the difference between the first
electrical charge and the second electrical charge downstream of method step d).

The invention further relates to a printed sheetlike composite; to a container precursor and to a container, each comprising the printed sheetlike composite; to an apparatus for printing a sheetlike composite; and to a use of the apparatus for printing a sheetlike composite.

- 5 The prior art discloses dimensionally stable food and drink product containers made from multilayer laminates, also referred to here as sheetlike composites. Containers of this kind are obtained by folding and sealing particular regions of the laminate to one another. The dimensional stability of the container is achieved by virtue of the laminate comprising a carrier layer which often consists of paperboard or cardboard. Food and drink products can be stored
- 10 in such food and drink product containers over a long period with minimum impairment. Typically, the sheetlike composites are formed from a carrier layer usually consisting of paperboard or paper, an adhesion promoter layer, a barrier layer and a further plastic layer, as disclosed inter alia in WO 90/09926 A2.
- 15 Typically, the above-described containers are provided with printed decoration on the outside. This allows the consumer of the food or drink product within the container to be provided with relevant information, for example ingredients of the food or drink product, directly on the container. In addition, the decoration serves for promotional purposes and for the configuration of a pleasing product appearance. In the prior art, the decoration is applied to the laminate by
- 20 an intaglio printing method prior to the folding of the laminate. For this purpose, a print roll having a multitude of recesses, called cells, is used. The cells are filled with a printing ink which, when pressed onto the outer face of the laminate to be printed, is absorbed by the laminate. Thus, the cells of the print roll correspond to the individual pixels of the printed decoration. In order to achieve a print of maximum quality, sufficient printing ink has to be
- 25 applied to the laminate as far as possible from every cell. If too little printing ink, if any, is absorbed by the laminate from a cell, this pixel will be missing in the print. This is also referred to as missing dots. For an acceptable print, only a maximum proportion of missing dots is tolerable. The rougher the laminate surface to be printed, for example a surface of a paperboard layer, the more missing dots will generally arise on printing. The absorption of the
- 30 printing ink by the laminate is made more difficult in that the liquid printing ink in the cell forms a meniscus. The surface level of the printing ink in the cell is accordingly concave,

meaning that it curves away from the laminate. As a result, only laminate surfaces that do not exceed a certain roughness can be satisfactorily printed. The surface roughness of the laminate is determined to a crucial degree by the paperboard layer. Thus, the paperboard layer has to be modified in a usually complex manner, in order to obtain a relatively smooth surface of the laminate having good printability. For this purpose, the paperboard layer is provided, for example, with one or more paper coating layers. This leads to considerable additional costs in the container production.

In general terms, it is an object of the present invention to at least partly overcome a disadvantage that arises from the prior art. It is a further object of the invention to provide a dimensionally stable food or drink product container made from a packaging material laminate with a decoration having an improved print. It is a further object of the present invention to provide a dimensionally stable food or drink product container made from a packaging material laminate with a decoration, wherein the decoration has an equally good or improved print on a relatively rough printed surface. It is a further object of the invention to provide a dimensionally stable food or drink product container made from a packaging material laminate with a decoration, wherein the decoration has been printed directly onto a paperboard or paper layer of the packaging material laminate. It is a further object of the invention to provide a dimensionally stable food or drink product container made from a packaging material laminate with a decoration, wherein the decoration has a lower basis weight for the same area coverage. It is a further object of the invention to provide a dimensionally stable food or drink product container made from a packaging material laminate with a decoration, wherein the decoration has a broader spectrum of area coverage. It is a further object of the invention to provide a dimensionally stable food or drink product container made from a packaging material laminate with a decoration, wherein the food or drink product container is producible at lower cost. It is a further object of the invention to provide a dimensionally stable food or drink product container having one of the above advantages, wherein the decoration has been obtained by intaglio printing. It is a further object of the invention to provide one of the above advantageous dimensionally stable food or drink product containers made from a packaging material laminate, wherein the packaging material laminate comprises an electrically conductive barrier layer, preferably of aluminium.

It is a particular object of the invention to provide an aforementioned food or drink product container, wherein the decoration is multicoloured. In this context, the multicoloured decoration preferably comprises at least 4, more preferably at least 6, printed colour screens of different colours. Particular preference is given here to exactly 5 or 6 printed colour screens of different colours. It is another object of the invention to provide a printing method, preferably an intaglio printing method, and an apparatus for the purpose, with which the above packaging material laminate for dimensionally stable food and drink product containers can be printed with one of the aforementioned decorations. It is additionally an object of the invention to provide the above method, wherein residues of ink solvents on the laminate are reduced. It is also an object of the invention to provide the above process, wherein a drying time of an ink is reduced with the same drying power. It is another object of the invention for the aforementioned method to be performable with maximum safety, especially with regard to operational safety.

A contribution to the at least partial achievement of at least one of the above objects is made by the independent claims. The dependent claims provide preferred embodiments which contribute to the at least partial achievement of at least one of the objects.

A contribution to the achievement of at least one of the objects of the invention is made by an embodiment 1 of a method comprising, as method steps,

a) providing a sheetlike composite comprising, as mutually superposed layers, from an outer surface of the sheetlike composite to an inner surface of the sheetlike composite,

- i) a carrier layer,
- ii) a barrier layer, and
- iii) an inner polymer layer,

wherein the sheetlike composite has a first electrical charge;

b) providing a first component comprising a first component surface, wherein the first component surface comprises a multitude of recesses, wherein the recesses comprise a composition comprising a colourant,

wherein the first component moves in a first direction,

wherein the first component has a second electrical charge;

- c) making a first change in the absolute value of the difference between the first electrical charge and the second electrical charge;
- d) contacting the outer surface of the sheetlike composite with the first component surface; and
- e) making a further change in the absolute value of the difference between the first electrical charge and the second electrical charge downstream of method step d).

One inventive embodiment 2 of the method is configured according to embodiment 1, wherein the first change and the further change are in opposite senses. In one configuration, it is preferable that the first change is an increase in the absolute value of the difference between the first electrical charge and the second electrical charge. In a further configuration, it is preferable that the further change is a decrease in the absolute value of the difference between the first electrical charge and the second electrical charge. Preferably, in the first change, a first electrical voltage of the sheetlike composite versus earth is produced, which, in the further change, is reduced to a further electrical voltage. Further preferably, the first electrical charge is in a range from 200 to 1200 V, preferably from 300 to 1100 V, more preferably from 400 to 1000 V, most preferably from 500 to 900 V.

One inventive embodiment 3 of the method is configured according to embodiment 1 or 2, wherein, in method step a), a further component comprising a further component surface is further provided, wherein the further component surface comprises a multitude of recesses, wherein the recesses comprise a further composition comprising a further colourant, wherein the further component moves in the first direction, wherein the further component has a third electrical charge; wherein the method comprises, downstream of method step e), the following method steps:

- f) making a first change in the absolute value of the difference between the first electrical charge and the third electrical charge; and

- g) contacting the outer surface of the sheetlike composite with the further component surface.

In one aspect of this embodiment, it is preferable that the further component surface comprises a further composition different from the composition of the first component surface. The further composition may differ from the first composition in many respects, the difference preferably lying in the colour of the colourant. Thus, in a further aspect of this embodiment, it is preferable that a plurality of further component surfaces each comprising a multitude of recesses, wherein the recesses comprise a composition comprising a colourant is provided.

10 Preferably, the number of further components and component surfaces is at least 1, more preferably at least 3, even more preferably at least 4. More preferably, the number of further components and component surfaces together is exactly 5 or 6. However, the number may also be 10 or more.

15 One inventive embodiment 4 of the process is configured according to embodiment 3, wherein the method comprises, downstream of method step g), a method step

- h) making a further change in the absolute value of the difference between the first electrical charge and the third electrical charge.

20 One inventive embodiment 5 of the method is configured according to any of the preceding embodiments, wherein the barrier layer is electrically insulating.

One inventive embodiment 6 of the method is configured according to any of the preceding embodiments, wherein, in method step c), the increase is effected by an application of electrical charge carriers from an electrode to the outer surface of the sheetlike composite.

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One inventive embodiment 7 of the method is configured according to any of embodiments 1 to 4 and 6, wherein the barrier layer is electrically conductive.

One inventive embodiment 8 of the method is configured according to embodiment 7, wherein the barrier layer comprises a metal or a metal oxide or both and in each case preferably consists thereof. A preferred metal is aluminium.

- 5 One inventive embodiment 9 of the method is configured according to any of the preceding embodiments, wherein, in method step c) or d) or in both, the sheetlike composite is contacted with an additional component, wherein the additional component moves in another direction, wherein the other direction is different from the first direction. In this context, the sheetlike composite is preferably contacted with the additional component on its inner surface.
- 10 Preferably, the sheetlike composite is guided by the additional component. Preferably, the first direction and the further direction are opposite directions. In a preferred aspect of this embodiment, the additional component presses the outer surface of the sheetlike composite onto the first component. In another preferred aspect of this embodiment, one or more further components each form a pair with one or more additional components.

- 15 One inventive embodiment 10 of the method is configured according to any of the preceding embodiments, wherein the first component rotates, wherein the first direction is a first direction of rotation.

- 20 One inventive embodiment 11 of the method is configured according to embodiment 9 or 10, wherein the additional component rotates, wherein the other direction is another direction of rotation. The other direction of rotation is preferably opposite to the first direction of rotation.

- One inventive embodiment 12 of the method is configured according to any of the preceding
- 25 embodiments, wherein, in method step d), the sheetlike composite is printed by intaglio printing. In one configuration, the sheetlike composite is further printed by intaglio printing in method step g). In this case, in method steps d) and g), preferably different compositions preferably comprising different colourants, preferably of different colour, are applied to, preferably printed onto, the outer surface of the sheetlike composite. This preferably results in
- 30 multicolour printing of the sheetlike composite. According to the desired number of colours, it is also possible for multiple further components and preferably also additional components to

be provided. In this case, downstream of every further component, there is an increase in the absolute value of an electrical charge difference between the sheetlike composite and the further component and, downstream of the further component and downstream of contacting of the outer surface of the sheetlike composite with the further component, a reduction in this absolute value.

One inventive embodiment 13 of the method is configured according to any of the preceding embodiments, wherein the first component is earthed.

One inventive embodiment 14 of the method is configured according to any of the preceding embodiments, wherein the sheetlike composite is characterized by an ignition residue in a range from 0.1 to 75 mg, preferably from 0.2 to 50 mg, more preferably from 0.3 to 30 mg, most preferably from 0.3 to 25 mg.

One inventive embodiment 15 of the method is configured according to any of the preceding embodiments, wherein the sheetlike composite further comprises, on a side of the carrier layer facing the outer surface, an outer polymer layer, wherein the outer polymer layer has a layer thickness in a range from 1 to 30 μm , preferably from 2 to 25 μm , more preferably from 3 to 20 μm , most preferably from 3 to 10 μm .

One inventive embodiment 16 of the method is configured according to any of the preceding embodiments, wherein, in method step d), the sheetlike composite is superimposed by a colour application on the outer surface, wherein the colour application is characterized by a number of missing dots in a range from 0 to 100, preferably from 0 to 70, more preferably from 0 to 60, more preferably from 0 to 40, more preferably from 0 to 30, more preferably from 0 to 20, more preferably from 0 to 10, most preferably from 0 to 8, in each case per 100 mm^2 .

One inventive embodiment 17 of the method is configured according to any of the preceding embodiments, wherein, in method step d), the sheetlike composite is superimposed by a colour application on the outer surface, wherein the colour application comprises a first colour application region and a further colour application region, wherein the first colour application

region is characterized by an area coverage of at least 50%, preferably of at least 60%, more preferably of at least 70%, more preferably of at least 80%, most preferably of at least 90%, wherein the further colour application region is characterized by an area coverage in a range from more than 0% up to 15%, preferably from more than 0% up to 13%, more preferably
5 from more than 0% up to 11%, more preferably from more than 0% up to 9%, most preferably from more than 0% up to 5%, wherein the first colour application region adjoins the further colour application region. The aforementioned degrees of area coverage preferably relate to the same colour.

- 10 One inventive embodiment 18 of the method is configured according to any of the preceding embodiments, wherein the outer surface is a surface of the carrier layer.

One inventive embodiment 19 of the method is configured according to any of the preceding embodiments, wherein the inner polymer layer comprises a polymer prepared by means of a
15 metallocene catalyst to an extent of 10% to 90% by weight, preferably to an extent of 25% to 90% by weight, more preferably to an extent of 30% to 80% by weight, based in each case on the total weight of the inner polymer layer. A preferred polymer polymerized by means of a metallocene catalyst is an mPE.

- 20 One inventive embodiment 20 of the method is configured according to any of the preceding embodiments, wherein the inner polymer layer comprises a polymer blend, wherein the polymer blend comprises an mPE to an extent of 10% to 90% by weight, preferably to an extent of 25% to 90% by weight, more preferably to an extent of 30% to 80% by weight, and a
25 further polymer to an extent of at least 10% by weight, preferably to an extent of at least 15% by weight, more preferably to an extent of at least 20% by weight, based in each case on the total weight of the polymer blend.

One inventive embodiment 21 of the method is configured according to any of the preceding embodiments, wherein the carrier layer is one selected from the group consisting of cardboard,
30 paperboard and paper, or a combination of at least two thereof, and preferably consists thereof.

One inventive embodiment 22 of the method is configured according to any of the preceding embodiments, wherein the carrier layer has at least one hole, wherein the hole is covered at least by the barrier layer and at least by the inner polymer layer as hole-covering layers. The hole-covering layers are each the layers that cover the at least one hole.

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One inventive embodiment 23 of the method is configured according to any of the preceding embodiments, wherein the outer surface does not form part of a cover layer of the carrier layer. A preferred cover layer is a "paper coating".

10 A contribution to the achievement of at least one of the objects of the invention is made by an embodiment 1 of a printed sheetlike composite 1, obtainable by the method according to any of embodiments 1 to 23.

One inventive embodiment 2 of the printed sheetlike composite 1 is configured according to
15 embodiment 1, wherein the outer surface of the sheetlike composite is superimposed by a colour application, wherein the colour application is characterized by a number of missing dots in a range from 0 to 100, preferably from 0 to 70, more preferably from 0 to 60, more preferably from 0 to 40, more preferably from 0 to 30, more preferably from 0 to 20, more preferably from 0 to 10, most preferably from 0 to 8, in each case per 100 mm². Preferably, the
20 outer surface has been printed with the colour application. Preferably, the outer surface of the sheetlike composite has been superimposed with a multitude of colour applications, wherein each colour application comprises a different colour. In this case, the number of colour applications is preferably at least 2, more preferably at least 3, even more preferably at least 4. More preferably, the number of colour applications is exactly 5 or 6. However, the number
25 may also be 10 or more. Most preferably, each of the aforementioned colour applications is characterized by a number of missing dots in a range from 0 to 100, preferably from 0 to 70, more preferably from 0 to 60, more preferably from 0 to 40, more preferably from 0 to 30, more preferably from 0 to 20, more preferably from 0 to 10, most preferably from 0 to 8, in each case per 100 mm².

One inventive embodiment 3 of the printed sheetlike composite 1 is configured according to the preceding embodiment, wherein the colour application comprises a first colour application region and a further colour application region, wherein the first colour application region is characterized by an area coverage of at least 50%, preferably of at least 60%, more preferably of at least 70%, more preferably of at least 80%, most preferably of at least 90%, wherein the further colour application region is characterized by an area coverage in a range from more than 0% up to 15%, preferably from more than 0% up to 13%, more preferably from more than 0% up to 11%, more preferably from more than 0% up to 9%, most preferably from more than 0% up to 5%, wherein the first colour application region adjoins the further colour application region. The aforementioned degrees of area coverage preferably relate to the same colour.

A contribution to the achievement of at least one of the objects of the invention is made by an embodiment 1 of an apparatus comprising, as apparatus constituents,

- a) a feed device arranged and designed to accommodate a sheetlike composite comprising, as mutually superposed layers, from an outer surface of the sheetlike composite to an inner surface of the sheetlike composite,
 - i) a carrier layer,
 - ii) a barrier layer, and
 - iii) an inner polymer layer;
- b) a first electrode arranged and designed for exchange of electrical charge carriers with the outer surface of the sheetlike composite;
- c) a first component comprising a first component surface, wherein the first component surface comprises a multitude of recesses, wherein the recesses are arranged and designed to accommodate a composition comprising a colourant, wherein the first component surface can be contacted with the outer surface of the sheetlike composite;
- d) downstream of the first electrode and the first component, a second electrode designed and arranged for exchange of electrical charge carriers with the outer surface of the sheetlike composite.

One inventive embodiment 2 of the apparatus is configured according to the preceding embodiment, wherein the first electrode and the second electrode are arranged and designed such that the first electrode can have an electrical charge different from the second electrode.

- 5 The difference in the charge of the two electrodes may be of any kind. It is possible for charges of different value of the same sign or else opposite charges to be present, preference being given to the latter. In addition, the above remarks relating to the charges of the electrodes in connection with the method according to the invention are applicable here too. Further preferably, the two electrodes are designed for contacting of the sheetlike composite, wherein
- 10 the sheetlike composite moves at a speed of at least 50 m/min, more preferably of at least 100 m/min, most preferably of 150 m/min. In this case, the sheetlike composite may also move at 600 m/min or more. For this purpose, the two electrodes preferably each comprise a brush made of electrically conductive material. Preferably, the first electrode is designed to produce an absolute value of a voltage of the sheetlike composite versus earth in a range from 500 to
- 15 1500 V, more preferably from 700 to 1300 V, most preferably from 900 to 1100 V. The second electrode is preferably designed for a reduction in the absolute value of the aforementioned voltage of the sheetlike composite verses earth to a value in a range from 0 to 500 V, preferably from 0 to 400 V, more preferably from 0 to 300 V, more preferably from 0 to 200 V, more preferably from 0 to 100 V, more preferably from 0 to 50 V, more preferably
- 20 from 0 to 20 V, most preferably from 0 to 5 V.

- One inventive embodiment 3 of the apparatus is configured according to either of the preceding embodiments 1 and 2, wherein, downstream of apparatus constituent d), a removal device arranged and designed to accommodate the sheetlike composite is provided. Both the
- 25 feed device and the removal device are configured such that the composite can be fed and removed continuously, preferably under tension. Preferably, the feed and removal device are designed as drums on which the composite can be unwound and wound.

- One embodiment 4 of the apparatus is configured according to any of the preceding
- 30 embodiments 1 to 3, wherein, downstream of apparatus constituent d), a further component comprising a further component surface, wherein the further component surface comprises a

multitude of recesses, wherein the recesses are arranged and designed to accommodate a composition comprising a colourant, is provided, wherein the further component surface can be contacted with the outer surface of the sheetlike composite. It is possible for not just one component but also for two or more further components to be provided. The number of further components is chosen, as already explained above in respect of the method according to the invention, preferably by considering the number of colours to be applied. Details with regard to the method according to the invention likewise apply here as preferred details to the apparatus according to the invention.

One inventive embodiment 5 of the apparatus is configured according to any of the preceding embodiments, wherein the barrier layer is electrically insulating.

One inventive embodiment 6 of the apparatus is configured according to any of embodiments 1 to 4, wherein the barrier layer is electrically conductive.

One inventive embodiment 7 of the apparatus is configured according to embodiment 6, wherein the barrier layer comprises a metal or a metal oxide or both and in each case preferably consists thereof. A preferred metal is aluminium.

One inventive embodiment 8 of the apparatus is configured according to any of embodiments 1 to 7, wherein the apparatus comprises an additional component, wherein the additional component is arranged and designed such that the sheetlike composite can be contacted with the additional component. It is preferably the case that the first component is movable in a first direction, the additional component being movable in another direction. It is preferable here that the other direction is opposite to the first direction. In this context, the sheetlike composite can preferably be contacted with the additional component on its inner surface. Preferably, the sheetlike composite can be guided by the additional component, preferably through a gap between the first component and the additional component. It is additionally preferable that the additional component is arranged upstream of the second electrode. Further preferably, the additional component is arranged downstream of the first electrode.

One inventive embodiment 9 of the apparatus is configured according to any of embodiments 4 to 8, wherein the first component is configured so as to be rotatable, wherein the first direction is a first direction of rotation, wherein the further component is configured so as to be rotatable in a further direction, wherein the further direction is a further direction of rotation.

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One inventive embodiment 10 of the apparatus is configured according to any of embodiments 1 to 9, wherein the first component is an intaglio print roll.

One inventive embodiment 11 of the apparatus is configured according to any of embodiments 1 to 10, wherein the first component has been earthed.

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One inventive embodiment 12 of the apparatus is configured according to any of embodiments 1 to 11, wherein the sheetlike composite is characterized by an ignition residue in a range from 0.1 to 75 mg, preferably from 0.2 to 50 mg, more preferably from 0.3 to 30 mg, most preferably from 0.3 to 25 mg.

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One inventive embodiment 13 of the apparatus is configured according to any of embodiments 1 to 12, wherein the sheetlike composite further comprises, on a side of the carrier layer facing the outer surface, an outer polymer layer, wherein the outer polymer layer has a layer thickness in a range from 1 to 30 μm , preferably from 2 to 25 μm , more preferably from 3 to 20 μm , most preferably from 3 to 10 μm .

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One inventive embodiment 14 of the apparatus is configured according to any of embodiments 1 to 13, wherein the outer surface is a surface of the carrier layer.

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One inventive embodiment 15 of the apparatus is configured according to any of embodiments 1 to 14, wherein the inner polymer layer comprises a polymer prepared by means of a metallocene catalyst to an extent of 10% to 90% by weight, preferably to an extent of 25% to 90% by weight, more preferably to an extent of 30% to 80% by weight, based in each case on the total weight of the inner polymer layer. A preferred polymer polymerized by means of a metallocene catalyst is an mPE.

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One inventive embodiment 16 of the apparatus is configured according to any of embodiments 1 to 15, wherein the inner polymer layer comprises a polymer blend, wherein the polymer blend comprises an mPE to an extent of 10% to 90% by weight, preferably to an extent of 25% to 90% by weight, more preferably to an extent of 30% to 80% by weight, and a further polymer to an extent of at least 10% by weight, preferably to an extent of at least 15% by weight, more preferably to an extent of at least 20% by weight, based in each case on the total weight of the polymer blend.

One inventive embodiment 17 of the apparatus is configured according to any of embodiments 1 to 16, wherein the carrier layer is one selected from the group consisting of cardboard, paperboard and paper, or a combination of at least two thereof, and preferably consists thereof.

One inventive embodiment 18 of the apparatus is configured according to any of embodiments 1 to 17, wherein the carrier layer has at least one hole, wherein the hole is covered at least by the barrier layer and at least by the inner polymer layer as hole-covering layers. The hole-covering layers are each the layers that cover the at least one hole.

One inventive embodiment 19 of the apparatus is configured according to any of embodiments 1 to 18, wherein the outer surface does not form part of a cover layer of the carrier layer.

A contribution to the achievement of at least one of the objects of the invention is made by an embodiment 1 of a printed sheetlike composite 2, comprising, as mutually superposed layers, from an outer surface of the printed sheetlike composite to an inner surface of the printed sheetlike composite,

- i) a colour application,
- ii) a carrier layer,
- iii) a barrier layer, and
- iv) an inner polymer layer,

wherein the printed sheetlike composite is characterized by an ignition residue in a range from 0.1 to 75 mg, preferably from 0.2 to 50 mg, more preferably from 0.3 to 30 mg, most

preferably from 0.3 to 25 mg. Preferably, the sheetlike composite comprises a multitude of colour applications on a side of the carrier layer remote from the barrier layer. Preferably, each colour application here comprises a different colour. In this case, the number of colour applications is preferably at least 2, more preferably at least 3, even more preferably at least 4.

- 5 More preferably, the number of colour applications is exactly 5 or 6. However, the number may also be 10 or more.

One inventive embodiment 2 of the printed sheetlike composite 2 is configured according to embodiment 1, wherein the sheetlike composite further comprises, between the colour
10 application and the carrier layer, an outer polymer layer, wherein the outer polymer layer is characterized by a layer thickness in a range from 1 to 30 μm , preferably from 2 to 25 μm , more preferably from 3 to 20 μm , most preferably from 3 to 10 μm .

A contribution to the achievement of at least one of the objects of the invention is made by an
15 embodiment 1 of a printed sheetlike composite 3, comprising, as mutually superposed layers, from an outer surface of the printed sheetlike composite to an inner surface of the printed sheetlike composite,

- i) a colour application,
- ii) an outer polymer layer,
- 20 iii) a carrier layer,
- iv) a barrier layer, and
- v) an inner polymer layer,

wherein the outer polymer layer is characterized by a layer thickness in a range from 1 to 30 μm , preferably from 2 to 25 μm , more preferably from 3 to 20 μm , most preferably from 3
25 to 10 μm . Preferably, the sheetlike composite comprises a multitude of colour applications on a side of the carrier layer remote from the barrier layer. Preferably, each colour application here comprises a different colour. In this case, the number of colour applications is preferably at least 2, more preferably at least 3, even more preferably at least 4. More preferably, the number of colour applications is exactly 5 or 6. However, the number may also be 10 or more.

One inventive embodiment 2 of the printed sheetlike composite 3 is configured according to embodiment 1, wherein the printed sheetlike composite is characterized by an ignition residue in a range from 0.1 to 75 mg, preferably from 0.2 to 50 mg, more preferably from 0.3 to 30 mg, most preferably from 0.3 to 25 mg.

One inventive embodiment 3 of the printed sheetlike composite 2 or 3 is configured according to the respective embodiment 1 or 2, wherein the colour application comprises a first colour application region and a further colour application region, wherein the first colour application region is characterized by an area coverage of at least 50%, preferably of at least 60%, more preferably of at least 70%, more preferably of at least 80%, most preferably of at least 90%, wherein the further colour application region is characterized by an area coverage in a range from more than 0% up to 15%, preferably from more than 0% up to 13%, more preferably from more than 0% up to 11%, more preferably from more than 0% up to 9%, most preferably from more than 0% up to 5%, wherein the first colour application region adjoins the further colour application region. The aforementioned degrees of area coverage preferably relate to the same colour.

One inventive embodiment 4 of the printed sheetlike composite 2 or 3 is configured according to any of its respective embodiments 1 to 3, wherein the colour application is characterized by a number of missing dots in a range from 0 to 100, preferably from 0 to 70, more preferably from 0 to 60, more preferably from 0 to 40, more preferably from 0 to 30, more preferably from 0 to 20, more preferably from 0 to 10, most preferably from 0 to 8, in each case per 100 mm². Most preferably, a multitude, even more preferably each, of the aforementioned colour applications is characterized by a number of missing dots in a range from 0 to 100, preferably from 0 to 70, more preferably from 0 to 60, more preferably from 0 to 40, more preferably from 0 to 30, more preferably from 0 to 20, more preferably from 0 to 10, most preferably from 0 to 8, in each case per 100 mm².

A contribution to the achievement of at least one of the objects of the invention is made by an embodiment 1 of a container precursor at least partly comprising the printed sheetlike

composite 1 according to any of embodiments 1 to 3, or the printed sheetlike composite 2 or 3 according to any of the respective embodiments 1 to 4.

5 A contribution to the achievement of at least one of the objects of the invention is made by an embodiment 1 of a closed container at least partly comprising the printed sheetlike composite 1 according to any of embodiments 1 to 3, or the printed sheetlike composite 2 or 3 according to any of its respective embodiments 1 to 4, wherein the printed sheetlike composite has been folded at least once, more preferably at least twice, more preferably at least 3 times, more preferably at least 4 times, even more preferably at least 5 times, most preferably at least 8
10 times.

A contribution to the achievement of at least one of the objects of the invention is made by an embodiment 1 of a use of the apparatus according to any of embodiments 1 to 19 for printing of the sheetlike composite. A preferred printing method is intaglio printing. Preferably, the
15 sheetlike composite is printed in multiple colours.

In one inventive embodiment 2 of the use of the apparatus, the printing is effected directly onto a surface of the carrier layer.

20 Preferred configurations of constituents of any category according to the invention, especially of the method, the printed sheetlike composite, the container precursor, the closed container, the apparatus and the use, are likewise preferred for constituents of the same name or corresponding constituents of the respective other categories according to the invention.

25 Charge transfer

Method steps c), e), f) and h) of the method according to the invention each comprise a change in the absolute value of a charge difference. In this context, the change in method steps c) and f) is preferably in the opposite sense to the change in method steps e) and h). Further preferably, the change in method steps c) and f) is an increase. The change in method steps e)
30 and h) is preferably a decrease. The increase is preferably effected by transferring electrical charge carriers from an electrode to the sheetlike composite, preferably to the outer face of the

sheetlike composite. The decrease is preferably effected by transferring electrical charge carriers from the sheetlike composite, preferably from the outer face of the sheetlike composite, to an electrode. More preferably, the change in method steps c), e), f) and h) is effected by means of a different electrode in each case. In the case of an electrically insulating barrier layer, the increase in method steps c) or f) or both is preferably effected by transferring electrical charge carriers from one electrode in each case to an additional component which contacts the sheetlike composite on its inner surface in each case. The additional component is preferably a rotating roll, preferably an impression roll. The first component and the further components are preferably rotating rolls, preferably print rolls. Preferably, a contra-rotating impression roll arranged with respect to each print roll contacts the sheetlike composite on its inner surface. Further preferably, the first component and the further components have been earthed. In a further preferred embodiment, the additional components have been earthed. In a preferred configuration of the method according to the invention, an electrical voltage of the barrier layer versus earth is always in a range from -50 to +50 V, preferably from -40 to +40 V, more preferably from -30 to +30 V, most preferably from -20 to +20 V.

Colour application

A colour application comprises at least one colourant. A preferred colour application consists of a multitude of preferably printed dots. The colour application, or the colour application and the further colour applications, preferably form a decoration.

Outer surface

The outer surface of the sheetlike composite is the surface which faces predominantly outward in a container to be produced from the sheetlike composite. Accordingly, the outer surface is in direct contact with an environment of the container. In the sheetlike composite, the outer surface and the inner surface form mutually opposite surfaces of the sheetlike composite.

Layers

Unless stated otherwise, in a layer sequence, the layers may follow one another indirectly, i.e. with one or at least two intermediate layers, or directly, i.e. with no intermediate layer. This is the case especially in the form of words where one layer superimposes another layer. A form

of words where a layer sequence comprises enumerated layers means that at least the layers specified are present in the sequence specified. This form of words does not necessarily mean that these layers follow on directly from one another. A form of words where two layers adjoin one another means that these two layers follow on from one another directly and hence with no intermediate layer.

Carrier layer

The carrier layer used may be any material which is suitable for a person skilled in the art for this purpose and which has sufficient strength and stiffness to impart stability to the container to such an extent that the container in the filled state essentially retains its shape. This is, in particular, a necessary feature of the carrier layer since the invention relates to the technical field of dimensionally stable containers. As well as a number of plastics, preference is given to plant-based fibrous materials, especially pulps, preferably sized, bleached and/or unbleached pulps, paper and paperboard being especially preferred. The basis weight of the carrier layer is preferably in a range from 120 to 450 g/m², especially preferably in a range from 130 to 400 g/m² and most preferably in a range from 150 to 380 g/m². A more preferred paperboard generally has a single-layer or multilayer structure and may have been coated on one or both sides with one or else more than one cover layer. In addition, a preferred paperboard has a residual moisture content of less than 20% by weight, preferably of 2% to 15% by weight and especially preferably of 4% to 10% by weight, based on the total weight of the paperboard. A particularly preferred paperboard has a multilayer structure. Further preferably, the paperboard has, on a surface facing the environment, at least one lamina, but more preferably at least two laminas, of a cover layer known to the person skilled in the art as a "paper coating". In addition, a more preferred paperboard has a Scott bond value in a range from 100 to 360 J/m², preferably from 120 to 350 J/m² and especially preferably from 135 to 310 J/m². By virtue of the aforementioned ranges, it is possible to provide a composite from which it is possible to fold a container with high integrity, easily and in low tolerances.

Barrier layer

The barrier layer used may be any material which is suitable for a person skilled in the art for this purpose and which has sufficient barrier action, especially with respect to oxygen. The barrier layer is preferably selected from

- 5 a. a plastic barrier layer as electrically insulating barrier layer;
 - b. a metal layer as electrically conductive barrier layer;
 - c. a metal oxide layer; or
 - d. a combination of at least two of a. to c.
- 10 If the barrier layer, according to alternative a., is a plastic barrier layer, this preferably comprises at least 70% by weight, especially preferably at least 80% by weight and most preferably at least 95% by weight of at least one plastic which is known to the person skilled in the art for this purpose, especially for aroma or gas barrier properties suitable for packaging containers. Useful plastic, especially thermoplastics, here include N- or O-bearing plastic,
- 15 either alone or in mixtures of two or more. According to the invention, it may be found to be advantageous when the plastic barrier layer has a melting temperature in a range from more than 155 to 300°C, preferably in a range from 160 to 280°C and especially preferably in a range from 170 to 270°C.
- 20 Further preferably, the plastic barrier layer has a basis weight in a range from 2 to 120 g/m², preferably in a range from 3 to 60 g/m², especially preferably in a range from 4 to 40 g/m² and further preferably from 6 to 30 g/m². Further preferably, the plastic barrier layer is obtainable from melts, for example by extrusion, especially laminar extrusion. Further preferably, the p plastic barrier layer may also be introduced into the sheetlike composite via lamination. It is
- 25 preferable in this context that a film is incorporated into the sheetlike composite. In another embodiment, it is also possible to select plastic barrier layers obtainable by deposition from a solution or dispersion of plastics.

Suitable polymers preferably include those having a weight-average molecular weight,

30 determined by gel permeation chromatography (GPC) by means of light scattering, in a range from $3 \cdot 10^3$ to $1 \cdot 10^7$ g/mol, preferably in a range from $5 \cdot 10^3$ to $1 \cdot 10^6$ g/mol and especially

preferably in a range from $6 \cdot 10^3$ to $1 \cdot 10^5$ g/mol. Suitable polymers especially include polyamide (PA) or polyethylene vinyl alcohol (EVOH) or a mixture thereof.

Among the polyamides, useful PAs are all of those that seem suitable to the person skilled in the art for the use according to the invention. Particular mention should be made here of PA 6, PA 6.6, PA 6.10, PA 6.12, PA 11 or PA 12 or a mixture of at least two thereof, particular preference being given to PA 6 and PA 6.6 and further preference to PA 6. PA 6 is commercially available, for example, under the Akulon[®], Durethan[®] and Ultramid[®] trade names. Additionally suitable are amorphous polyamides, for example MXD6, Grivory[®] and Selar[®] PA. It is further preferable that the PA has a density in a range from 1.01 to 1.40 g/cm³, preferably in a range from 1.05 to 1.30 g/cm³ and especially preferably in a range from 1.08 to 1.25 g/cm³. It is further preferable that the PA has a viscosity number in a range from 130 to 250 ml/g and preferably in a range from 140 to 220 ml/g.

Useful EVOHs include all the EVOHs that seem suitable to the person skilled in the art for the use according to the invention. Examples of these are commercially available, inter alia, under the EVALTM trade names from EVAL Europe NV, Belgium, in a multitude of different versions, for example the EVALTM F104B or EVALTM LR171B types. Preferred EVOHs have at least one, two, more than two or all of the following properties:

- an ethylene content in a range from 20 to 60 mol%, preferably from 25 to 45 mol%;
- a density in a range from 1.0 to 1.4 g/cm³, preferably from 1.1 to 1.3 g/cm³;
- a melting point in a range from more than 155 to 235°C, preferably from 165 to 225°C;
- an MFR value (210°C/2.16kg when $T_{S(EVOH)} < 230^\circ\text{C}$; 230°C/2.16kg when $210^\circ\text{C} < T_{S(EVOH)} < 230^\circ\text{C}$) in a range from 1 to 25 g/10min, preferably from 2 to 20 g/10min;
- an oxygen permeation rate in a range from 0.05 to $3.2 \text{ cm}^3 \cdot 20 \mu\text{m} / \text{m}^2 \cdot \text{day} \cdot \text{atm}$, preferably in a range from 0.1 to $1 \text{ cm}^3 \cdot 20 \mu\text{m} / \text{m}^2 \cdot \text{day} \cdot \text{atm}$.

Preferably at least one polymer layer, further preferably the inner polymer layer, or preferably all polymer layers, have a melting temperature below the melting temperature of the barrier layer. This is especially true when the barrier layer is formed from polymer. In this case, the melting temperatures of the at least one polymer layer, especially the inner polymer layer, and

the melting temperature of the barrier layer differ preferably by at least 1 K, especially preferably by at least 10 K, even more preferably by at least 50 K, further preferably at least 100 K. The temperature difference should preferably be chosen only such that it is sufficiently high that there is no melting of the barrier layer, especially no melting of the plastic barrier layer, during the folding.

According to alternative b., the barrier layer is a metal layer. Suitable metal layers are in principle all layers comprising metals which are known to the person skilled in the art and which can provide high light opacity and oxygen impermeability. In a preferred embodiment, the metal layer may take the form of a foil or a deposited layer, for example after a physical gas phase deposition. The metal layer is preferably an uninterrupted layer. In a further preferred embodiment, the metal layer has a thickness in a range from 3 to 20 μm , preferably in a range from 3.5 to 12 μm and especially preferably in a range from 4 to 10 μm .

Metals selected with preference are aluminium, iron or copper. A preferred iron layer may be a steel layer, for example in the form of a foil. Further preferably, the metal layer is a layer comprising aluminium. The aluminium layer may appropriately consist of an aluminium alloy, for example AlFeMn, AlFe1.5Mn, AlFeSi or AlFeSiMn. The purity is typically 97.5% or higher, preferably 98.5% or higher, based in each case on the overall aluminium layer. In a preferred configuration, the metal layer consists of an aluminium foil. Suitable aluminium foils have a ductility of more than 1%, preferably of more than 1.3% and especially preferably of more than 1.5%, and a tensile strength of more than 30 N/mm², preferably more than 40 N/mm² and especially preferably more than 50 N/mm². Suitable aluminium foils in the pipette test show a droplet size of more than 3 mm, preferably more than 4 mm and especially preferably of more than 5 mm. Suitable alloys for creation of aluminium layers or foils are commercially available under the EN AW 1200, EN AW 8079 or EN AW 8111 names from Hydro Aluminium Deutschland GmbH or Amcor Flexibles Singen GmbH. In the case of a metal foil as barrier layer, it is possible to provide an adhesion promoter layer between the metal foil and a closest polymer layer on one or both sides of the metal foil.

Further preferably, the barrier layer selected, according to alternative c., may be a metal oxide layer. Useful metal oxide layers include all metal oxide layers that are familiar and seem suitable to the person skilled in the art, in order to achieve a barrier effect with respect to light, vapour and/or gas. Especially preferred are metal oxide layers based on the metals already mentioned above, aluminium, iron or copper, and those metal oxide layers based on titanium oxide or silicon oxide compounds. A metal oxide layer is produced by way of example by vapour deposition of metal oxide on a polymer layer, for example an oriented polypropylene film. A preferred method for this purpose is physical gas phase deposition.

In a further preferred embodiment, the metal layer of the metal oxide layer may take the form of a layer composite composed of one or more polymer layers with a metal layer. Such a layer is obtainable, for example, by vapour deposition of metal on a plastic layer, for example an oriented polypropylene film. A preferred method for this purpose is physical gas phase deposition.

Polymer layers

The term "polymer layer" refers hereinafter especially to the inner polymer layer, the outer polymer layer and the intermediate polymer layer. An intermediate polymer layer refers here to a polymer layer between the carrier layer and the barrier layer. A preferred polymer is a polyolefin. The polymer layers may have further constituents. The polymer layers are preferably introduced into or applied to the sheetlike composite material in an extrusion method. The further constituents of the polymer layers are preferably constituents that do not adversely affect the behaviour of the polymer melt on application as a layer. The further constituents may, for example, be inorganic compounds, such as metal salts, or further polymers, such as further thermoplastics. However, it is also conceivable that the further constituents are fillers or pigments, for example carbon black or metal oxides. Suitable thermoplastics for the further constituents especially include those that are readily processible by virtue of good extrusion characteristics. Among these, polymers obtained by chain polymerization are suitable, especially polyesters or polyolefins, particular preference being given to cyclic olefin copolymers (COCs), polycyclic olefin copolymers (POCs), especially polyethylene and polypropylene, and very particular preference to polyethylene. Among the

polyethylenes, preference is given to HDPE (*high density polyethylene*), MDPE (*medium density polyethylene*), LDPE (*low density polyethylene*), LLDPE (*linear low density polyethylene*), VLDPE (*very low density polyethylene*) and PE (*polyethylene*), and mixtures of at least two thereof. It is also possible to use mixtures of at least two thermoplastics. Suitable polymer layers have a melt flow rate (MFR) in a range from 1 to 25 g/10 min, preferably in a range from 2 to 20 g/10 min and more preferably in a range from 2.5 to 15 g/10 min, and a density in a range from 0.890 g/cm³ to 0.980 g/cm³, preferably in a range from 0.895 g/cm³ to 0.975 g/cm³, and further preferably in a range from 0.900 g/cm³ to 0.970 g/cm³. The polymer layers preferably have at least one melting temperature in the range from 80 to 155°C, preferably in a range from 90 to 145°C and more preferably in a range from 95 to 135°C.

Polyolefin

A preferred polyolefin is a polyethylene (PE) or a polypropylene (PP) or both. A preferred polyethylene is one selected from the group consisting of an LDPE, an LLDPE, and an HDPE, or a combination of at least two thereof. A further preferred polyolefin is an mPolyolefin (polyolefin prepared by means of a metallocene catalyst). Suitable polyethylenes have a melt flow rate (MFR = MFI – melt flow index) in a range from 1 to 25 g/10 min, preferably in a range from 2 to 20 g/10 min and especially preferably in a range from 2.5 to 15 g/10 min, and a density in a range from 0.910 g/cm³ to 0.935 g/cm³, preferably in a range from 0.912 g/cm³ to 0.932 g/cm³, and further preferably in a range from 0.915 g/cm³ to 0.930 g/cm³.

mPolymer

An mPolymer is a polymer which has been prepared by means of a metallocene catalyst. Metallocene is an organometallic compound in which a central metal atom is arranged between two organic ligands, for example cyclopentadienyl ligands. A preferred mPolymer is an mPolyolefin, preferably an mPolyethylene or an mPolypropylene or both. A preferred mPolyethylene is one selected from the group consisting of an mLDPE, an mLLDPE, and an mHDPE, or a combination of at least two thereof.

Inner polymer layer

The inner polymer layer is based on thermoplastic polymers, where the inner polymer layer may include a particulate inorganic solid. However, it is preferable that the inner polymer layer comprises a thermoplastic polymer to an extent of at least 70% by weight, preferably at least 80% by weight and particularly preferable at least 95% by weight, based in each case on the total weight of the inner polymer layer. Preferably, the polymer or polymer mixture of the inner polymer layer has a density (to ISO 1183-1:2004) in a range from 0.900 to 0.980 g/cm³, more preferably in a range from 0.900 to 0.960 g/cm³ and most preferably in a range from 0.900 to 0.940 g/cm³.

Extrusion

In the extrusion, the polymers are typically heated to temperatures of 210 to 350°C, measured in the molten polymer film beneath the exit from the extruder die. The extrusion can be effected by means of extrusion tools which are known to those skilled in the art and are commercially available, for example extruders, extruder screws, feed blocks, etc. At the end of the extruder, there is preferably an opening through which the polymer melt is pressed. The opening may have any shape that allows extrusion of the polymer melt to the composite precursor. For example, the opening may be angular, oval or round. The opening is preferably in the form of a slot of a funnel. In a preferred configuration of the method, application is effected through a slot. The slot preferably has a length in a range from 0.1 to 100 m, preferably in a range from 0.5 to 50 m, especially preferably in a range from 1 to 10 m. In addition, the slot preferably has a width in a range from 0.1 to 20 mm, preferably in a range from 0.3 to 10 mm, especially preferably in a range from 0.5 to 5 mm. During the application of the polymer melt, it is preferable that the slot and the composite precursor move relative to one another. Preference is given to such a process wherein the composite precursor moves relative to the slot.

In a preferred extrusion coating method, the polymer melt is stretched during the application, this stretching preferably being effected by melt stretching, and most preferably by monoaxial melt stretching. For this purpose, the layer is applied to the composite precursor in the molten state by means of a melt extruder, and the layer applied, which is still in the molten state, is

subsequently stretched in the preferably monoaxial direction, in order to achieve orientation of the polymer in this direction. Subsequently, the layer applied is left to cool for the purpose of heat-setting. In this context, it is especially preferable that the stretching is effected by at least the following application steps:

- 5
- b1. emergence of the polymer melt as a melt film through at least one extruder die slot with a velocity of emergence V_{out} ;
 - b2. application of the melt film to the composite precursor moving relative to the at least
10 one extruder die slot with a velocity of movement V_{for} ;

where $V_{\text{out}} < V_{\text{for}}$. It is especially preferable that V_{for} is greater than V_{out} by a factor in the range from 5 to 200, especially preferably in a range from 7 to 150, further preferably in a range from 10 to 50 and most preferably in a range from 15 to 35. It is preferable here that V_{for} is at
15 least 100 m/min, especially preferably at least 200 m/min and most preferably at least 350 m/min, but typically not more than 1300 m/min. Once the melt layer has been applied to the composite precursor by means of the above-described stretching process, the melt layer is left to cool down for the purpose of heat-setting, this cooling preferably being effected by quenching via contact with a surface which is kept at a temperature in a range from 5 to 50°C,
20 especially preferably in a range from 10 to 30°C.

In a further preferred configuration, the area which has emerged is cooled down to a temperature below the lowest melting temperature of the polymers provided in this area or its flanks, and then at least the flanks of the area are separated from this area. The cooling can be
25 effected in any manner which is familiar to the person skilled in the art and seems to be suitable. Preference is given here too to the heat-setting which has already been described above. Subsequently, at least the flanks are separated from the area. The separation can be conducted in any manner which is familiar to the person skilled in the art and seems to be suitable. Preferably, the separation is effected by means of a knife, laser beam or waterjet, or a
30 combination of two or more thereof, the use of knives being especially preferable, especially knives for shearing.

Melting temperatures

A preferred mPolyolefin is characterized by at least one first melting temperature and a second melting temperature. Preferably, the mPolyolefin is characterized by a third melting temperature in addition to the first and second melting temperature. A preferred first melting temperature is in a range from 84 to 108°C, preferably from 89 to 103°C, more preferably from 94 to 98°C. A preferred further melting temperature is in a range from 100 to 124°C, preferably from 105 to 119°C, more preferably from 110 to 114°C.

Adhesion/adhesion promoter layer

An adhesion promoter layer may be present between layers which do not directly adjoin one another, preferably between the barrier layer and the inner polymer layer. Useful adhesion promoters in an adhesion promoter layer include all polymers which are suitable for producing a firm bond through functionalization by means of suitable functional groups, through the forming of ionic bonds or covalent bonds with a surface of a respective adjacent layer. Preferably, these comprise functionalized polyolefins which have been obtained by copolymerization of ethylene with acrylic acids such as acrylic acid, methacrylic acid, crotonic acid, acrylates, acrylate derivatives or carboxylic anhydrides that bear double bonds, for example maleic anhydride, or at least two of these. Among these, preference is given to polyethylene-maleic anhydride graft polymers (EMAH), ethylene-acrylic acid copolymers (EAA) or ethylene-methacrylic acid copolymers (EMAA), which are sold, for example, under the Bynel[®] and Nucrel[®] 0609HSA trade names by DuPont or Escor[®] 6000ExCo by ExxonMobil Chemicals.

According to the invention, it is preferable that the adhesion between a carrier layer, a polymer layer or a barrier layer and the next layer in each case is at least 0.5 N/15mm, preferably at least 0.7 N/15mm and especially preferably at least 0.8 N/15mm. In one configuration according to the invention, it is preferable that the adhesion between a polymer layer and a carrier layer is at least 0.3 N/15mm, preferably at least 0.5 N/15mm and especially preferably at least 0.7 N/15mm. It is further preferable that the adhesion between a barrier layer and a polymer layer is at least 0.8 N/15mm, preferably at least 1.0 N/15mm and especially preferably

at least 1.4 N/15mm. If a barrier layer indirectly follows a polymer layer with an adhesion promoter layer in between, it is preferable that the adhesion between the barrier layer and the adhesion promoter layer is at least 1.8 N/15mm, preferably at least 2.2 N/15mm and especially preferably at least 2.8 N/15mm. In a particular configuration, the adhesion between the individual layers is sufficiently strong that a carrier layer is torn apart in an adhesion test, called a paperboard fibre tear in the case of a paperboard as carrier layer.

Adhesion promoter

Useful adhesion promoters in the intermediate polymer layer include all polymers which are suitable for producing a firm bond through functionalization by means of suitable functional groups, through the forming of ionic bonds or covalent bonds with a surface of a respective adjacent layer. Preferably, these comprise functionalized polyolefins which have been obtained by copolymerization of ethylene with acrylic acids such as acrylic acid, methacrylic acid, crotonic acid, acrylates, acrylate derivatives or carboxylic anhydrides that bear double bonds, for example maleic anhydride, or at least two of these. Among these, preference is given to polyethylene-maleic anhydride graft polymers (EMAH), ethylene-acrylic acid copolymers (EAA) or ethylene-methacrylic acid copolymers (EMAA), which are sold, for example, under the Bynel[®] and Nucrel[®] 0609HSA trade names by DuPont or Escor[®] 6000ExCo by ExxonMobil Chemicals.

Components

The first component is designed to accommodate the composition in the recesses, also called cells, and for transfer of at least a portion of the composition from the recesses on the outer surface of the sheetlike composite. For this purpose, the outer surface is preferably pressed onto the first component surface. A preferred first component is a print plate or a print roll or both. A preferred print plate is an intaglio print plate. A preferred print roll is an intaglio print roll. A preferred first component surface has a flat design or that of an outer cylindrical surface or both. A preferred additional component is a further roll. A preferred further roll is a counter-pressure roll. A preferred counter-pressure roll is an impression roll. The impression roll preferably consists of a hard material, such as wood or metal, coated with a rubber layer.

Composition

A preferred composition is a solution or a suspension or both. A further preferred composition is a printing ink. A preferred printing ink is a printing ink for intaglio printing. A preferred colourant is a pigment. The composition preferably comprises a convex surface in each of the
5 recesses.

Contacting/printing

A preferred contacting method is pressing. The contacting method is preferably printing. In this case, the sheetlike composite is preferably guided through the gap between the intaglio
10 print roll (first or further component) and the impression roll (additional component).

Cover layer

A preferred cover layer is a "paper coating". A "paper coating" in papermaking is a cover layer comprising inorganic solid particles, preferably pigments and additives. The "paper coating " is
15 preferably applied as an aqueous phase, preferably as a suspension or dispersion, to a surface of a paper- or paperboard-containing layer. A preferred dispersion is an aqueous dispersion. A preferred suspension is an aqueous suspension. A further preferred liquid phase comprises inorganic solid particles, preferably pigments; a binder; and additives. A preferred pigment is selected from the group consisting of calcium carbonate, kaolin, talc, silicate, a plastic pigment
20 and titanium dioxide. A preferred kaolin is a calcined kaolin. A preferred calcium carbonate is one selected from the group consisting of marble, chalk and a precipitated calcium carbonate (PCC) or a combination of at least two thereof. A preferred silicate is a sheet silicate. A preferred plastic pigment is spherical, preferably hollow spherical. A preferred binder is one selected from the group consisting of styrene-butadiene, acrylate, acrylonitrile, a starch and a
25 polyvinyl alcohol or a combination of at least two thereof, preference being given to acrylate. A preferred starch is one selected from the group consisting of cationically modified, anionically modified and fragmented starch or a combination of at least two thereof. A preferred additive is one selected from a rheology modifier, a tinting dye, an optical brightener, a carrier for an optical brightener, a flocculating agent, a deaerator and a surface energy
30 modifier or a combination of at least two thereof. A preferred deaerator is an emulsion paint

deaerator, preferably based on silicone or based on fatty acids or both. A preferred surface energy modifier is a surfactant.

Container precursor

5 A container precursor is a precursor of the closed container which arises in the course of production of a closed container. In this context, the container precursor comprises the sheetlike composite in the form of a blank. In this context, the sheetlike composite may be in an unfolded or folded state. A preferred container precursor has been cut to size and is designed for production of a single closed container. A preferred container precursor which
10 has been cut to size and is designed for production of a single closed container is also referred to as a shell or sleeve. In this context, the shell or sleeve comprises the sheetlike composite in folded form. Moreover, the shell or sleeve comprises a longitudinal seam and is open in a top region and a base region. A typical container precursor which has been cut to size and is designed for production of a multitude of closed containers is often also referred to as a tube.

15 A further preferred container precursor is open, preferably in a top region or a base region, more preferably in both. A preferred container precursor is in the form of a shell or tube or both. A further preferred container precursor comprises the printed sheetlike composite in such a way that the printed sheetlike composite has been folded at least once, preferably at least
20 twice, more preferably at least 3 times, most preferably at least 4 times. A preferred container precursor is in one-piece form. More preferably, a base region of the container precursor is in a one-piece design with a lateral region of the container precursor.

Container

25 The closed container according to the invention may have a multitude of different forms, but preference is given to an essentially cuboidal structure. In addition, the full area of the container may be formed from the sheetlike composite, or it may have a two-part or multipart construction. In the case of a multipart construction, it is conceivable that, as well as the sheetlike composite, other materials are also used, for example plastic, which can be used
30 particularly in the top or base regions of the container. In this context, however, it is preferable that the container is formed from the sheetlike composite to an extent of at least 50%,

especially preferably to an extent of at least 70% and further preferably to an extent of at least 90% of the area. In addition, the container may have a device for emptying the contents. This may be formed, for example, from a polymer or mixture of polymers and be mounted on the outside of the container. It is also conceivable that this device has been integrated into the container by direct injection moulding. In a preferred configuration, the container according to the invention has at least one edge, preferably from 4 to 22 or else more edges, especially preferably from 7 to 12 edges. Edges in the context of the present invention are understood to mean regions which arise in the folding of a surface. Examples of edges include longitudinal contact regions between two wall surfaces of the container in each case, also referred to as longitudinal edges herein. In the container, the container walls are preferably the surfaces of the container framed by the edges. Preferably, the interior of a container according to the invention comprises a food or drink product. Preferably, the closed container does not comprise any lid or base, or either, that has not been formed in one piece with the sheetlike composite. A preferred closed container comprises a food or drink product.

Food or drink product

A preferred closed container according to the invention comprises a food or drink product. Food and drink products include all kinds of food and drink known to those skilled in the art for human consumption and also animal feeds. Preferred food and drink products are liquid above 5°C, for example milk products, soups, sauces, non-carbonated drinks. The container or the container precursor can be filled in various ways. Firstly, the food or drink product and the container or the container precursor can be sterilized as far as possible separately prior to the filling, by means of suitable measures such as the treatment of the container or the container precursor with H₂O₂, UV radiation or other suitable high-energy radiation, plasma treatment or a combination of at least two of these, and the heating of the food or drink product, and then introduced into the container or the container precursor. This method of filling is frequently referred to as "aseptic filling" and is preferred in accordance with the invention. A further widespread method, in addition to or else instead of aseptic filling, is that the container or container precursor filled with food or drink product is heated to reduce the microbe count. This is preferably effected by pasteurizing or autoclaving. In this mode of operation, it is also possible to use less sterile food or drink products and containers or container precursors.

Hole/opening aid

In order to facilitate the openability of the closed container according to the invention, a carrier layer may have at least one hole. In a particular configuration, the hole is covered by at least one barrier layer, and preferably a polymer layer, as hole-covering layers. In addition, one or more further layers, especially adhesion promoter layers, may be provided between the layers already mentioned. It is preferable here that the hole-covering layers are at least partly joined to one another, preferably to an extent of at least 30%, preferably at least 70% and more preferably to an extent of at least 90% of the area formed by the hole. In a particular configuration, it is preferable that the hole penetrates the entire sheetlike composite and is covered by a closure or opening device that closes the hole. In connection with a preferred embodiment, the hole provided in the carrier layer may have any shape which is known to those skilled in the art and is suitable for various closures, drinking straws or opening aids. Usually, a closed container is opened by at least partial destruction of the hole-covering layers that cover the hole. This destruction can be effected by cutting, pressing into the container or pulling out of the container. The destruction can be effected by means of an openable closure which is connected to the container and is arranged in the region of the hole, usually above the hole, or a drinking straw which is used to puncture the hole-covering layers that cover the hole.

In a further preferred embodiment, a carrier layer of the sheetlike composite has a multitude of holes in the form of a perforation, wherein the individual holes are covered at least by a barrier layer, and preferably a polymer layer, as hole-covering layers. A container produced from such a composite can then be opened by tearing along the perforation. Holes of this kind for perforations are preferably produced by means of a laser. Particular preference is given to the use of laser beams when a metal foil or a metallized foil is being used as barrier layer. It is further possible that the perforation is introduced by mechanical perforation tools usually having blades.

In a further preferred embodiment, the sheetlike composite is subjected to a thermal treatment at least in the region of the at least one hole. In the case of a plurality of holes in the carrier layer that are present in the form of a perforation, it is especially preferable to conduct this

thermal treatment around the edge region of the hole as well. The thermal treatment can be effected by means of radiation, by means of hot gas, by means of contact with a hot solid, by means of mechanical vibrations, preferably by means of ultrasound, or by means of a combination of at least two of these measures. More preferably, the thermal treatment is effected by irradiation, preferably electromagnetic radiation and especially preferably electromagnetic induction, or else by means of hot gas. The optimal operating parameters to be chosen in each case are known to the person of average skill in the art.

Colourant

According to DIN 55943:2001-10, colourant is the collective term for all colouring substances, especially for dyes and pigments. A preferred colourant is a pigment. A preferred pigment is an organic pigment. Pigments that are notable in connection with the invention are especially the pigments mentioned in DIN 55943:2001-10 and those mentioned in "Industrial Organic Pigments, Third Edition" (Willy Herbst, Klaus Hunger Copyright © 2004 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim ISBN: 3-527-30576-9).

TEST METHODS

The test methods which follow were utilized within the context of the invention. Unless stated otherwise, the measurements were conducted at an ambient temperature of 25°C, an ambient air pressure of 100 kPa (0.986 atm) and a relative air humidity of 50%.

MFR

MFR is measured according to standard ISO 1133 (unless stated otherwise at 190°C and 2.16 kg).

Density

Density is measured according to standard ISO 1183-1.

Melting temperature

The melting temperature is determined on the basis of the DSC method ISO 11357-1, -5. The instrument is calibrated according to the manufacturer's instructions on the basis of the following measurements:

- 5 - temperature indium - onset temperature,
- heat of fusion indium,
- temperature zinc - onset temperature.

Viscosity number of PA

- 10 Viscosity number of PA is measured according to standard ISO 307 in 95% sulphuric acid.

Oxygen permeation rate

Oxygen permeation rate is determined according to standard ISO 14663-2 Appendix C at 20°C and 65% relative air humidity.

15

Moisture content of paperboard

Moisture content of paperboard is measured according to standard ISO 287:2009.

Adhesion

- 20 The adhesion of two adjacent layers is determined by fixing them in a 90° peel test instrument, for example the Instron “German rotating wheel fixture”, on a rotatable roller which rotates at 40 mm/min during the measurement. The samples had been cut beforehand into strips of width 15 mm. On one side of the sample, the laminas are detached from one another and the detached end is clamped in a tensile device directed vertically upward. A measuring
- 25 instrument to determine the tensile force is attached to the tensile device. As the roller rotates, the force needed to separate the laminas from one another is measured. This force corresponds to the adhesion of the layers to one another and is reported in N/15 mm. The separation of the individual layers can be effected mechanically, for example, or by means of a controlled pretreatment, for example by soaking the sample in 30% acetic acid at 60°C for 3 min.

30

Molecular weight distribution

Molecular weight distribution is measured by gel permeation chromatography by means of light scattering: ISO 16014-3/-5.

5 Missing dots

For examination in a light microscope, five regions of the printed container or laminate with a size of 10 mm × 10 mm are examined. An unprinted dot in the print matrix corresponds to a missing dot. The missing dots are counted for each of the five regions. The arithmetic mean (average value) of the five measurements corresponds to the value "Missing dots".

10

Detection of colourants

Detection of organic colourants can be conducted in accordance with the methods described in "Industrial Organic Pigments, Third Edition" (Willy Herbst, Klaus Hunger Copyright © 2004 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim ISBN: 3-527-30576-9).

15

Area coverage

The area coverage is a measure of the extent to which a colour surface appears to be covered to a normal observer. The area coverage can be calculated by the Murray-Davies formula. All area coverage values in this document were measured with the aid of a spectrophotometer (SpectroEyeTM) from X-Rite (Ch-8105 Regensburg).

20

Ignition residue

In accordance with the standard DIN EN ISO 186 (in a departure from DIN EN 20 287), specimens of 50 mm · 50 mm in size (0.0025 m²) are created from the packaging containers or packaging container precursors or laminates to be tested in order to determine the ignition loss.

25

Subsequently, the following steps are conducted:

1. The paperboard plies are separated by pulling them apart. This involves separating the outer paperboard ply together with the paper coating layer and any outer

30

polymer layer present from the centre ply. The centre ply comprising the inner polymer layer is discarded.

2. Any outer polymer layer present and the outer ply of the paperboard including the paper coating are subsequently converted to ash according to DIN 54370 by ignition method A at 575°C for about 3 hours.

3. The ignition residue is weighed. The absolute value is reported in milligrams (mg).

Layer thickness of the outer polymer layer/of the colour application

A sample of about 2.5 to 3.0 cm · 1.0 to 1.5 cm in size is taken from the composite material (laminate, sheetlike composite) to be examined. The longitudinal side of the sample is taken transverse to the running direction of the extrusion and the fibre direction of the paperboard. The sample is fixed in a metal clamp which forms a smooth surface. The sample excess should not be more than 2-3 mm. The metal clamp is fixed prior to the cut. In order to obtain a clean cut, especially of the paperboard fibres, the portion of the sample protruding from the metal clamp is iced with cold spray. Subsequently, this portion is removed with a disposable blade. The fixing of the sample in the metal clamp is then loosened such that the sample can be moved about 3-4 mm out of the metal clamp. It is then fixed again. For examination in a light microscope, the sample in the sample holder is placed onto the stage of the light microscope under one of the objectives. The appropriate objective should be selected according to the layer thickness of the region to be examined. Exact centring is effected in the course of microscope examination. The light source used in most cases is a lateral illumination (swan's neck). If required, additionally or alternatively, the epiluminescent light source of the light microscope is used. If the sample has been optimally focused and illuminated, the individual layers of the composite are apparent. Documentation and measurements are accomplished with an Olympus camera having appropriate image processing software from Analysis. The layer thickness of the outer polymer layer is reported in absolute terms in micrometres (µm).

List of instruments and materials:

Light microscope; Nikon Eclipse E800

Objectives; magnification X2.5; X5; X10; X20; X50

Illumination: swan's neck

Camera: Olympus DP 71

Software: analySIS

5 Disposable microtome blades; from Leica

Sample holder: metal clamp

Cold spray

Hex key

Vice

10 Cut-resistant gloves

Scissors

Electrical charge/electrical voltages

If a charge of the laminate by an electrode or a voltage of the laminate is to be measured, the
15 measurement is conducted in transverse direction (transverse to the web movement) in the
middle of the composite material web at a distance of 1 cm with a Fluke 280 combined with a
Fluke 80k-6 high-voltage probe from Fluke Deutschland GmbH, Glottertal, Germany. In
addition, the measurement is conducted in the direction of web movement midway between
the electrode by which the electrical charges are applied to the sheetlike composite and the
20 component with which the sheetlike composite is printed, on the outer surface of the laminate.
The measuring instrument measures the electrical field as a measure of the charge on the
sheetlike composite. In addition, the measuring instrument determines the electrical voltage
applied therefrom. The same measuring instrument is also used to measure the further
electrical voltages cited herein.

25

The invention is described in more detail hereinafter by examples and drawings, although the
examples and drawings do not imply any restriction of the invention. Moreover, the drawings
are schematic and not to scale.

30 Production of the composite material (laminate)

A commercial uncoated paperboard (NaturaD UC 200mN; Stora Enso AB; Stockholm, Sweden) is treated according to the following steps:

1. First of all, the paperboard is coated in the laboratory according to the examples and comparative examples with one or more coats of a liquid paper coating. The number of paper coatings to be applied is guided by the ignition residue of the laminate which is to be achieved. The ignition residue is reported in each case in the tables for the examples and comparative examples below. The formulation of the paper coating here is: 100 parts pigment (Hydrocarb 60; Omya Inc; Cincinnati, US) and 20 parts binder / SB latex (MAINCOTE™ HG-56; Dow; Germany). In this context, a sheetlike composite having an ignition residue of 50 mg has a twice-coated carrier layer, a sheetlike composite having an ignition residue of 30 mg has a once-coated carrier layer, and a sheetlike composite having an ignition residue of 2 mg has an uncoated carrier layer.
2. In the extrusion coating process, the coated paperboards are coated with an outer polymer layer and the inner layers specified below. The laminate is produced with an extrusion coating system from Davis Standard. In the first step, the outer polymer layer is applied to the carrier layer. In the second step, the lamination layer is applied together with the barrier layer to the carrier layer that has been coated with the outer polymer layer beforehand. In the last step, the inner polymer layer is applied to the barrier layer. For application of the individual layers, the polymers or polymer blends are melted in an extruder. In the case of application of one polymer or polymer blend in a layer, the resultant melt is transferred via a feed block into a nozzle and extruded onto the carrier layer. In the case of application of two or more polymers or polymer blends in a layer, the resultant melts are combined by means of a feed block and then co-extruded onto the carrier layer.
3. The composite materials obtained are printed with a decoration composed of 6 colour applications by intaglio printing either
 - a) entirely without charging of the laminate (non-inventive comparative examples),

b) with charging via the impression roll which makes contact with the inner surface (inner polymer layer) of the laminate,

5 c) with charging by means of one electrode upstream of each print roll-impression roll pair, with the same voltage applied to all electrodes, or

d) with charging by means of a charging electrode upstream of each print roll-impression roll pair and discharging by means of a discharge electrode arranged
10 downstream of each print roll-impression roll pair.

Thus, according to point d), there is one charge electrode and one discharge electrode between successive print roll-impression roll pairs. In this case, a voltage with a different sign from the discharge electrodes has been applied to the charge electrodes.

15 For the printing with the 6-colour decoration, 6 print roll-impression roll pairs are used in succession.

4. The print quality is analysed in accordance with the test methods.

20 Examples and comparative examples with an electrically conductive barrier layer

For the examples adduced hereinafter and the comparative examples, laminates having the layer structure which follows were used. These were obtained and tested according to the above points 1. to 4.

Colour decoration
Outer polymer layer: LDPE Novex® M19N430 from Ineos Köln GmbH
Paper coating
Carrier layer: NaturaD UC 200mN; Stora Enso AB; Stockholm, Sweden
LDPE Novex® M19N430 from Ineos Köln GmbH
Barrier layer: Aluminium EN A W 8079 from Hydro Aluminium Deutschland GmbH with layer thickness 6 µm
PE blend comprising an mLDPE to an extent of 30% by weight and an LDPE to an extent of 70% by weight with basis weight 22 g/m ²

Comparative Examples 1 to 4 (non-inventive)

For Comparative Examples 1 to 4, the printing was effected according to the above point 3a)

5 entirely without charging of the laminate.

Comparative Example	Thickness of outer polymer layer [µm]	Ignition residue [mg]	Number of missing dots in colour application 1 [per 100 mm²]	Number of missing dots in each of colour applications 2-6 [per 100 mm²]
1	15	50	9	9
2	15	30	15	15
3	15	2	121	121
4	11	30	45	45

Comparative Examples 5 to 8 (non-inventive)

For Comparative Examples 5 to 8, the printing was effected according to the above point 3b) via the impression rolls of each print unit, with the same voltage applied to each impression roll.

5

Comparative Example	Thickness of outer polymer layer [μm]	Ignition residue [mg]	Number of missing dots in colour application 1 [per 100 mm²]	Number of missing dots in each of colour applications 2-6 [per 100 mm²]
5	15	50	10	10
6	15	30	16	16
7	15	2	128	128
8	11	30	42	42

Comparative Examples 9 to 12 (non-inventive)

For Comparative Examples 9 to 12, the printing was effected according to the above point 3c) with charging by means of one electrode upstream of each print roll-impression roll pair, with the same voltage applied to all electrodes. No additional discharge electrodes were used here.

10

Comparative Examples	Thickness of outer polymer layer [μm]	Ignition residue [mg]	Number of missing dots in colour application 1 [per 100 mm²]	Number of missing dots in each of colour applications 2-6 [per 100 mm²]
9	15	50	0	6
10	15	30	0	15
11	15	2	7	32
12	11	30	7	32

Examples 1 to 4 (inventive)

For Examples 1 to 4, the printing was effected according to the above point 3d). Accordingly,
5 6 print roll-impression roll pairs, in each case with electrodes as shown in Figure 5, were used in succession.

Examples	Thickness of outer polymer layer [μm]	Ignition residue [mg]	Number of missing dots in colour application 1 [per 100 mm²]	Number of missing dots in each of colour applications 2-6 [per 100 mm²]
1	15	50	0	0
2	15	30	0	0
3	15	2	7	7
4	11	30	6	6

10 The printing in the above examples and comparative examples for each print unit was effected at 60 dots per cm. The layer thicknesses of the outer polymer layers reported in the above tables are each accurate to $\pm 1.5 \mu\text{m}$ for measurement-related reasons.

Evaluation

Between Comparative Examples 1 to 4 on the one hand and Comparative Examples 5 to 8, no improvement was observed in the parameters adduced above within the scope of statistical deviations. In Comparative Examples 9 to 12, an improvement in the print was achieved. It is noticeable here, however, that the results for the second and every subsequent colour application are worse than for the first colour application. This disadvantage was remedied in Examples 1 to 4. According to the invention, a decoration with 6 colour applications of very good print quality is obtained here. Moreover, the experiments have shown that it was possible to improve the ink drying after each print unit, meaning that the colour printed on dried quicker after each print unit with the same drying power. An improvement is found here only for the first colour application in Comparative Examples 9 to 12 over Comparative Examples 1 to 8. In Examples 1 to 4, an improvement was found for all 6 colour applications. It is thus possible, since a shorter drying time is achieved for all colour applications in accordance with the invention, to conduct the laminate through the print units at greater speed. This allows the time required for the printing of the laminate to be shortened. This increases the productivity of the laminate production and hence makes production less costly.

The figures show:

- Figure 1 a flow diagram of the method according to the invention;
- Figure 2a) a schematic cross section through a sheetlike composite according to the invention;
- Figure 2b) a schematic cross section through a further sheetlike composite according to the invention;
- Figure 3 a schematic cross section through a first component according to the invention;
- Figure 4a) a schematic cross section through a printed sheetlike composite according to the invention;
- Figure 4b) a schematic cross section through a further printed sheetlike composite according to the invention;

- Figure 5 a schematic view of an apparatus according to the invention;
Figure 6 a schematic view of a container precursor according to the invention;
Figure 7 a schematic view of a closed container according to the invention;
Figure 8 a schematic detail of an enlarged top view of a printed sheetlike composite according to the invention;
Figure 9 a schematic detail of an enlarged top view of a printed sheetlike composite not according to the invention;
Figure 10 a plot of the print quality by a method not according to the invention; and
Figure 11 a plot of the print quality by a method according to the invention.

Figure 1 shows a flow diagram of the process 100 according to the invention. In a method step a) 101 of the method 100, the sheetlike composite 200 according to Figure 2 is provided. This sheetlike composite has a first electrical charge. This means that the sheetlike composite overall has a total charge which is the first electrical charge. In method step a) 101, the
5 sheetlike composite is preferably electrically uncharged. In a method step b) 102 of the method 100 of the invention, a first component 300 according to Figure 3 is provided. The first component 300 moves in a first direction 304. In this context, the first component 300 is an intaglio printing cylinder which rotates in a first direction 304 which is a first direction of
10 rotation. The intaglio printing cylinder has a further electrical charge. It is electrically uncharged and has been earthed. In a method step c) 103, the absolute value of the difference between the first electrical charge and the further electrical charge is increased. This is accomplished by electrically negatively charging the sheetlike composite. For this purpose, electrons are applied to the outer surface 201 of the sheetlike composite 200 by means of an
15 electrode 502. In a method step d) 104, the outer surface 201 of the sheetlike composite 200 is contacted with the first component surface 301. For this purpose, the sheetlike composite 200 is pressed against the intaglio printing cylinder by means of an additional component 501, an impression roll. Therein, the impression roll rotates in a direction 503 which is a direction of rotation. The first direction of rotation 304 is the opposite direction to the direction of rotation
20 503. Method step d) 104 is followed, in Fig. 1, by a method step e). In this step, charges are transferred or removed by a second electrode 506 from the composite 200, especially via the

outer surface 201 thereof. The method 100 can especially be executed with the apparatus 500 according to Figure 5.

Figure 2a) shows a schematic cross section through a sheetlike composite 200 according to the invention. The sheetlike composite 200 consists of the following layers that are mutually superposed in this sequence, from an outer surface 201 of the sheetlike composite 200 to an inner surface 202 of the sheetlike composite 200: a carrier layer 203 made of paperboard, an LDPE layer 204, an adhesion promoter layer 205, a barrier layer 206 made of aluminium, an EAA layer 207, and an inner polymer layer 208. The inner polymer layer 208 consists here of a polymer blend comprising an mPE to an extent of 80% by weight and an LDPE to an extent of 20% by weight, based in each case on the total weight of the polymer blend. In this case, the outer surface 201 is a surface of the carrier layer 203 remote from the barrier layer 206. Moreover, the outer surface 201 is that surface of the sheetlike composite 200 which faces outward in a food or drink product container produced from the sheetlike composite 200. The inner surface 202 is the surface of the sheetlike composite 200 which faces inward in a food or drink product container produced from the sheetlike composite 200 and is accordingly in contact with the food or drink product 701 introduced. The sheetlike composite 200 shown in Figure 2a) may especially be printed with a decoration according to the method 100 according to Figure 1 or with the aid of the apparatus 500 according to Figure 5 or both.

Figure 2b) shows a schematic cross section through a further sheetlike composite 200 according to the invention. The sheetlike composite 200 according to Figure 2b) is that according to Figure 2a), wherein, in Figure 2b), the carrier layer 203 is superimposed by an outer polymer layer 209 of polyethylene such that the outer surface 201 is a surface of the outer polymer layer 209.

Figure 3 shows a schematic cross section through a first component 300 according to the invention. The first component 300 comprises a first component surface 301 comprising a multitude of recesses 302. The first component 300 is an intaglio printing cylinder and the first component surface 301 is an outer cylindrical surface of the intaglio printing cylinder. The recesses 302 are cells. The cells each comprise a composition 303. This is shown in Figure 3,

in that the larger dotted circle on the right-hand side of Figure 3 shows an enlarged view of the cell in the smaller dotted circle on the left-hand side of Figure 3. The composition 303 is a printing ink comprising a colourant. The colourant is a pigment. The intaglio printing cylinder moves in a first direction 304, in that it rotates in a first direction of rotation.

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Figure 4a) shows a schematic cross section through a printed sheetlike composite 400 according to the invention. The printed sheetlike composite 400 consists of the following layers that are mutually superposed in this sequence, from an outer surface 201 of the printed sheetlike composite 400 to an inner surface 202 of the printed sheetlike composite 400: a colour application 401, a carrier layer 203 made of paperboard, an LDPE layer 204, an adhesion promoter layer 205, a barrier layer 206 made of aluminium, an EAA layer 207, and an inner polymer layer 208. The inner polymer layer 208 consists here of a polymer blend comprising an mPE to an extent of 80% by weight and an LDPE to an extent of 20% by weight, based in each case on the total weight of the polymer blend. The colour application 401 comprises a first colour transfer region 402 and a further colour transfer region 403. The first colour application region 402 adjoins the further colour application region 403. The first colour application region is characterized by an area coverage of 80%. The further colour application region is characterized by an area coverage of the same colour of 5%. The colour application 401 is a decoration of the printed sheetlike composite 400. This decoration has improved contrast of the area coverage with regarding the aforementioned colour. The outer surface 201 is a surface of the colour application 401 remote from the carrier layer 203. Moreover, the outer surface 201 is that surface of the printed sheetlike composite 400 which faces outward in a food or drink product container produced from the printed sheetlike composite 400. The inner surface 202 is the surface of the printed sheetlike composite 400 which faces inward in a food or drink product container produced from the printed sheetlike composite 400 and is accordingly in contact with the food or drink product 701 introduced. The printed sheetlike composite 400 is especially obtainable by printing the sheetlike composite 200 according to Figure 2a) by the method 100 according to Figure 1 or with the aid of the apparatus in Figure 5 or both.

30

Figure 4b) shows a schematic cross section through a further printed sheetlike composite 400 according to the invention. The printed sheetlike composite 400 according to Figure 4b) is that according to Figure 4a), wherein, in Figure 4b), there is an outer polymer layer 209 of polyethylene between the colour application 401 and the carrier layer 203. The colour application 401 is printed onto the outer polymer layer 209.

Figure 5 shows a schematic view of an apparatus 500 according to the invention. The apparatus 500 is suitable for printing the sheetlike composite 200 according to Figure 2a) and 2b) with a decoration by means of an intaglio printing method. More particularly, the apparatus 500 is designed for execution of the method 100 according to Figure 1. The apparatus 500 comprises a sheetlike composite 200 according to Figure 2a). The latter is kept ready on a feed device 505 configured in the form of a drum with several layers of composite. In addition, the apparatus 500 comprises a first component 300 which is an intaglio printing cylinder according to Figure 3. The intaglio printing cylinder is earthed here by means of the earth 504. For this purpose, more particularly, a shaft which functions as the axis of rotation of the intaglio printing cylinder may be earthed. The intaglio printing cylinder moves in a first direction 304, in that the intaglio printing cylinder rotates in a first direction of rotation. The apparatus 500 further comprises an additional component 501 which is an impression roll. The impression roll moves in a direction 503, in that the impression roll rotates in a direction of rotation 503. This direction of rotation 503 is the opposite direction to the first direction of rotation 304. The impression roll guides the sheetlike composite 200 in such a way that the outer surface 201 of the sheetlike composite 200 is pressed onto the first component surface 301 having the recesses 302. In this case, the sheetlike composite 200 is guided through a gap between the impression roll and the intaglio printing roll and printed in the process. The apparatus 500 further comprises a first electrode 502 which is arranged and designed such that it applies electrons to the outer surface 201 of the sheetlike composite 200. In this context, for every subregion of the outer surface 201, electrons are first applied to the subregion from the electrode 502 and then the subregion is printed by contact with the intaglio printing roll. Thus, the sheetlike composite 200 has an electrically negative charge, while the intaglio printing cylinder and the composition 303, which is a printing ink, are electrically uncharged. Accordingly, there are electrostatic attraction forces between the printing ink and the outer

surface 201 of the sheetlike composite 200. As shown in the enlarged region on the right in Figure 5, the printing ink in the cells comprises a convex surface, i.e. one that curves outward. Once a subregion of the composite 200 has run through the intaglio print roll, the subregion is moved past a second electrode 506. In the present context, the electrode 506 is provided on the outer surface 201 of the composite 200, in order to contribute to a further discharge of the composite 200. The further electrode 506 is followed, in Fig. 5, by a removal device 508 configured as a drum.

Figure 6 shows a schematic view of a container precursor 600 according to the invention. The container precursor 600 shown here is a shell. The shell comprises a top region 602 and a base region 603. The top region 602 and the base region 603 each comprise creases 604. By folding along the creases 604 and sealing, it is possible to seal each of the top region 602 and the base region 603 and hence to obtain a closed container 700 according to Figure 7 from the shell. Accordingly, the container precursor 600 is a precursor of the closed container 700 that arises in the container production process. In this context, the container precursor 600 comprises a blank of the sheetlike composite 400 according to Figure 4a). In the container precursor 600, the sheetlike composite 400 has been folded; it comprises 4 folds 601 here. In addition, the shell comprises a longitudinal seam 605, along which the end regions of the sheetlike composite 400 are sealed to one another.

Figure 7 shows a schematic view of a closed container 700 according to the invention. The closed container 700 is obtainable by folding the container precursor 600 in Figure 6 along the creases 604 and sealing folded regions to close the top region 602 and the base region 603. Accordingly, the closed container 700 comprises a blank of the sheetlike composite 400 according to Figure 4a). In addition, the closed container comprises at least 8 folds 601. The closed container 700 surrounds an interior which comprises a food or drink product 701. The food or drink product 701 may be liquid, but may also comprise solid constituents. The closed container 700 shown in Figure 7 is in one-piece form. In addition, the closed container 700 may be provided with a fitment to improve openability. This is the case especially when the carrier layer 203 of the sheetlike composite 400 has a hole.

Figure 8 shows a schematic detail of an enlarged top view of a colour application 401 of a printed sheetlike composite 400 according to the invention. The colour application 401 was obtained by printing with the apparatus 500 according to Figure 5 and consists of printed dots 801. The printed sheetlike composite 400 consists of the following layers, mutually superposed in this sequence, from an outer surface 201 of the printed sheetlike composite 400 to an inner surface 202 of the printed sheetlike composite 400: the colour application 401; an outer polymer layer 209 of LDPE Novex® M19N430 from Ineos Köln GmbH; a single paper coating obtainable by coating with a liquid formulation comprising 100 parts pigment (Hydrocarb 60; Omya Inc; Cincinnati, US) and 20 parts binder / SB latex (MAINCOTE™ HG-56; Dow; Germany); a carrier layer 203 of NaturaD UC 200mN, Stora Enso AB, Stockholm, Sweden; an LDPE layer 204 of LDPE Novex® M19N430 from Ineos Köln GmbH; a barrier layer 206 of Aluminium EN A W 8079 from Hydro Aluminium Deutschland GmbH having a layer thickness of 6 µm; and an inner polymer layer 208 of a PE blend, comprising an mLDPE to an extent of 30% by weight and an LDPE to an extent of 70% by weight, based in each case on the total weight of the inner polymer layer 208, having a basis weight of 22 g/m². The colour application 401 consists of a print obtained by intaglio printing, characterized by a pattern having 60 dots per cm and an area coverage of 30%.

Figure 9 shows a schematic detail of an enlarged top view of a print 901 of a printed sheetlike composite 900 not according to the invention. The print 901 was obtained by printing with the apparatus 500 according to Figure 5, without charging of the sheetlike composite 200 by means of the electrode 502. Thus, the print 901 was not obtained by the method 100 according to the invention. The print 901 consists of printed dots 801. The printed sheetlike composite 900 consists of the following layers, mutually superposed in this sequence: the print 901; an outer polymer layer 209 of LDPE Novex® M19N430 from Ineos Köln GmbH; a single paper coating obtainable by coating with a liquid formulation comprising 100 parts pigment (Hydrocarb 60; Omya Inc; Cincinnati, US) and 20 parts binder / SB latex (MAINCOTE™ HG-56; Dow; Germany); a carrier layer 203 of NaturaD UC 200mN, Stora Enso AB, Stockholm, Sweden; an LDPE layer 204 of LDPE Novex® M19N430 from Ineos Köln GmbH; a barrier layer 206 of Aluminium EN A W 8079 from Hydro Aluminium Deutschland GmbH having a layer thickness of 6 µm; and an inner polymer layer 208 of a PE blend,

comprising an mLDPE to an extent of 30% by weight and an LDPE to an extent of 70% by weight, based in each case on the total weight of the inner polymer layer 208, having a basis weight of 22 g/m². The print 901 is characterized by a pattern having 60 dots per cm and an area coverage of 30%. The print 900 shown is characterized by a much higher number of missing dots compared to the printed sheetlike composite 400 according to the invention from Figure 8.

Figure 10 shows a plot 1000 of the print quality by a method not according to the invention. Printing was effected here, without electrostatic assistance according to the invention, onto various laminates consisting of the following layers of a layer sequence: an outer polymer layer of LDPE; a carrier layer of paperboard; an intermediate polymer layer as lamination layer consisting of the LDPE 23L430 from Ineos GmbH, Cologne; a barrier layer of aluminium; and an inner polymer layer. This involved 6 successive colour applications of different colours. Thus, a multicoloured decoration was obtained. The ordinate axis 1001 shows a basis weight of the outer polymer layer in g/m². The abscissa axis 1002 shows a basis weight of a cover layer of the carrier layer that faces the outer polymer layer in g/m². In the plot 1000, the region 1003 has a still acceptable print quality, the region 1004 good print quality, and the region 1005 excellent print quality. The decorations having print qualities that are shown in the plot 1000 were each printed with a pattern of 60 dots 801 per cm and an area coverage of 90%. In the plot 1000, the region 1005 has fewer than 3 missing dots 902 per 100 mm² for each colour application, the region 1004 has 3 to 10 missing dots 902 per 100 mm² for each colour application, and the region 1003 has more than 10 missing dots 902 per 100 mm² for each colour application.

Figure 11 shows a plot 1100 of the print quality by the method 100 according to the invention. Printing was effected here by the method 100 according to the invention onto various sheetlike composites 200 consisting of the following layers of a layer sequence: an outer polymer layer 209 of LDPE; a carrier layer 203 of paperboard; an LDPE layer 204 as lamination layer consisting of the LDPE 23L430 from Ineos GmbH, Cologne; a barrier layer 206 of aluminium; and an inner polymer layer 208. This involved 6 successive colour applications 401 of different colours. Thus, a multicoloured decoration was obtained. The ordinate axis 1001

shows a basis weight of the outer polymer layer 209 in g/m^2 . The abscissa axis 1002 shows a basis weight of a cover layer of the carrier layer 203 that faces the outer polymer layer 209 in g/m^2 . In the plot 1100, the region 1005 has fewer than 3 missing dots 902 per 100 mm^2 for each colour application, the region 1004 has 3 to 10 missing dots 902 per 100 mm^2 for each colour application, and the region 1003 has more than 10 missing dots 902 per 100 mm^2 for each colour application. It is clearly apparent that an improved print quality has been achieved compared to Figure 10.

LIST OF REFERENCE SYMBOLS

100	method according to the invention
101	method step a)
102	method step b)
103	method step c)
104	method step d)
105	method step e)
200	sheetlike composite
201	outer surface
202	inner surface
203	carrier layer
204	LDPE layer
205	adhesion promoter layer
206	barrier layer
207	EAA layer
208	inner polymer layer
209	outer polymer layer
300	first component
301	first component surface
302	recess
303	composition
304	first direction
400	printed sheetlike composite according to the invention
401	colour application
402	first colour application region
403	further colour application region
500	apparatus according to the invention
501	additional component
502	electrode
503	direction of rotation of the additional component
504	earth

505	feed device
506	second electrode
507	earth
508	removal unit
600	container precursor of the invention
601	fold
602	top region
603	base region
604	crease
605	longitudinal seam
700	closed container of the invention
701	food or drink product
801	printed dot
900	printed sheetlike composite not according to the invention
901	print not obtained in accordance with the invention
902	missing dot
1000	plot of the print quality by a method not according to the invention
1001	basis weight of the outer polymer layer in g/m ²
1002	basis weight of the cover layer of the carrier layer in g/m ²
1003	print quality still acceptable
1004	good print quality
1005	excellent print quality
1100	plot of the print quality by a method according to the invention

PATENT CLAIMS

1. A method (100) comprising, as method steps (101 to 104),
- 5 a) providing a sheetlike composite (200) comprising, as mutually superposed layers, from an outer surface (201) of the sheetlike composite (200) to an inner surface (202) of the sheetlike composite (200),
- i) a carrier layer (203),
- ii) a barrier layer (206), and
- iii) an inner polymer layer (208),
- 10 wherein the sheetlike composite (200) has a first electrical charge;
- b) providing a first component (300) comprising a first component surface (301), wherein the first component surface (301) comprises a multitude of recesses (302), wherein the recesses (302) comprise a composition (303) comprising a colourant, wherein the first component (300) moves in a first direction (304),
- 15 wherein the first component (300) has a second electrical charge;
- c) making a first change in the absolute value of the difference between the first electrical charge and the second electrical charge;
- d) contacting the outer surface (201) of the sheetlike composite (200) with the first component surface (301); and
- 20 e) making a further change in the absolute value of the difference between the first electrical charge and the second electrical charge downstream of method step d).
2. The method according to Claim 1, wherein the first change and the further change are in opposite senses.
- 25
3. The method according to Claim 1 or 2, wherein, in method step a), a further component comprising a further component surface is further provided, wherein the further component surface comprises a multitude of recesses (302), wherein the recesses (302) comprise a composition (303) comprising a colourant,
- 30 wherein the further component (300) moves in the first direction (304), wherein the further component has a third electrical charge;

wherein the method (100) comprises, downstream of method step e), the following method steps:

f) making a first change in the absolute value of the difference between the first electrical charge and the third electrical charge; and

g) contacting the outer surface (201) of the sheetlike composite (200) with the further component surface (301).

4. The method according to Claim 3, wherein the method (100) comprises, downstream of method step g), a method step

h) making a further change in the absolute value of the difference between the first electrical charge and the third electrical charge.

5. The method (100) according to any of the preceding claims, wherein the barrier layer (206) is electrically insulating.

6. The method (100) according to any of the preceding claims, wherein, in method step c) (103), the change is made by an application of electrical charge carriers from an electrode (502) to the outer surface (201) of the sheetlike composite (200).

7. The method (100) according to any of Claims 1 to 4 or 6, wherein the barrier layer (206) is electrically conductive.

8. The method (100) according to any of the preceding claims, wherein the sheetlike composite (200) is characterized by an ignition residue in a range from 0.1 to 75 mg.

9. The method (100) according to any of the preceding claims, wherein the sheetlike composite (200) further comprises an outer polymer layer (209) on a side of the carrier layer (203) facing the outer surface (201),

wherein the outer polymer layer (209) has a layer thickness in a range from 1 to 20 μm .

10. The method (100) according to any of the preceding claims, wherein, in method step d), the sheetlike composite (200) on the outer surface (201) is superposed by a colour application (401),
wherein the colour application (401) is characterized by a number of missing dots in a
5 range from 0 to 100 per 100 mm².
11. A printed sheetlike composite (400) obtainable by the method (100) according to any of Claims 1 to 10.
- 10 12. An apparatus (500) comprising, as apparatus constituents:
- a) a feed device (505) arranged and designed to accommodate a sheetlike composite (200) comprising, as mutually superposed layers, from an outer surface (201) of the sheetlike composite (200) to an inner surface (202) of the sheetlike composite (200),
15
 - i) a carrier layer (203),
 - ii) a barrier layer (206), and
 - iii) an inner polymer layer (208);
 - b) a first electrode (502) arranged and designed for exchange of electrical charge carriers with the outer surface (201) of the sheetlike composite (200);
 - 20 c) a first component (300) comprising a first component surface (301),
wherein the first component surface (301) comprises a multitude of recesses (302),
wherein the recesses (302) are arranged and designed to accommodate a composition (303) comprising a colourant,
wherein the first component surface (301) can be contacted with the outer surface
25 (201) of the sheetlike composite (200);
 - d) downstream of the first electrode (502) and the first component (300), a second electrode (506) designed and arranged for exchange of electrical charge carriers with the outer surface (201) of the sheetlike composite (200).

13. A printed sheetlike composite (400) comprising, as mutually superposed layers, from an outer surface (201) of the printed sheetlike composite (400) to an inner surface (202) of the printed sheetlike composite (400),

- i) a colour application (401),
- ii) a carrier layer (203),
- iii) a barrier layer (206), and
- iv) an inner polymer layer (208),

wherein the printed sheetlike composite (400) is characterized by an ignition residue in a range from 0.1 to 75 mg.

14. The printed sheetlike composite (400) according to Claim 13, wherein the sheetlike composite further comprises an outer polymer layer (209) between the colour application (401) and the carrier layer (203),

wherein the outer polymer layer (209) is characterized by a layer thickness in a range from 1 to 20 μm .

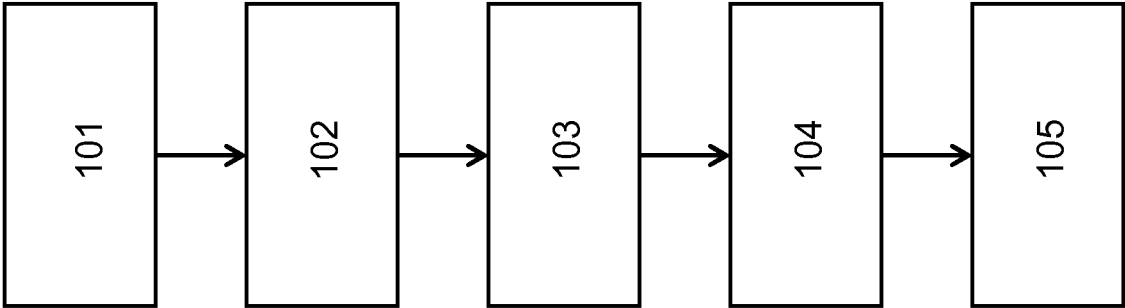
15. A container precursor (600) at least partly comprising the printed sheetlike composite (400) according to any of Claims 11, 13 or 14.

16. A closed container (700) at least partly comprising the printed sheetlike composite (400) according to any of Claims 11, 13 or 14,

wherein the printed sheetlike composite (400) has been folded at least once.

17. A use of the apparatus (500) according to Claim 12 for printing of the sheetlike composite (200).

Figure 1



100

Figure 2

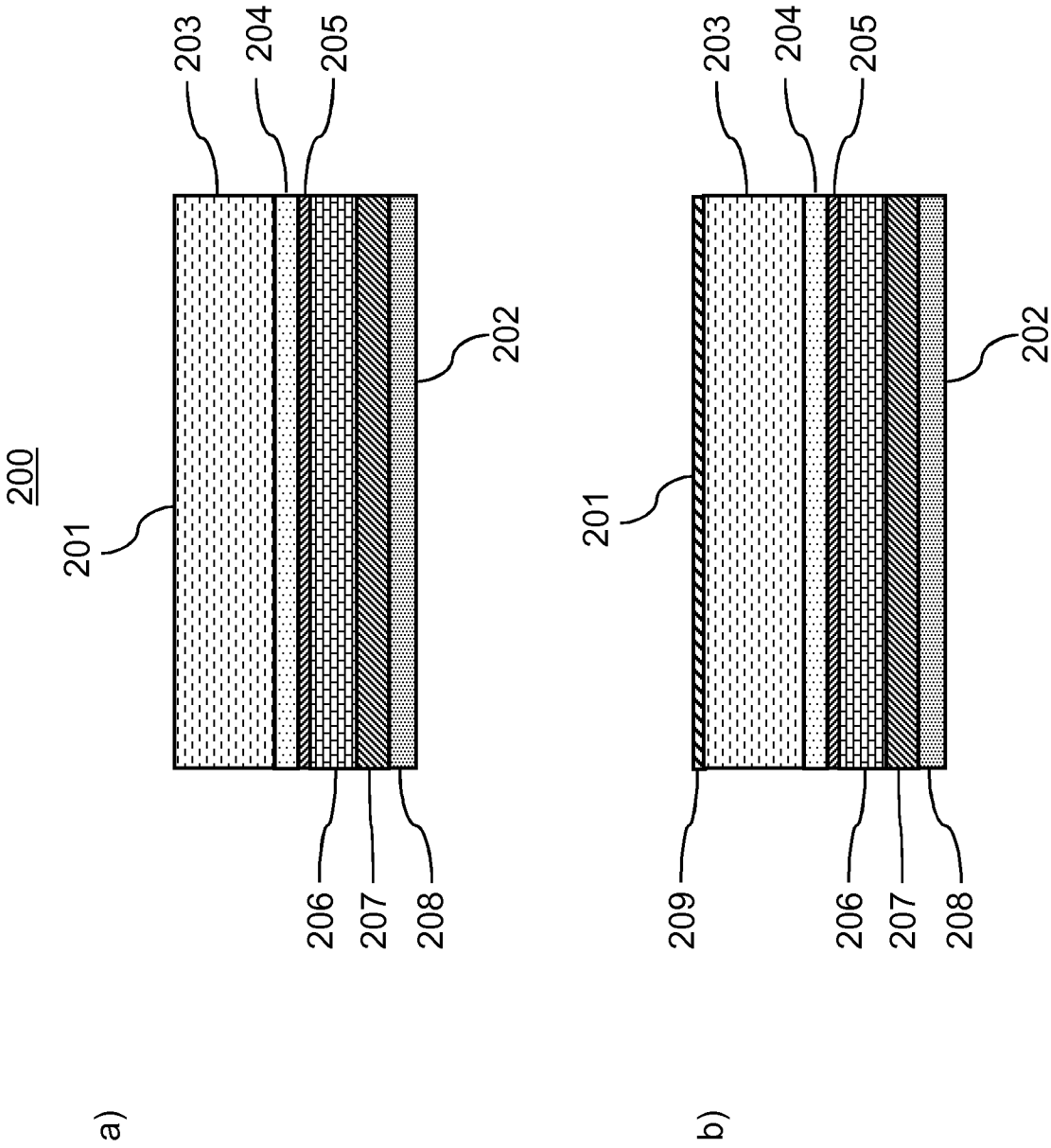


Figure 3

300

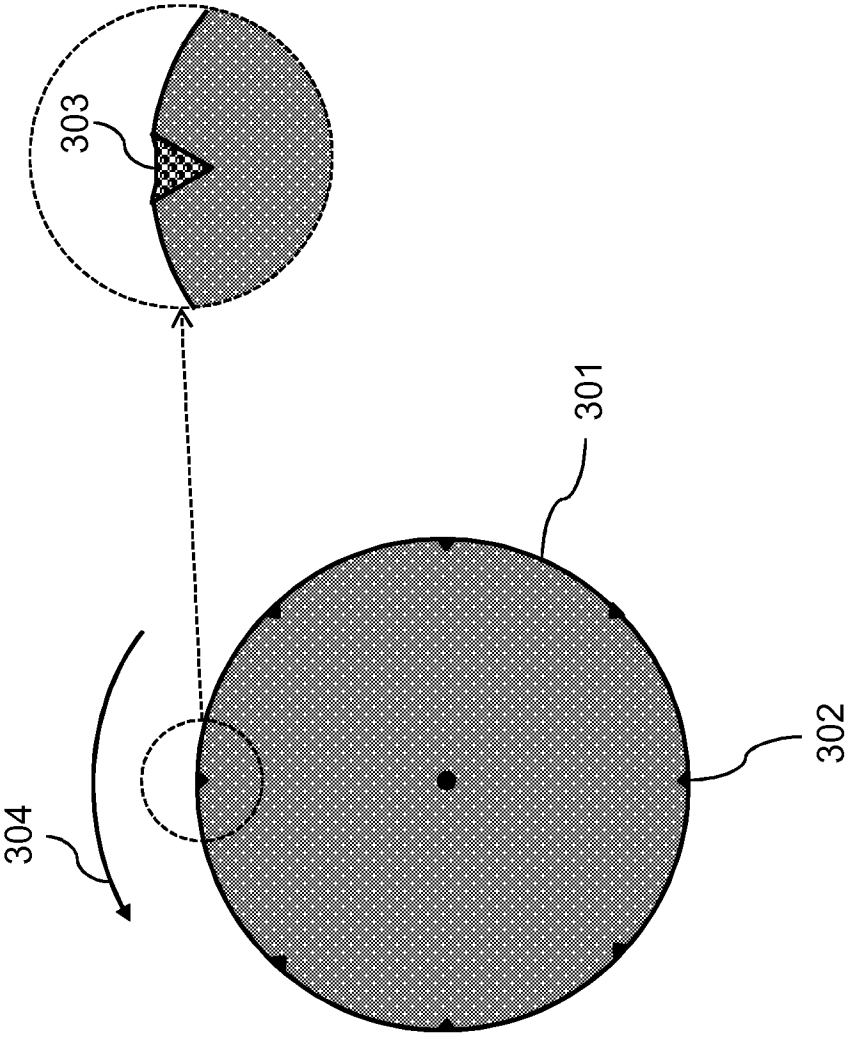


Figure 4

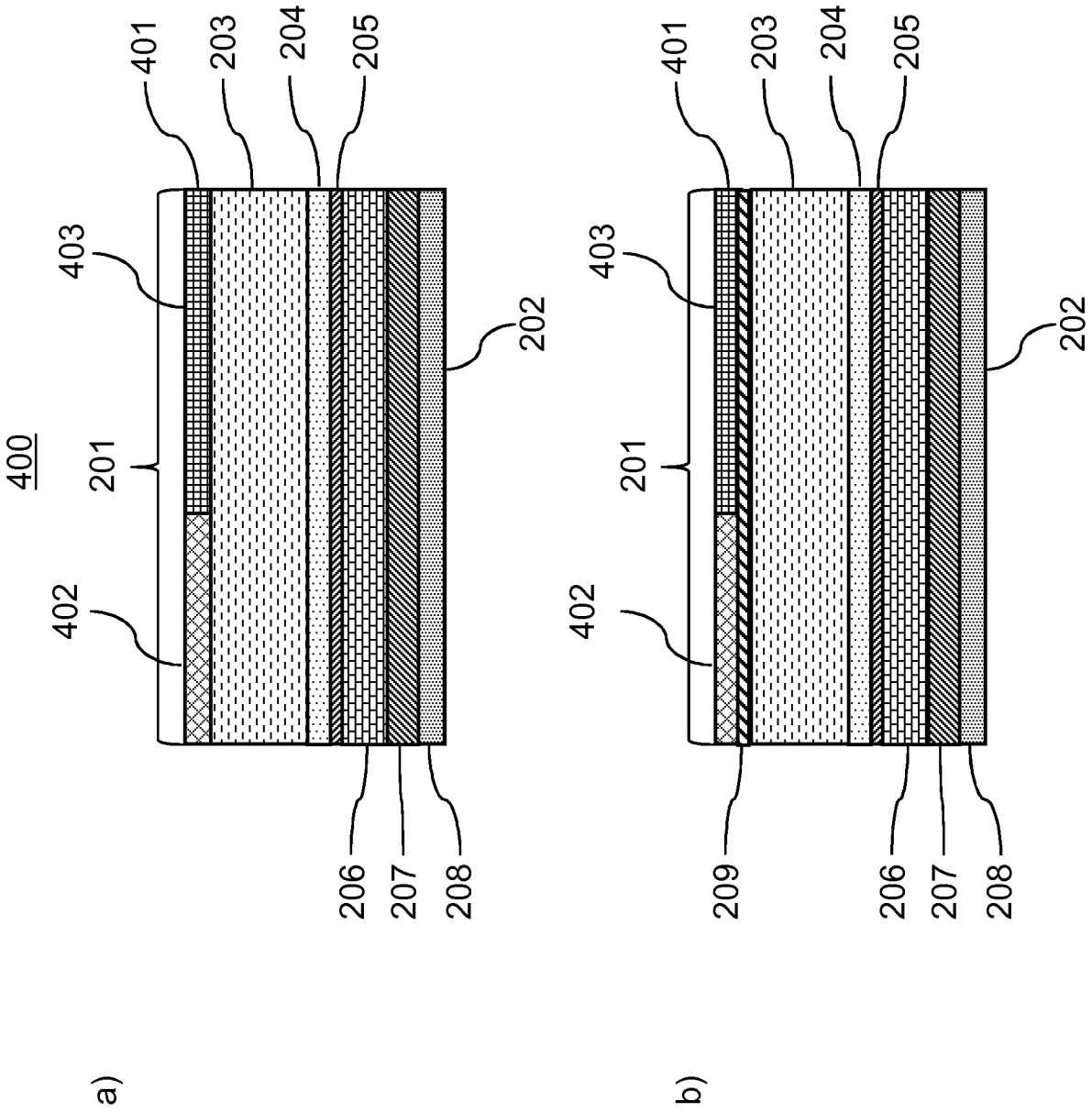


Figure 5

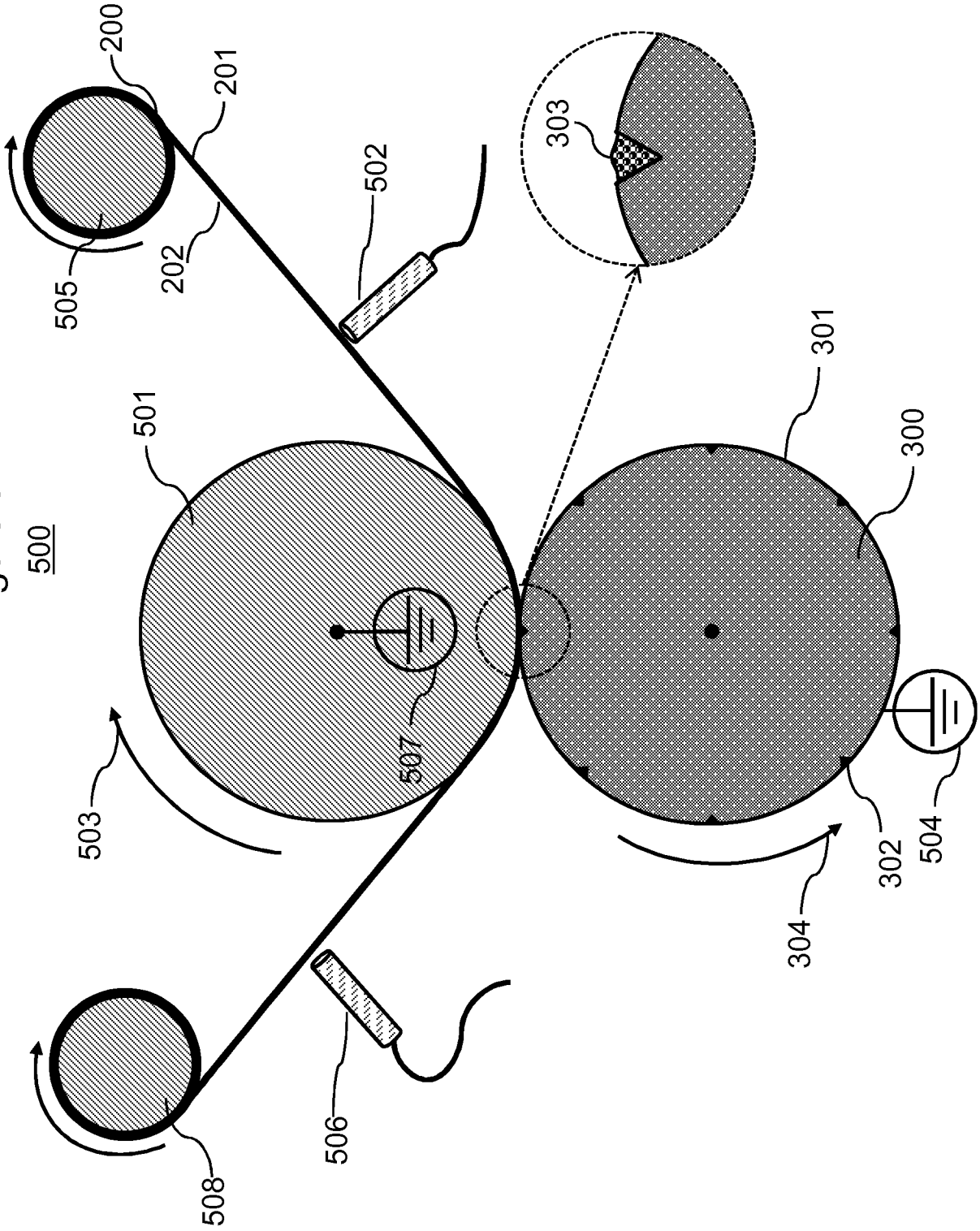


Figure 6

600

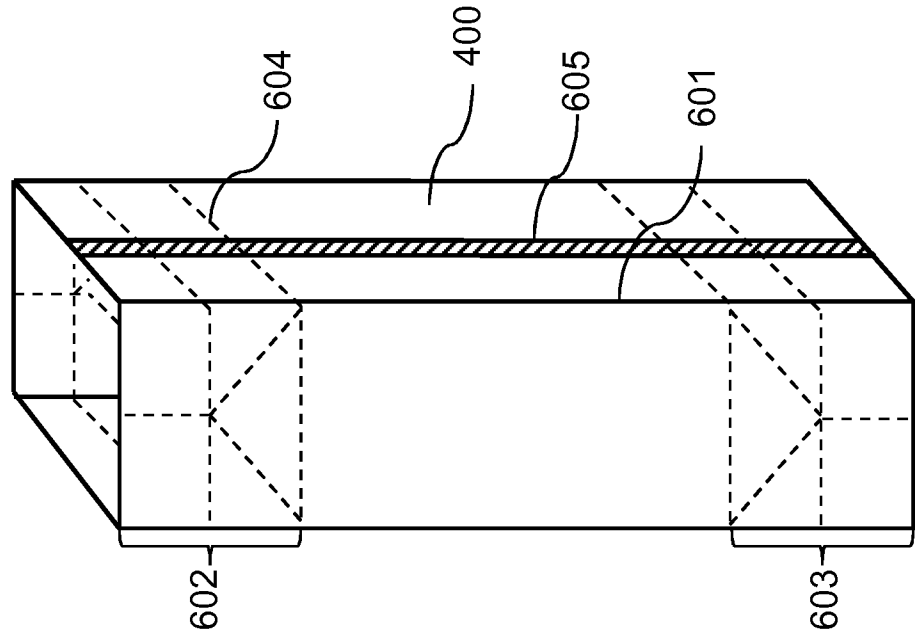


Figure 7

700

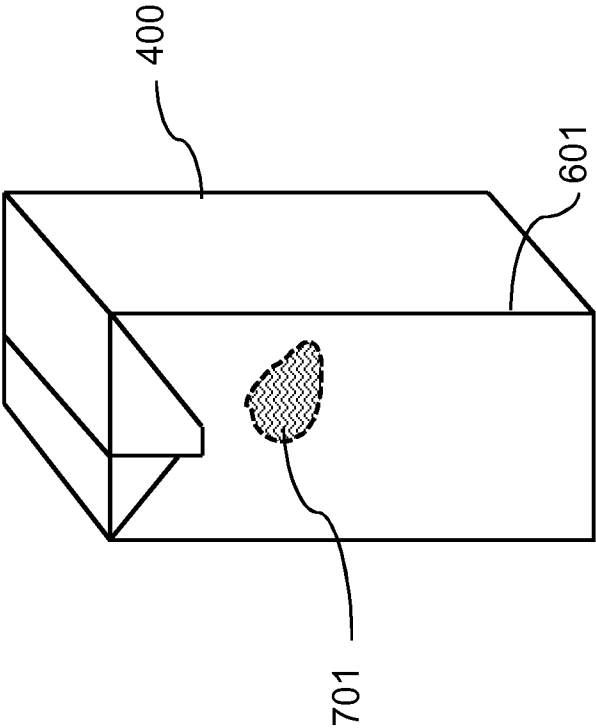


Figure 8

400

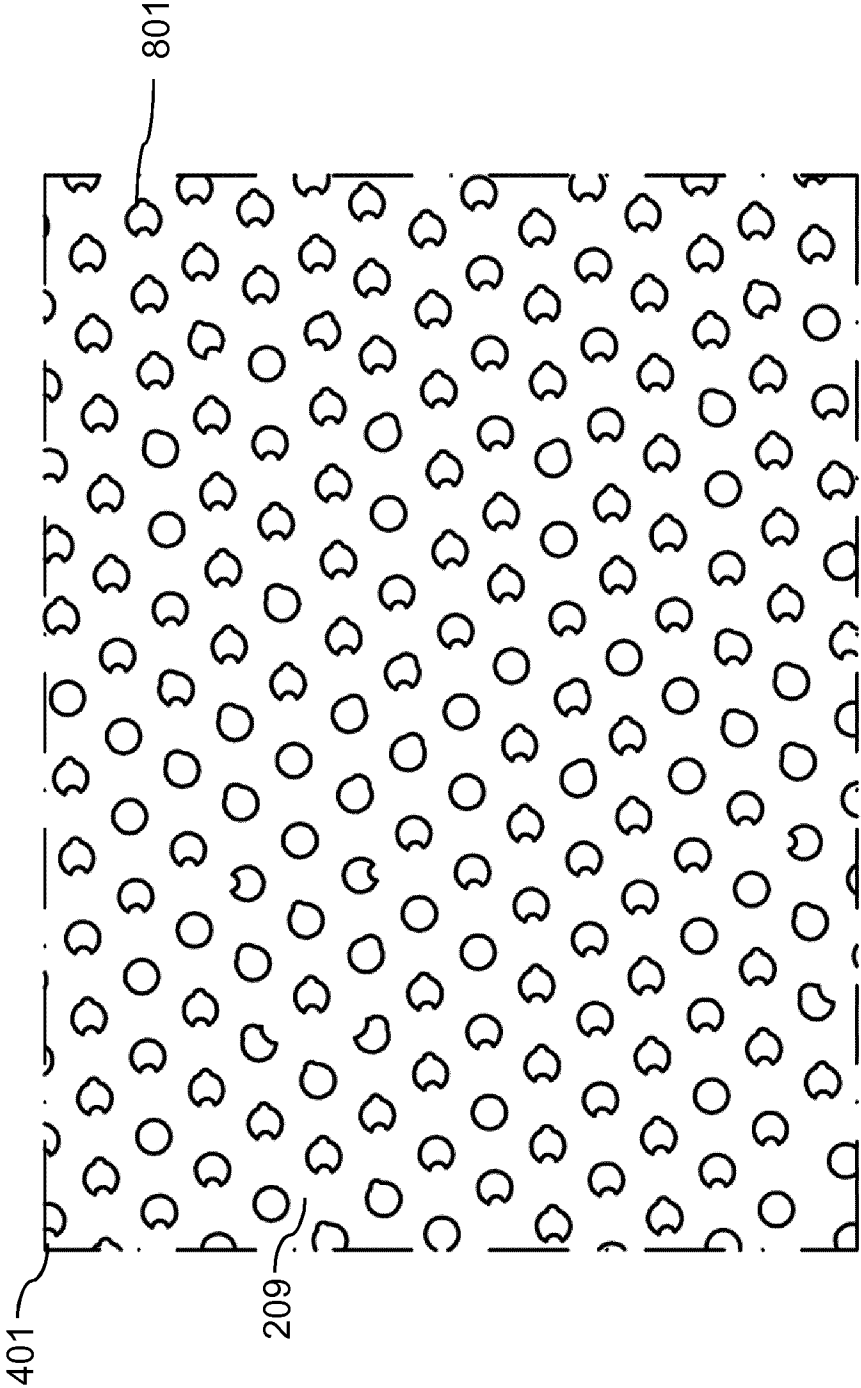


Figure 9

900

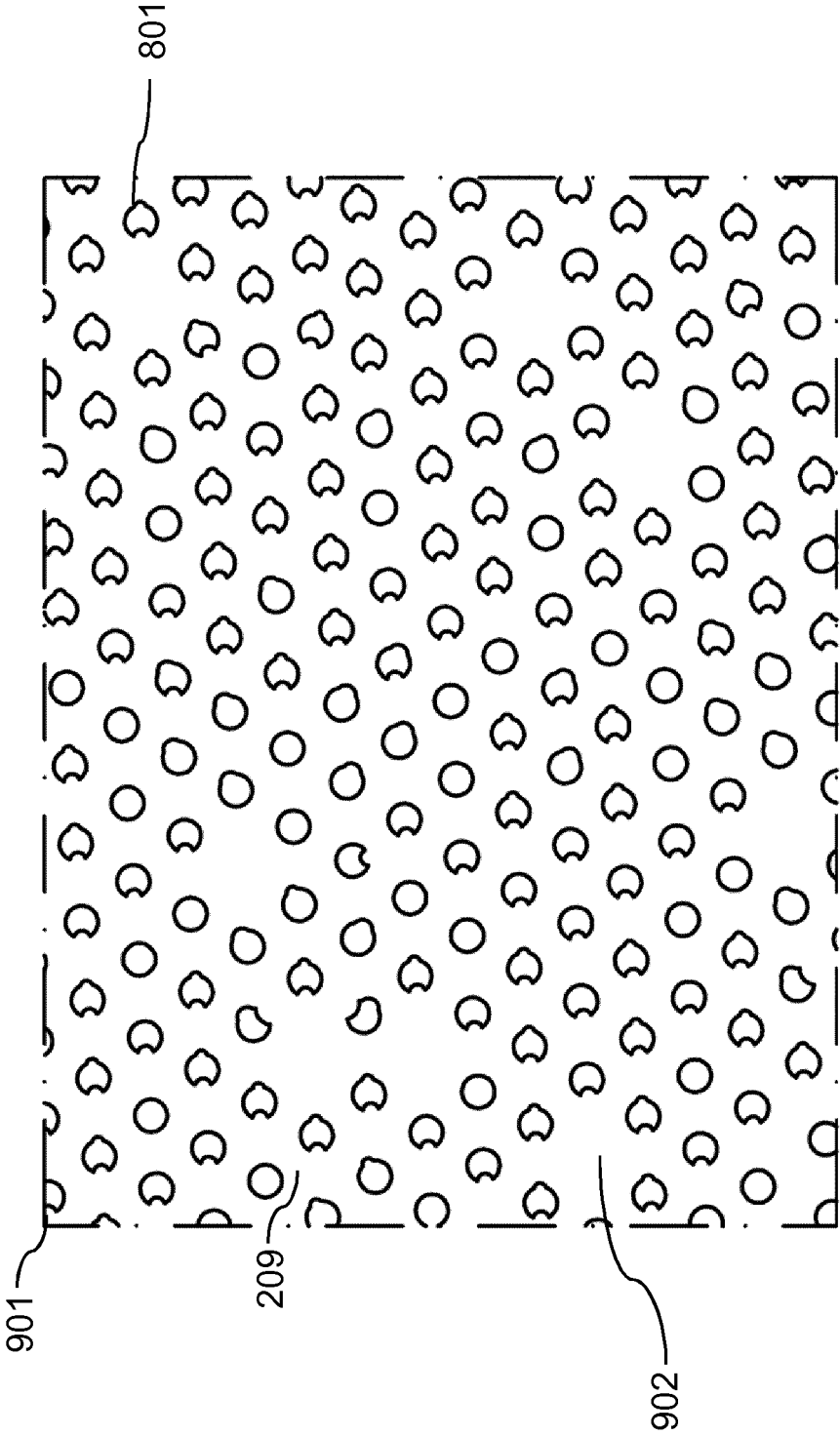


Figure 10

1000

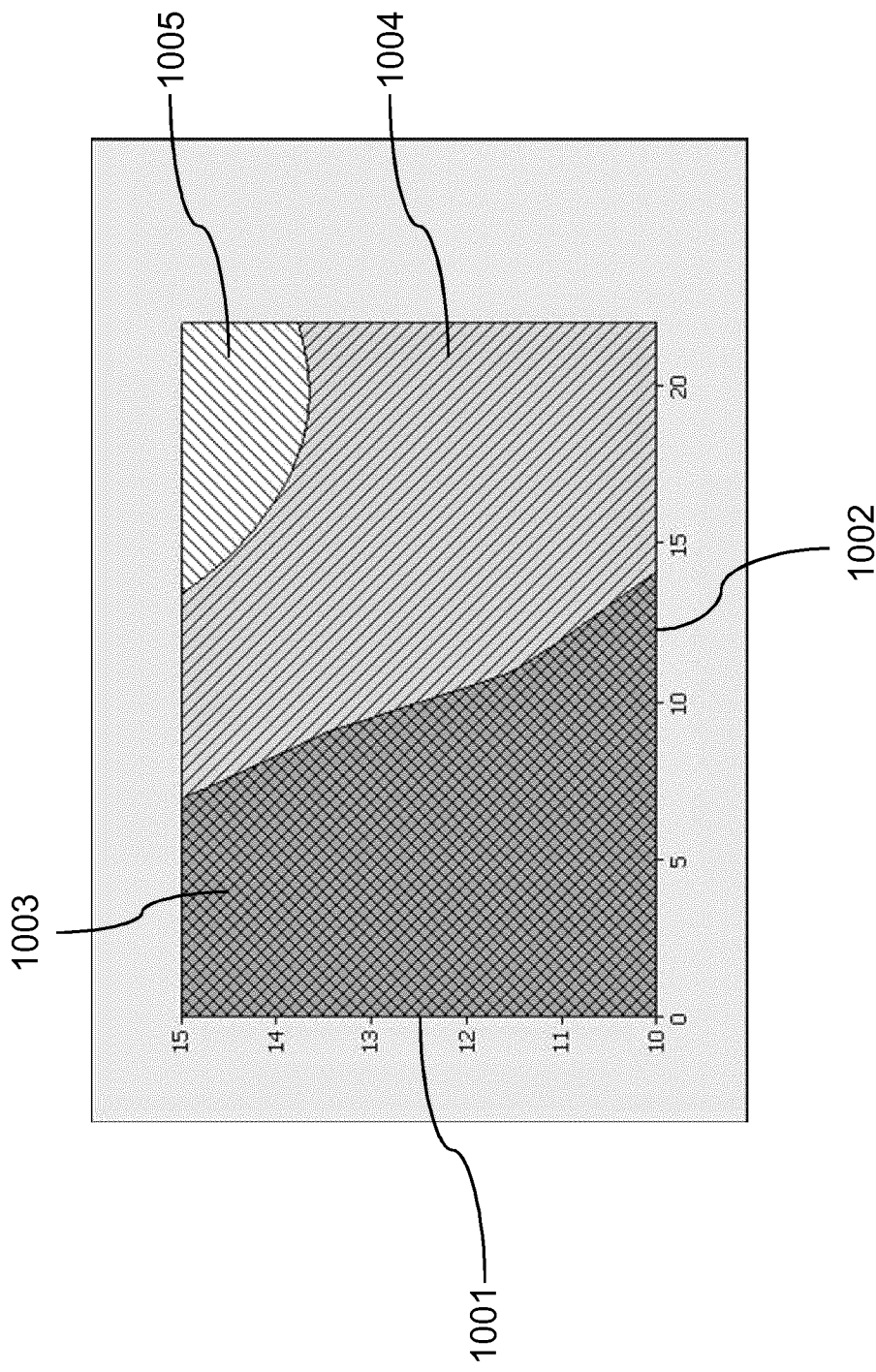
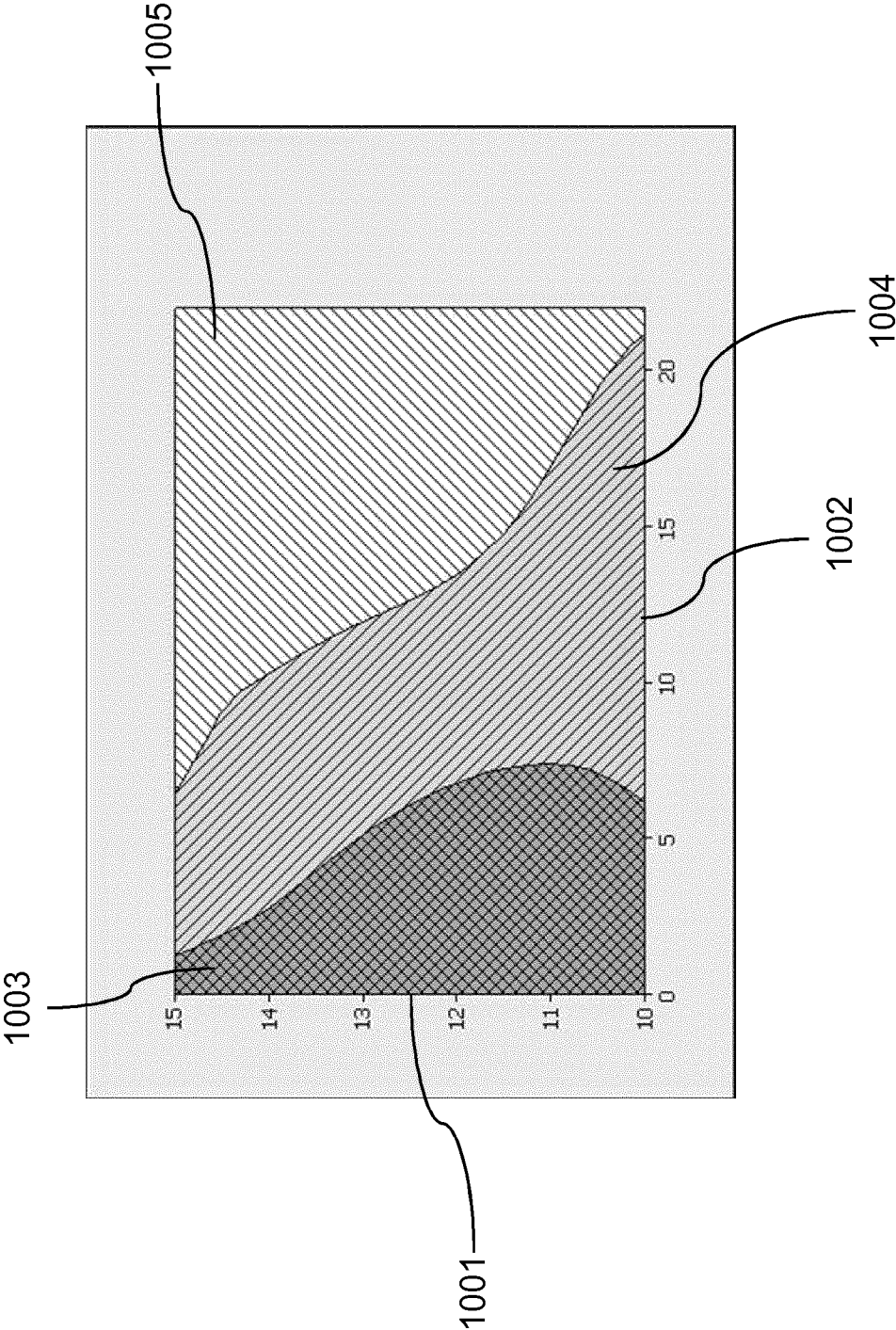


Figure 11

1100



INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2017/062447

A. CLASSIFICATION OF SUBJECT MATTER

INV. B41M1/10 B32B27/10
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)

B41M 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

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Y	page 5, line 30 - page 8, line 34; figure 1	1-10,12,17
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Further documents are listed in the continuation of Box C.



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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/062447

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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