



(51) International Patent Classification:
B41J 11/00 (2006.01)

(21) International Application Number:
PCT/EP2018/067989

(22) International Filing Date:
03 July 2018 (03.07.2018)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
201710540873.5 05 July 2017 (05.07.2017) CN

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(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

(54) Title: **INK JET PRINTING A PATTERN ON A SURFACE OF A PACKAGING COMPOSITE USING RADIATION CURABLE INK**

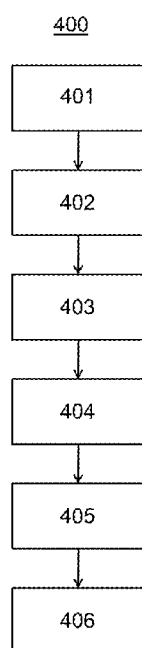


Fig. 4

(57) **Abstract:** The present invention refers a printing device for printing a pattern on a surface S of a target using a radiation curable ink composition, comprising at least in downstream direction: a. a plasma treating unit; b. at least an inkjet printing unit; c. a 1st UV treatment unit; d. a 2nd UV treatment unit; wherein the output power of the 1st UV treatment unit is less than the output power of the 2nd UV treatment unit. The invention further refers to a process of printing a pattern on a surface S of a target, comprising at least these process steps: a) providing the target the surface S; b) modifying the surface tension of at least a part of surface S to a first value; c) applying a pattern of droplets of at least one ink composition onto the surface S; d) curing at least a part of the at least one ink composition; and e) curing the rest of the at least one ink composition. The invention further relates to a target, which is obtainable by the cited process, and to a container comprising the cited target.

Published:

— *with international search report (Art. 21(3))*

5 INK JET PRINTING A PATTERN ON A SURFACE OF A PACKAGING COMPOSITE
 USING RADIATION CURABLE INK

Technical field of the invention

10 The present invention refers a printing device for printing a pattern on a surface S of a target using a radiation curable ink composition, comprising in direction of a treatment path of the target at least: a. a plasma treating unit; b. at least an inkjet printing unit downstream of the plasma treating unit; c. a 1st UV treatment unit downstream of the inkjet printing unit; d. a 2nd UV treatment unit downstream of the 1st UV treatment unit; wherein the output power of the 1st UV treatment unit is less than the output power of the 2nd UV treatment unit. The invention
15 further refers to a process of printing a pattern on a surface S of a target, comprising at least these process steps: a) providing the target the surface S; b) modifying the surface tension of at least a part of surface S to a first value; c) applying a pattern of droplets of at least one ink composition onto the surface S; d) curing at least a part of the at least one ink composition; and curing the rest of the at least one ink composition. The invention further relates to a target
20 comprising a surface S, which carries a printed pattern, which is obtainable by the cited process, and to a container comprising the cited target. The invention further relates to a use of an inkjet printing unit and a 1st and a 2nd UV treatment to manufacture a printed pattern on a surface S of a target wherein the printed pattern has an enhanced resistance against chemicals, improved data storage capacity per area, and wherein the printed pattern can be varied from
25 print to print.

Background of the invention

30 For some time, foodstuffs have been preserved, whether they be foodstuffs for human consumption or else animal feed products, by storing them either in a can or in a jar closed by a lid. In this case, shelf life can be increased firstly by separately and very substantially sterilising the foodstuff and the container in each case, here the jar or can, and then introducing the

foodstuff into the container and closing the container. However, these measures of increasing the shelf life of foodstuffs, which have been tried and tested over a long period, have a series of disadvantages, for example the need for another sterilisation later on. Cans and jars, because of their essentially cylindrical shape, have the disadvantage that very dense and space-saving storage is not possible. Moreover, cans and jars have considerable intrinsic weight, which leads to increased energy expenditure in transport. Moreover, production of glass, tinplate or aluminium, even when the raw materials used for the purpose are recycled, necessitates quite a high expenditure of energy. In the case of jars, an aggravating factor is elevated expenditure on transport. The jars are usually prefabricated in a glass factory and then have to be transported to the facility where the foodstuff is dispensed with utilization of considerable transport volumes. Furthermore, jars and cans can be opened only with considerable expenditure of force or with the aid of tools and hence in a rather laborious manner. In the case of cans, there is a high risk of injury emanating from sharp edges that arise on opening. In the case of jars, it is a repeated occurrence that broken glass gets into the foodstuff in the course of filling or opening of the filled jars, which can lead in the worst case to internal injuries on consumption of the foodstuff. In addition, both cans and jars have to be labelled for identification and promotion of the foodstuff contents. The jars and cans cannot be printed directly with information and promotional messages. In addition to the actual printing, a substrate is thus needed for the purpose, a paper or suitable film, as is a securing means, an adhesive or sealant.

Other packaging systems are known from the prior art, in order to store foodstuffs over a long period with minimum impairment. These are containers produced from sheetlike composites – frequently also referred to as laminates. Sheetlike composites of this kind are frequently constructed from a thermoplastic plastic layer, a carrier layer usually consisting of cardboard or paper which imparts dimensional stability to the container, an adhesion promoter layer, a barrier layer and a further plastic layer. As the carrier layer imparts rigidity and dimensional stability to the container produced from the laminate, these laminate containers are to be seen in a line of development with the above mentioned glasses and jars. In this the above mentioned laminate containers differ severely from pouches and bags produced from thin foils without carrier layer.

The laminate containers of the prior art already have many advantages over the conventional jars and cans. For example, a decoration or print image can be printed directly onto the laminate or laminate precursor without the need for separate substrate. Such a decoration may comprise information about ingredients of the foodstuff to be stored in the laminate container and/or provide a visually appealing appearance to the consumer. Nevertheless, there are improvement opportunities even in the case of these packaging systems. For example, there is a need for applying information to the laminate container which may be chosen individually for the foodstuff in the container. Typically, the decoration is printed by a printing process involving a printing roll – such as intaglio printing or flexographic printing. Hence, the decoration cannot be varied to individually suit a container.

Summary of the invention

In general terms, it is an object of the present invention to at least partly overcome one disadvantage which arises from the prior art. It is a further object of the invention to provide a laminate for the production of dimensionally stable foodstuff containers and/or such a foodstuff container having a decoration and a machine readable pattern, wherein the pattern is reliably readable under various conditions, preferably under various lighting conditions. In this context, it is a further object of the invention that as much data as possible can be encoded into the pattern, preferably with as little impairment of the decoration as possible. Further in this context, it is an object of the invention that a content of the data encoded into the pattern can be chosen as flexible as possible. Preferably, the data can be chosen to individually fit the foodstuff to be stored in the container or to specifics of the individual process by which the laminate or the container is produced. The preceding object is preferably solved under the condition of the pattern being based on a predetermined coding. It is a further object that in the context of one of the preceding advantageous laminates or containers an adhesion strength of the decoration and/or the pattern is as high as possible. Therein, the adhesion strength may be relevant for a visual appearance of the decoration or the pattern, or for a health risk of a consumer of the foodstuff. It is a further object that in the context of one of the preceding advantageous laminates or containers a process for manufacturing this laminate or container bears an as little as possible risk of impairing a moisture barrier of the laminate or container. It is a further object that in the context of one of the preceding advantageous containers that a foodstuff can be

stored as long as possible in the container with as little impairment of a taste of the foodstuff as possible.

5 It is a further object of the invention to provide a process for producing a laminate for the production of dimensionally stable foodstuff containers and/or for the production of such a foodstuff container having a decoration and a 2D-code, wherein the process is as flexible as possible with regard to the process stage in which the 2D-code is applied. Further, it is an object of the invention to provide a process for producing a laminate for the production of dimensionally stable foodstuff containers and/or for the production of such a foodstuff containers having a
10 decoration and a 2D-code, wherein inks of the decoration and the 2D-code can as much as possible be chosen independently from each other. Further, it is an object to provide one of the preceding advantageous processes, wherein the process can be performed as fast as possible. Further, it is an object to provide one of the preceding advantageous processes, wherein an amount of basic material used for the process can be reduced. Therein, a preferred basic material is an ink.
15

A contribution to 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 at least partial achievement of at least one of the objects.

20

A contribution to the achievement of at least one of the objects of the invention is made by an embodiment |1| which is **a printing device** for printing a pattern on a surface S of a target using a radiation curable ink composition, comprising in direction of a treatment path of the target at least:

25

- a. a plasma treating unit;
- b. at least an inkjet printing unit downstream of the plasma treating unit;
- c. a 1st UV treatment unit downstream of the inkjet printing unit;
- d. a 2nd UV treatment unit downstream of the 1st UV treatment unit;

30

wherein the output power of the 1st UV treatment unit is less than the output power of the 2nd UV treatment unit.

The target is preferably sheetlike. A treatment path of a target is defined to extend from upstream to downstream of a process. With regard to a configuration of a device, e.g. a printing device, a treatment path indicates the path a sample follows from feed to the finished good. In a printing device, e.g., the treatment path begins at a feeder of substrate, e.g. a roll, goes possibly through a pre-treatment unit, a printing unit, one or more curing units, possibly through another pre-treatment, printing and curing unit via cutting and creasing until a colored and/or printed substrate leaves the printing device.

In the meaning of the claim, the output power of the 1st and the 2nd UV treatment unit is compared irrespective of the wavelength at which the output power is achieved for each UV treatment unit. Accordingly, the feature “wherein the output power of the 1st UV treatment unit is less than the output power of the 2nd UV treatment unit” is fulfilled when the 1st UV treatment unit has less output power than the 2nd UV treatment unit, also when the specified peak wavelength and/or the specified wavelength band are different for the 1st and the 2nd UV treatment unit.

Another contribution to the achievement of at least one of the objects of the invention is made by an embodiment |1a| which is **a printing system** comprising at least two components, which are preferable discriminable, wherein component A comprises a plasma treating unit; and component B comprises an inkjet printing unit, a 1st and a 2nd UV treatment unit, wherein the product obtainable from component A is fed at least in part into the component B. The term discriminable is used in the present context to indicate that the two components are separate machines and that a printing process is discontinuous when being run on the printing system. The term printing system is used to indicate that the process of printing using such system is disruptive, and not continuous. Usually, a printing system requires some un- and re-loading of a semi-finished good during operation. All embodiments described below with regard to the printing device are also embodiments for the printing system of the invention. The below described process for printing a pattern on a surface S of a target can be also applied using a printing system.

In an embodiment [2] according to the printing device of the invention, the 1st UV treatment unit is configured to emit UV irradiation of a peak wavelength in the range from 100 to 420 nm, preferably in a range from 300 to 405nm, or in a range from 350 to 405 nm. Preferably, 80% or more, yet more preferred 90% or more, or 95% or more of the total amount of UV irradiation emitted from a source of UV irradiation in the 1st UV treatment unit is emitted at the mentioned peak wavelength, and in the mentioned band, respectively. Further preferred, the source of UV irradiation in the 1st UV treatment unit has a wavelength dispersion FWHM (full width half max) of ± 10 nm, more preferred ± 5 nm, each from the peak wavelength. Examples of preferred sources of UV irradiation for the 1st UV treatment unit are a UV laser and a UV light emitting diode (UV-LED), or an device comprising two or more UV-LEDs.

In an embodiment [3] according to the printing device of the invention, the 1st and 2nd UV treatment units are configured to emit UV light of a spectral distribution wherein the spectral distribution of the 1st UV treatment unit is narrower than the spectral distribution of the 2nd UV treatment unit. A spectral distribution of a UV treatment in the context of the present invention is the wavelength band, in which UV irradiation is emitted during the UV treatment. Such wavelength band is narrower than a comparative wavelength band, if the difference of upper limit and lower limit of the band is smaller than for the compared with band.

In an embodiment [4] according to the printing device of the invention, the 2nd UV treatment unit is configured to emit UV light in a band in the range from 100 to 420 nm, preferably in the range from 150 to 350nm. UV irradiation with a broader spectral distribution in the 2nd treatment increases the efficiency and the overall curing of the droplet.

In an embodiment [5] of the printing device of the invention, the plasma treatment unit is designed and positioned to modify the surface tension σ of the surface S of the target to a value in the range of from 37 to 45 dyn, preferably in the range from 40 to 45 dyn, yet more preferred to a value of 41 ± 1 dyn. This is found to be specifically useful if the surface S of the target is a polyolefin, a copolymer comprising at least one polyolefin or a blend of at least one polyolefin and another plastic.

In a further embodiment |5a| of the invention, the printing device is configured according to any one of the aforementioned embodiments, wherein the plasma treatment unit is designed and positioned to increase the surface tension of the surface S of the target to a value of 37 to 45 dyn, preferably to a value in the range from 40 to 45, yet more preferred to a value of 41±1 dyn.

In an embodiment |6| of the printing device of the invention, the printing device is configured for a target of a width in the range of from 500 to 1800mm, preferred 500 to 815mm.

In a further embodiment |7| of the printing device of the invention, the printing device comprises at least one roll which has a width in the range of from 450 to 1850mm, preferred 550 to 950mm, wherein the width of the roll extends perpendicular to the treatment path of the target at the position of the roll. The roll is preferably selected from the group consisting of: a roll carrying the target, a product roll, a deflector roll, a dancer roll, and a buffering roll positioned between the 1st and 2nd UV treatment unit.

In an embodiment |8| of the printing device of the invention, the printing device is configured for processing the target at a speed in a range from 150 to 400 m/min, preferred in a range from 150 to 350m/min., or from 150 to 300 m/min., or from 200 to 400 m/min.

In a further embodiment |9| of the printing device of the invention, the printing device comprises at least one roll which is configured for processing the target at a speed in a range from 150 to 400 m/min, preferred in a range from 150 to 350m/min, or from 150 to 300 m/min., or from 200 to 400 m/min. Preferred embodiments of the roll are those as mentioned with regard to embodiment |7|.

In a further embodiment |10| of the printing device of the invention, the printing device comprises at least one further printing unit. The at least one further printing unit can be positioned upstream or downstream of the above mentioned inkjet printing unit. Preferable, the further printing unit is positioned upstream of the above mentioned inkjet printing unit.

In an embodiment |11| thereto the further printing unit is an inkjet printing unit. Such printing unit could have another plasma treating unit, e.g. another corona plasma unit, upstream. The further printing unit can be part of the printing device, or part of another printing device different to the printing device of embodiment |1|. In a second embodiment thereto the further printing unit does not operate based on inkjet printing technology. For example, the further printing unit could operate based on intaglio printing.

In a further embodiment to the printing device of the invention ratio of the number of UV treatment units to the number of inkjet printing units in the printing device is more than 1:1, e.g. 2:1.

In an embodiment |12| of the printing device of the invention, the 1st UV treatment unit comprises one or more UV-LEDs.

In a further preferred |13| embodiment of the printing device of the invention, the 1st UV treatment unit emits UV irradiation at a peak wavelength selected from the group consisting of 365 nm, 385 nm, 395 nm and 405 nm, or a combination of two or more thereof.

In a further preferred embodiment |14| of the printing device of the invention, the 1st UV treatment unit emits an output power of 2 to 20 kW/m². This can be achieved by a single source of UV irradiation in the UV treatment unit, or by a combination of more than one, e.g. 2, 3, 4, 5, 6, 7, 8, 9, 10 and more sources of UV irradiation.

In a further embodiment |15| of the printing device of the invention, the printing device is configured according to any one of the aforementioned embodiments, wherein the 2nd UV treatment unit comprises one or more UV-lamps.

In a further preferred embodiment |16| of the printing device of the invention, the 2nd UV treatment unit emits UV irradiation at UV band in the range from 100 to 420nm, preferably in the range from 150 to 350nm. Two or more sources of UV irradiation, e.g. 3, 4, 5, 6, 7, 8, 9, 10 and more, can be combined within in the 2nd UV treatment unit.

In a further preferred embodiment [17] of the printing device of the invention, the 2nd UV treatment unit emits an output power in the range from 80 to 300 kW/m², preferably from 100 to 250 kW/m², or from 120 to 200 kW/m². As before, this can be achieved by a single source of UV irradiation in the UV treatment unit, or by a combination of more than one, e.g. 2, 3, 4, 5, 5, 6, 7, 8, 9, 10 and more sources of UV irradiation.

In an embodiment [18] of the printing device of invention, the 1st UV treatment unit is arranged downstream in a distance in the range from 200 to 1000 mm from the printing unit, more preferable downstream in a distance in the range from 400 to 800 mm.

In an embodiment [19] of the printing device of the invention, the shortest distance between the target, preferably the surface S of the target, and the 1st UV treatment unit is in the range from 1 to 10 cm, preferably in the range from 2 to 7 cm, or in the range from 2 to 5 cm.

In a further embodiment [20] of the printing device of the invention, the shortest distance between the target, preferably the surface S of the target, and the 2nd UV treatment unit is in the range from 1 to 10 cm, preferably in the range from 2 to 7 cm, or in the range from 2 to 5 cm.

In a further embodiment [21] of the printing device of the invention the shortest distance between the print head and the target, preferably the surface S of the target, is in the range from 0.1 to 1 cm, preferably in the range from 0.1 to 1 cm, or in the range from 0.5 to 2 mm, or in the range from 0.5 to 1 mm.

In an embodiment [22] of the printing device of the invention, no inkjet unit is arranged between the 1st and the 2nd UV treatment unit.

In an embodiment [23] of the printing device of the invention, a buffering unit is arranged between the 1st and the 2nd UV treatment unit.

In an embodiment [24] of the printing device according to embodiment [23], the buffering unit is configured and positioned to host in a range from 0.1 to 5 m of the target, preferably 0.3 to 3m of the target.

In a further embodiment |25| of the printing system of the invention, the pattern comprises a 2D-code, a 3D-code, a barcode, an arrangement of characters and numbers, one or more pictograms.

5 In a further embodiment|26| of the printing device of the invention, the printing device is configured to process a target which preferably is a sheetlike composite comprising as layers of a layer sequence in a direction from an outer surface of the sheetlike composite to an inner surface of the sheetlike composite:

- 10 i.) an outer polymer layer; and
ii.) a carrier layer;
wherein the outer polymer layer faces the ink jet printing unit;
iii.) optionally a barrier layer;
iv.) optionally a inner polymer layer.

15 In a further embodiment |27| of the printing device of the invention, the printing device is configured to process a target which has an outer polymer layer which comprises a polyolefin.

In a further embodiment |28| of the printing device of the invention, the printing device further
20 comprises downstream of the printing device:

- e. a form shaping unit.

A contribution to the achievement of at least one of the objects of the invention is made by an embodiment |1| of a **process of printing a pattern** on a surface S of a target, comprising at
25 least these process steps:

- a) providing the target having surface S;
b) modifying the surface tension of at least a part of surface S to a first value; preferably to a value as described for embodiments |5| or |5a| of the printing device;
c) applying a pattern of droplets of at least one ink composition onto the surface S;
30 preferably using an inkjet printing unit as described above;

- d) curing at least a part of the ink composition(s); preferably in a 1st UV treatment, further preferably in a 1st UV treatment unit as described above; and optionally waiting for 0.2 to 5 seconds; preferably 0.5 to 3.5 seconds;
- e) further curing the rest of the ink composition(s); preferably in a 2nd UV treatment, further preferably in a 2nd UV treatment unit.

The process steps are conducted in the order of the alphabet. The target is preferably sheetlike.

In an embodiment |2| of process of the invention, the process comprises a further printing step upstream of step c.). This printing step can be another ink jet printing step or a step different thereto, e.g. a step of intaglio printing; further preferably using a printing unit as described in embodiments |10| and |11| of the printing device and further embodiments referring thereto.

In an embodiment |3| of the process of the invention, the target has a width in the range of from 500 to 1800 mm, and preferably in the range from 500 to 815 mm.

In an embodiment |4| of the process of the invention, step d) is performed under irradiation with UV light of a peak wavelength in the range from 100 to 420 nm; further preferred embodiments thereto are the same as mentioned with regard to embodiment |2| of the printing device of the invention.

In an embodiment |5| of the process of the invention, the curing in step d) is performed at the interface of the droplets and the target. The interface in the context of the present invention is, where the liquid phase of the droplet and the solid phase of the target and a gas phase meet. The gas phase is usually air, but could also be a protecting atmosphere, a reactive atmosphere and the like. The interface is usually observed at the edge of the droplet.

In an embodiment |6| of the process of the invention, step e) is performed under irradiation with UV light in a band in the range from 100 to 420nm, preferably in the range from 150 to 350nm.

In an embodiment |7| of the process of the invention, step d) is performed under irradiation with UV light which has a narrower spectral distribution than the UV light irradiated in step e).

5 In an embodiment |8| of the process of the invention, the surface tension of the surface S of the target is modified in step b) to a value in the range of from 37 to 45 dyn. Further preferred ranges are identical with those described with embodiment |5| or |5a| of printing system of the invention.

10 In an embodiment |9| of the process of the invention, step b) is performed by a plasma treatment. The plasma treatment according to this embodiment may be any plasma treatment which the skilled person may consider appropriate in the context of the invention. A preferred example of plasma treatment is a corona treatment. Such plasma treatment can be performed using the plasma treatment unit described for the printing device of the invention.

15 In an embodiment |10| of the process of the invention, the pattern is printed on a white area of a target, wherein the target has a printed decor. A white area in terms of the present invention is an area which is either colored white or light grey, or an area which is not colored before being printed upon with the process or printing device of the invention.

20 In an embodiment |11| of the process of the invention, the ink composition has an UV activation wavelength at least in the range from 100 to 420nm, preferably in a range from 300 to 405nm, or in a range from 350 to 405 nm.

25 In an embodiment |12| of the process of the invention the ink composition comprises at least one, possibly two or more volatile organic compounds (VOCs) in a total amount of less than 8, preferably less than 3 wt.%, each of the wt.% based on the total weight of the ink composition. This relates in particular to the droplets of ink composition used in step c) of the process. Volatile organic compounds (VOC) in terms of the present invention are those organic liquids which have a boiling point smaller than or equal to 260 °C at a standard atmospheric pressure
30 of 101.3 kPa and a vapor pressure of 0.01 kPa or more in operation conditions.

In an embodiment |13| of the process of the invention, the speed of the target in direction of the treatment path is in the range from 150 to 400 m/min. Further preferable embodiments thereto are as described for embodiment |8| and |9| of the printing device of invention.

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In an embodiment |14| of the process of the invention, the time between end of step c) and beginning of step d) is in a range of from 0.046 to 0.69s, preferably in a range from 0.25 to 0.58s.

10 In an embodiment |15| of the process of the invention, the time between end of step d) and beginning of step e) is in the range from 0.3 to 5.0 s, preferably in the range from 0.4 and 3.0 s, or from 0.3 to 2.5s.

In an embodiment |16| of the process of the invention, the process comprises an upstream printing step preceding step c). An upstream printing step can be in principle use any printing
15 technique which is known to the person skilled in the art for. For example, such printing step could be another ink jet printing step or an intaglio printing step.

In an embodiment |17| of the process of the invention, the pattern comprises a 2D-code, a 3D-code, a barcode, an arrangement of characters and numbers, one or more pictograms. Further
20 embodiments and details regarding the pattern are described below.

In an embodiment |18| of the process of the invention, the process further comprises a process step downstream of step e):

f) form shaping of the target.

25

In an embodiment |19| of the process of the invention, the process is performed by employing a device according to any one of embodiments |1| to |28| of the printing device of the invention.

A contribution to the achievement of at least one of the objects of the invention is made by
30 an embodiment 1 of a **target** comprising a surface S, which target carries a printed pattern, obtainable by a process of the invention or one of the embodiments thereof; preferably, the

process of the invention or one of its embodiments is conducted in a printing device according to the invention or one of the embodiments thereof.

A contribution to the achievement of at least one of the objects of the invention is made by an embodiment 1 of **a container** comprising a target according to the invention. By preference, the container is a closed container. Preferably, the container is produced based on a container precursor. The container precursor can be based on a target which preferably is a composite, possibly a sheetlike composite, as described in the context of the invention.

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 an inkjet printing unit** and a 1st and a 2nd UV treatment to manufacture a printed pattern on a surface S of a target wherein the printed pattern has an enhanced resistance against chemicals, an improved data storage capacity per area, and wherein the printed pattern can be varied from print to print.

In an embodiment [2] of the use of an inkjet printing unit according to the invention, an upstream printing step is performed preceding the inkjet printing unit.

Irradiation

The irradiation according to the invention may be any irradiation which the skilled person may consider appropriate in the context of the invention. More specifically, the irradiation according to the invention must be suited to produce at least some curing of the radiation curable ink composition. The irradiation of the invention is preferably selected from the group consisting of ultraviolet light (UV), visible light (VIS), infrared radiation (IR) and electron beam (EB). The irradiation may further comprise a combination of two or more of the aforementioned elements, e.g. of UV and VIS, UV and IR, UV and IR, UV and EB, IR and EB, VIS and EB, VIS and IR.

A treatment with irradiation can be performed using a treatment unit which comprises at least one source of irradiation. For example, a treatment with UV irradiation can be performed using

a UV treatment unit. A treatment with IR irradiation can be performed using a IR treatment unit. A treatment with electron beam can be performed using a electron beam treatment unit.

Plasma treating unit

5 The plasma treating unit according to the invention may be any plasma treating unit which the skilled person may consider appropriate in the context of the invention. The plasma treatment unit of the printing device is positioned upstream of the ink jet printing unit. The plasma treatment unit emits a plasma during operation which is applied to the surface S of the target. By effect of the plasma, the surface tension of the target can be modified, preferably increased, as
10 mentioned with regard to embodiment |5| of the invention.

In principle, any method for generation of and treatment with plasma can be used which the skilled person may consider appropriate in the context of the invention. A preferred method for plasma generation and treatment is a so-called Corona-treatment. This kind of treatment is
15 known to the skilled person.

Ink jet printing unit

An ink jet printing unit according to the invention may be any ink jet printing unit which the skilled person may consider appropriate in the context of the invention. Preferably, the inkjet
20 printing unit comprises one or more, e.g. 2, 3, 4, 5, 6, 7, 8 print heads. Each print head is configured to apply an ink composition to a target.

When using more than one print head, the print heads can be arranged in a direction substantially perpendicular to the treatment path of the target. In such an arrangement one or more of
25 the print heads of the ink jet printing unit can be positioned at a permanent position or a be repositioned along a part of the width of the target and the treatment path of the target. An arrangement substantially perpendicular to the treatment path of the target is sometimes also referred to as a “line of service”. A configuration of more than one print heads in one line of service may serve for different purposes. In a first alternative, employing two or more re-
30 positionable print heads instead of one could improve print speed. In such a configuration, each print head only has to cover printing over a fraction of the total width of the target. Dis-

tances to be covered are reduced, accordingly the speed of target could be enhanced. In a first alternative, the two or more print heads can be re-positioned but each print head moves only little around a fixed position during operation. That way, a target which has a repetitive pattern based on the width of the target, can be printed more efficiently. For example, the target could be a composite material designed for use as a foodstuff storage container. Typically, the size of the target exceeds the size of the container and two or more, e.g. 3, 4, 5, 6 or 7 designs are printed in parallel. Afterwards, the target could be cut into the number of designs thus giving the appropriate number of designs.

Furthermore, the print heads could be at least partially arranged in direction of the treatment path of the target. Then, a second print head is positioned downstream of the first print head, both within the same ink jet printing unit. In this scenario, the area which is printed onto by the first print head is also be printed onto by a second print head, and by a third print head etc. Such configuration may serve for different purposes. In a first alternative, employing two or more print heads in downstream direction could be used to improve print speed of patterns which have more than one color. In this event, the print heads would be filled with ink compositions of different color. In a second alternative, the print heads could be filled with ink compositions of the same color. Employing two or more print heads in downstream direction could be used to increase printing speed. For example, this could be achieved if the first print head applies the first and then every second droplet to the target, whereas the second print head applies the second and then every second droplet to the target in the spaces left from applying droplets by the first print head.

Furthermore, the print heads could be arranged in an array. The configuration of an array according to the invention is a combination of the two aforementioned configurations. In an array, a number of print head is arranged, whereby some print heads line up in a direction substantially perpendicular to the treatment path of the target and some other print heads line up substantially in downstream direction. That way, arrays of e.g. 3 x 2, 3 x 3, 4 x 2, 2 x 4 and so on can be formed. In another alternative, an array could be formed by print heads which are lined up perpendicular to the treatment path of the target in two lines, i.e. two lines of service, but staggered with respect to downstream alignment.

UV treatment unit

A UV treatment unit according to the invention may be any UV treatment unit which the skilled person may consider appropriate in the context of the invention. The UV treatment according to the invention unit comprises at least one source which is able to emit UV irradiation. The UV irradiation according to the invention may be any UV irradiation which the skilled person may consider appropriate in the context of the invention. UV irradiation can have a wavelength in the range of from 315 – 410 nm. In general, sources of UV irradiation emit in a band rather than at a single wavelength. A band is called a span over a range of wavelengths. Often, a peak wavelength and a spectral distribution therefrom is mentioned instead of the band. In all cases, it is preferred that 80% or more, yet more preferred 90% or more, or 95% or more of the total amount of UV irradiation emitted from a source of UV irradiation is emitted at the mentioned peak wavelength, and in the mentioned band, respectively.

Depending on the source, UV irradiation can be emitted in a narrow band or broad band. A narrow band often has a wavelength spectral distribution FWHM (full width half max) of ± 10 nm, more preferred ± 5 nm, each from the peak wavelength. A UV laser and a UV light emitting diode (UV-LED) and devices of two or more UV-LEDs are preferred sources of narrow band UV irradiation. Preferred sources of broad band UV irradiation are lamps which are filled with a particular gas, e.g. Deuterium, Xenon, lamps filled with Quicksilver and a noble gas like argon, or those fitted with a filament comprising tungsten.

According to the invention, the printing device comprises at least a 1st UV treatment unit and a 2nd UV treatment unit. Both UV treatment units are positioned downstream of the inkjet printing unit, wherein the 2nd UV treatment unit is positioned downstream of the 1st UV treatment unit. Furthermore, the output power of the 1st UV treatment unit is less than the output power of the 2nd UV treatment unit. The output power in the context of the present invention is the UV power expressed in W/m². It is commonly cited with reference to a specified peak wavelength or over a specified wavelength band.

Form shaping unit

A form shaping unit according to the invention may be any form shaping unit which the skilled person may consider appropriate in the context of the invention. Preferably, the form shaping unit comprises at least one device to perform one or more tasks selected from the group consisting of folding, cutting, creasing and hole punching.

Buffering unit

A buffering unit according to the invention may be any buffering unit which the skilled person may consider appropriate in the context of the invention. Preferably, a buffering unit comprises one or more buffer rolls of which some of them can preferably be moved. During operation, a target, e.g. a web is threaded from an upstream treatment unit over the one or more buffer rolls and the runs into a downstream treatment unit. So, the buffering unit provides for a distance between the upstream and the downstream treatment unit. By moving at least some of the buffer rolls, the distance between the upstream and the downstream treatment unit can be varied. In a continuous process, where the target is e.g. a web, the buffering unit can be used to adjust the distance at a given velocity of the target to set a delay between the upstream and the downstream treatment unit. The upstream treatment unit is e.g. an ink jet printing unit, a first UV treatment unit and the like. The downstream treatment unit comprises e.g. another, second UV treatment unit, a cutting and/or creasing unit and the like. A buffering unit through which the target is conveyed between the treatment with UV light in the first and second UV treatment unit can be employed to provide an idle period between the two UV treatments. The following Table 1 provides some idle period based on the distance in the buffering unit and the velocity of the target.

Table 1

Idle period [s]	Speed of target [m/min]	Distances provided by buffer unit [m]
0.30	150	0.75
	300	1.50
	350	1.75
0.36	150	0.90
	300	1.80
	350	2.10
0.50	150	1.25
	300	2.50
	350	2.92
1.00	150	2.50
	300	5.00
	350	5.83
1.50	150	3.75
	300	7.50
	350	8.75
2.00	150	5.00
	300	10.00
	350	11.67
2.50	150	6.25
	300	12.50
	350	14.58
2.54	150	6.35
	300	12.70
	350	14.82

5 Target

The target according to the invention may be any target which the skilled person may consider appropriate in the context of the invention. Preferably, the target is sheetlike. It can be flat or curved. In the context of the present invention, the term “sheetlike” refers to an object, which is much smaller in one direction than in the other two directions. The three directions are defined by the 3D rectangular space. For example, a “sheetlike” object extends about 20 cm in a

direction a, perpendicular thereto about 30 cm in a direction b, and about 0.1 cm in a direction c, wherein direction c is perpendicular to the plane defined by the vectors of directions a and b. Preferred examples of a sheetlike target are sheets, a web, sleeves, foil or film. A sheetlike, flat target can be stored e.g. on stack in form of sheets. A sheetlike flat target can be stored e.g. on a roll when being a web. When being stored on the rolled, the sheetlike target is curved. When unwounded for processing, the sheetlike target might become flat.

In a preferred embodiment, the target is selected from the group consisting of a composite, paper, carton, a textile, a non-woven, a foil and a layered structure.

Preferably, the target is a composite, further preferred a sheetlike composite. The sheetlike composite comprises one or more layers, preferably at least

- a.) An outer polymer layer having an outer surface;
- b.) An carrier layer;
- c.) An barrier layer; and
- d.) Inner polymer layer having an inner surface.

The sheetlike composite may have further layers selected from: a polymer layer, an adhesion layer, an adhesion promoter layer, and a combination of two or more thereof. Each of these furthers layers can be positioned between any two of the layers mentioned in a.) – d.). further- more two or more of these layer can be positioned between any two of the layers mentioned in a.) – d.).

Further, the sheetlike composite may have a first and a second, and possibly further composite regions, wherein in the first composite region (201) the sheetlike composite (100) further comprises a first colour application (109), superimposing the outer polymer layer (103) on a side of the outer polymer layer (103) which is facing away from the inner surface (102) of the sheetlike composite (100); wherein in the second composite region (202) the sheetlike composite (100) further comprises a second colour application (110), superimposing the outer polymer layer (103) on the side of the outer polymer layer (103) which is facing away from the inner

surface (102) of the sheetlike composite (100); wherein the second colour application (110) comprises a 2D-code.

Composite regions

5 Generally, the first, second and third composite region refer to distinct regions which each extend in a sheet plane of the sheetlike composite. Analogously, the first, second and third composite precursor region refer to distinct regions which each extend in a sheet plane of the sheetlike composite precursor. Therein, the plane may be flat or curved. For example, the plane may be curved if the sheetlike composite or the sheetlike composite precursor is rolled
10 up to form a roll. Preferably, the first composite region or the second composite region or both is a continuous region. Preferably, the first composite region and the second composite region adjoin each other along a continuous border line. Preferably, the first composite region does not comprise any part of the second colour application. Further preferably, the second composite region does not comprise any part of the first colour application. Preferably, the first composite precursor region or the second composite precursor region or both is a continuous region. Preferably, the first composite precursor region and the second composite precursor region adjoin each other along a continuous border line. Further, the third composite region or the third composite precursor region or both is a continuous region. Preferably, the third composite region is positioned between the first composite region and the second composite region. Preferably, the third composite precursor region is positioned between the first composite precursor region and the second composite precursor region.
20

Pattern

The pattern according to the invention may be any pattern which the skilled person may consider appropriate in the context of the invention. The pattern of the invention is printed on the
25 surface S of the target, which preferably is also an outer surface. In principle, the pattern may comprises information which can be read by a human or by a machine. The pattern may comprise information which is stored in the pattern as a 1D-, 2D or 3D-code. An example of a 1D-code is a line of dots.

30

2D-Code

The 2D-code according to the invention may be any 2D-code which the skilled person may consider appropriate in the context of the invention. Preferably, the 2D-code comprises a plurality of graphic elements and a plurality of gaps between these graphic elements. Preferred graphic elements are lines, preferably straight lines; rectangles, preferably squares; circles; and dots; and combinations of these. Further preferably, data may be encoded into the 2D-code along two axes of a 3-dimensional system of coordinates, hence in 2 dimensions which span a plane. These two axes of the system of coordinates are also referred to as 2 dimensions. In this context the 2D-code is preferably a 2-dimensional reproduction of data in form of the graphic elements, wherein these graphic elements are arranged in a predetermined 2-dimensional area, thereby encoding the data in 2 dimensions. Therein, pieces of information which are stored in the 2 dimensions are preferably independent from each other. In this context preferred systems of coordinates are a Cartesian system of coordinates and a polar system of coordinates. A preferred 2D-code is machine-readable, wherein preferably the 2D-code is readable by an optoelectronic sensor. Preferably, the 2D-code is readable by a 2D-code reader. Therein, the 2D-code reader may be a device, having an optoelectronic sensor; or a scanner software; or both. A preferred optoelectronic sensor is a laser scanner or a CCD-camera, for example of a smartphone.

A preferred 2D-code is one selected from the group consisting of a matrix code, a 2D-barcode and a dot-code or a combination of at least two thereof. Therein, a matrix code is particularly preferred. A preferred 2D-barcode comprises a plurality of stacked 1D-barcodes. Further preferred 2D-barcodes are Codablock, Code 49, Code 16k and PDF417. Preferred matrix codes are Aztec code, Code 1, ColorCode, Color Construct Code, CrontoSign, CyberCode, Data Matrix, DataGlyphs, Datastrip Code, EZcode, High Capacity Color Barcode, Hax Xin Barcode, HieCode, InterCode, MaxiCode, NexCode, Qode, QR code, ShotCode, SPARQCode, VOICEYE, wherein QR code and SPARQCode are preferred, wherein QR code is particularly preferred. Preferred dot-codes are Dot Code A, Snowflake code and BeeTagg. A further preferred 2D-code has an area of not more than 40 cm², preferably not more than 30 cm², more preferably not more than 25 cm², even more preferably not more than 20 cm², more preferably not more than 15 cm², more preferably not more than 10 cm², still more preferably not more than 8 cm², most preferably not more than 5 cm².

3D-Code

The 3D-code according to the invention may be any 3D-code which the skilled person may consider appropriate in the context of the invention. Preferably, the 3D-code comprises a plurality of graphic elements and a plurality of gaps between these graphic elements. Preferred graphic elements are lines, preferably straight lines; rectangles, preferably squares; circles; and dots; and combinations of these. In contrast to a 2D-Code, the graphic elements of a 3D-code further extend into the third dimension, also referred to as the height. In a first embodiment thereto, the graphic elements of a 3D-code have about the same height. This could serve to create a tactile code which can be read by machines and people with well eye-sight, further enabling the blind and those individuals who have an impaired eye sight to feel the code. In another embodiment thereto, a 3D-code could be used to store information using a tactile alphabet, again enabling the blind and the visually impaired people to read the information contained by the code. In a further embodiment, 3D-code could be composed of graphic elements which have different heights. This could be used, e.g. to store more information on a defined 2D-printing area.

Colour application

Generally, a colour application is a solid material on a surface, wherein the solid material comprises at least one 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 inorganic pigment or an organic pigment or both, wherein the organic pigment is particularly preferred. 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). However, other pigments may be considered as well. For example, the following are further notable suitable pigments:

- i. red or magenta pigments: pigment red 3, 5, 19, 22, 31, 38, 43, 48:1, 48:2, 48:3, 48:4, 48:5, 49:1, 53:1, 57:1, 57:2, 58:4, 63:1, 81, 81:1, 81:2, 81:3, 81:4, 88, 104, 108, 112, 122, 123, 144, 146, 149, 166, 168, 169, 170, 177, 178, 179, 184, 185, 208, 216, 226, 257, pigment violet 3, 19, 23, 29, 30, 37, 50 and 88;
- 5 ii. blue or cyan pigments: pigment blue 1, 15, 15:1, 15:2, 15:3, 15:4, 15:6, 16, 17-1, 22, 27, 28, 29, 36 and 60;
- iii. green pigments: pigment green 7, 26, 36 and 50;
- iv. yellow pigments: pigment yellow 1, 3, 12, 13, 14, 17, 34, 35, 37, 55, 74, 81, 83, 93, 94, 95, 97, 108, 109, 110, 128, 137, 138, 139, 153, 154, 155, 157, 166, 167, 168, 177, 10 180, 185 and 193 and
- v. white pigments: pigment white 6, 18 and 21.

The first colour application preferably comprises one or more colourants in a total proportion of 1 to 30 % by weight, preferably 3 to 27 % by weight in total, more preferably of 5 to 24 %
 15 by weight in total, most preferably of 10 to 20 % by weight in total, based in each case on the weight of first colour application.

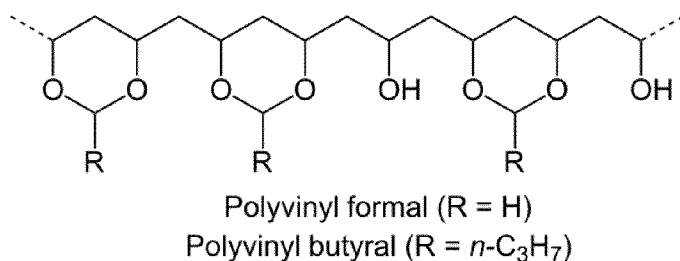
The first colour application preferably comprises at least 2 colourants, more preferably at least 3 colourants, more preferably at least 4 colourants, even more preferably at least 5, most preferably at least 6 colourants. In a preferred embodiment, the first colour application comprises
 20 exactly 4 colourants or exactly 6 colourants. A preferred first colour application is obtainable from the first ink composition, or from the first ink composition and one or more further ink compositions, each as described herein in the context of the process according to the invention, by hardening these ink composition(s). Furthermore, a preferred first colour application is a
 25 decoration or comprises a plurality of decorations, preferably a plurality of identical decorations. A preferred decoration is a decoration of a container, preferably a foodstuff container, to be produced from the sheetlike composite. A preferred decoration comprises information for identification and/or promotion of a foodstuff, preferably the foodstuff to be stored in a container, to be produced from the sheetlike composite. Further preferably, the first decoration
 30 comprises a polyvinyl acetal in a proportion of at least 40 % by weight, preferably at least 45 % by weight, more preferably at least 50 % by weight, more preferably at least 55 % by

weight, most preferably at least 60 % by weight, based in each case on the weight of the first colour application.

The second colour preferably comprises at least 1 colourant, or at least 2 colourants, or at least 3 colourants, or at least 4. In a particularly preferred embodiment, the second colour application comprises exactly 1 colourant, which is preferably a black pigment. An example of a black pigment is soot. A preferred second colour application is obtainable from the second ink composition, as described herein in the context of the process according to the invention, by hardening this second ink composition. Furthermore, a preferred second colour application forms a plurality of graphic elements of the 2D-code. Preferably, the second colour application comprises a crosslinked polymer, which is preferably a poly-addition product.

Polyvinyl acetal

15 Polyvinyl acetals are thermoplastics which are prepared by reaction of polyvinyl alcohol with aldehydes or ketones. According to the aldehyde used, for example formaldehyde, acetaldehyde or butyraldehyde, a distinction is made between various polyvinyl acetals. Preferred polyvinyl acetals are polyvinyl formal and polyvinyl butyral. A particularly preferred polyvinyl acetal is polyvinyl butyral (PVB).



Poly-addition product

As poly-addition product of the second colour application, all those poly-addition products known to the person skilled in the art which to him seem to be suitable for the sheetlike composite according to the invention come into consideration. In contrast to chain polymerisates, 25 monomers of the poly-addition products are able to react with each other to form di-, tri- or oligomers without the need for an initiator which, as with radical polymerisation, starts a reac-

tion of a monomer which then successively reacts with other monomers. The di, tri- or oligomers which are formed at the start of the poly-addition are additionally able to react with each other to form larger units. Typical poly-addition products are polyamides, polycarbonates, polyesters, polyphenylenoxides, polysulphones, polyepoxides or polyurethanes or a combination of at least two thereof, particularly preferred poly-addition products being those composed at least 50 % by weight, preferably at least 70 % by weight and particularly preferably 90 % by weight of polyurethane, in each case based on the poly-addition product. It is further preferred that the second colour application comprises at least 50 % by weight, preferably at least 70 % by weight and at particularly preferably at least 90 % by weight, in each case based on the weight of the second colour application, of the poly-addition product. However, the second colour application generally comprises no more than 99 % by weight of the poly-addition product in order to be able to comprise further materials as well.

Ink compositions

The ink compositions referred to in the context of the process according to the invention are preferably liquids. Preferred liquids are solutions or slurries or both. The first ink composition and each further ink composition preferably comprise a polyvinyl acetal, a solvent and a colourant. Therein, the first ink composition and each further ink composition each comprise preferably 1 to 30 % by weight, more preferably 2 to 25 % by weight, most preferably 3 to 20 % by weight, of the polyvinyl acetal, in each case based on the weight of the ink composition. Further, the first ink composition and each further ink composition each comprise preferably 1 to 30 % by weight, more preferably 2 to 25 % by weight, most preferably 3 to 20 % by weight, of the colourant, in each case based on the weight of the ink composition. Moreover, the first ink composition and each further ink composition each comprise preferably 10 to 90 % by weight, more preferably 15 to 85 % by weight, most preferably 20 to 80 % by weight, of the solvent, in each case based on the weight of the ink composition. Preferred first ink compositions or preferred further ink compositions or both are selected from the group consisting of an intaglio printing ink, an offset printing ink a gravure printing ink, a rotogravure printing ink, a flexographic printing ink, a relief printing ink and a flat printing ink or a combination of at least two thereof.

The second ink composition preferably comprises at least one, preferably at least 2, more preferably at least 5, more preferably at least 10, more preferably at least 15, most preferably at least 20, crosslinking initiators; at least 2 components which can react with each other, wherein this reaction can preferably be started by at least one of the preceding crosslink initiator; a solvent; and a colourant. Preferably, the at least two components are suitable for forming a poly-addition product, preferably a polyurethane. At least one of the crosslinking initiators, preferably a combination of at least two, more preferably all, of the crosslinking initiators, is suitable for initiating the reaction of the at least two components, wherein the reaction is preferably a crosslinking reaction. A preferred crosslinking initiator is a photo-initiator, which may preferably be activated by irradiation with UV-light.

Further, it is preferred in the process according to the invention that the first, further and/or second ink composition has a viscosity in the range from 0.05 to 0.3 Pa·s and preferably in a range from 0.1 to 0.2 Pa·s during applying this ink composition onto the outer surface.

15

Solvent

Materials with a melting point lower than 10 °C are considered as solvent. In principle, all solvents known to the person skilled in the art and which are suitable for the process according to the invention come into consideration. Polar solvents are preferred. Here, protic and aprotic solvents are suitable, of which aprotic polar solvents are preferred, of which esters and ketones, acetone for example, are particularly preferred. As ester, above all ethylacetate, N-propylacetate or methoxypropylacetate come into consideration. A preferred solvent is ethanol. Ethanol particularly preferred as solvent for the first or any further ink composition.

20

Surface S

The surface S, also referred to as the “outer surface” of the target is a surface of the target which is intended to be in contact with the environment of an object produced using the target, e.g. a container. This does not mean that, in individual regions of such a container, outer surfaces of various regions of the target are not folded against one another or joined to one another, for example sealed to one another.

25
30

Inner surface

The inner surface of the target is a surface of the target which is intended to be in contact with the contents, e.g. when the target is produced to be a container, preferably a foodstuff.

5 Print forme

The print forme may also be referred to as print image storage means or printing form or both. A preferred print image storage means is one selected from the group consisting of a print cylinder, a print roller and a print plate or a combination of at least two thereof. A preferred print cylinder is an intaglio print cylinder or a flexographic print cylinder or both. A preferred print
10 roller is an intaglio print roller or a flexographic print roller or both.

Layers

Unless otherwise stated, the layers in a layer sequence can follow one another indirectly, i.e. with one or at least two intermediate layers, or directly, i.e. without intermediate layer. This is
15 in particular the case with wording wherein there is a layer superimposed on another layer. Wording wherein a layer sequence includes a list of layers means that at least the stated layers are present in the stated sequence. This wording does not necessarily mean that these layers follow one another directly. Wording wherein two layers are adjoin one another means that these two layers follow one another directly and therefore without intermediate layer.

20

Carrier layer

Material used as carrier layer can be any suitable material which is known to the person skilled in the art for this purpose and which has strength and stiffness sufficient to provide the container with stability to such an extent that the container in essence retains its shape in the presence of its contents. This document also uses the term dimensionally stable to describe a container of this type. In particular, bags and containers made of foils without carrier layer are not
25 dimensionally stable. Preferred materials for the carrier layer are not only several plastics but also plant-based fibre materials, in particular chemical pulps, preferably glued, bleached and/or unbleached chemical pulps, particular preference being given here to paper and paperboard.
30 The weight per unit area of the carrier layer is preferably in the range from 120 to 450 g/m², particularly preferably in the range from 130 to 400 g/m² and most preferably in the range

from 150 to 380 g/m². A preferred paperboard generally has a single- or multilayer structure and can have been coated on one or both sides with one or more covering layers. The residual moisture content of a preferred paperboard is moreover less than 20% by weight, preferably from 2 to 15% by weight and particularly preferably from 4 to 10% by weight, based on the total weight of the paperboard. A particularly preferred paperboard has a multilayer structure. It is further preferable that the paperboard has, on the surface facing towards the environment, at least one, but particularly preferably at least two, sublayers of a covering layer known to the person skilled in the art as “paper coating”. The Scott Bond value of a preferred paperboard is moreover in the range from 100 to 360 J/m², preferably from 120 to 350 J/m² and particularly preferably from 135 to 310 J/m². Use of the abovementioned ranges allows provision of a composite from which it is easily possible to fold a highly leakproof container with narrow tolerances. A preferred carrier layer includes on at least one surface, preferably on each of two mutually opposite surfaces, a covering layer. Except where this is expressly excluded, it is preferable that each carrier layer includes a covering layer on each surface. It is preferable that the carrier layer is of one-piece design.

The carrier layer has a bending resistance which can be determined according to the standard ISO 2493:2010 using a bending measurement device. As a bending measurement device an L&W Bending Tester - code 160 of Lorentzen & Wettre, Sweden has been applied in making the present invention. The bending resistance is determined by deflecting the sample by 15°. In a first direction, the carrier layer preferably has a bending resistance in the range from 80 to 550 mN. In the case of a carrier layer having a plurality of fibres, the first direction is preferably a direction of orientation of the fibres. In the field of paper and cardboard making this direction of orientation of fibres is also known as running direction. In a second direction which is perpendicular to the first direction, a carrier layer having a plurality of fibres further preferably has bending resistance in the range from 20 to 300 mN. Samples used to determine the preceding bending resistances with the bending measurement device mentioned above have a width of 38 mm and a clamping length of 50 mm. A preferred composite having the carrier layer is characterised by a bending resistance in the first direction in the range from 100 to 700 mN. Further preferably, this composite has a bending resistance in the second direction in the range from 50 to 500 mN. Therein, the bending resistance measurements of the composite

have been performed using the same measuring device as mentioned above for the carrier layer. Furthermore, measurement samples of the composite also had a width of 38 mm and a clamping length of 50 mm.

5 Barrier layer

Material used as barrier layer can be any material which is known for this purpose to the person skilled in the art and which exhibits adequate barrier action in particular in relation to oxygen. It is preferable that the barrier layer is selected from

- 10 a. a plastics barrier layer;
 b. a metal layer;
 c. a metal oxide layer; or
 d. a combination of at least two of a. to c.

- 15 It is preferable that the barrier layer is of one-piece design.

If, according to alternative a., a barrier layer is a plastics barrier layer, this preferably includes at least 70% by weight, particularly at least 80% by weight and most preferably at least 95% by weight, of at least one plastic which is known for this purpose to the person skilled in the art, in particular on account of aroma properties or, respectively, gas-barrier properties that are suitable for packaging containers. Plastics, in particular thermoplastics, that can be used here are N- or O-containing plastics, either as such or else in mixtures of two or more. A melting point of the plastics barrier layer in the range from more than 155 to 300°C, preferably in the range from 160 to 280°C and particularly preferably in the range from 170 to 270°C can prove
20 advantageous according to the invention. A preferred electrically insulating barrier layer is a plastics barrier layer.
25

It is further preferable that the weight per unit area of the plastics barrier layer is in the range from 2 to 120 g/m², preferably in the range from 3 to 60 g/m², particularly preferably in the range from 4 to 40 g/m² and with further preference from 6 to 30g/m². It is further preferable
30 that the plastics barrier layer can be obtained from melts, for example via extrusion, in particu-

lar layer extrusion. It is further preferable that the plastics barrier layer can be introduced into the composite by way of lamination. Preference is given here to incorporation of a foil into the composite. According to another embodiment it is also possible to select plastics barrier layers which can be obtained via deposition from a solution or dispersion of plastics.

5

Suitable polymers are preferably those whose weight-average molar mass, determined by gel permeation chromatography (GPC) using light scattering, is in the range from $3 \cdot 10^3$ to $1 \cdot 10^7$ g/mol, preferably in the range from $5 \cdot 10^3$ to $1 \cdot 10^6$ g/mol and particularly preferably in the range from $6 \cdot 10^3$ to $1 \cdot 10^5$ g/mol. Suitable polymers that in particular can be used are poly-
 10 amide (PA) or polyethylene vinyl alcohol (EVOH) or a mixture thereof.

Among the polyamides, it is possible to use any of the PAs that appear to a person skilled in the art to be suitable for the inventive use. 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 here to PA 6 and PA 6.6, and further preference being given here to PA 6. PA 6 is obtainable commercially by way of example with the trademark Akulon[®], Durethan[®] and Ultramid[®]. Other suitable materials are amorphous polyamides such as MXD6, Grivory[®], and also Selar[®] PA. It is further preferable that the density of the PA is in the range from 1.01 to 1.40 g/cm³, preferably in the range from 1.05 to 1.30 g/cm³ and particularly preferably in
 20 the range from 1.08 to 1.25 g/cm³. It is further preferable that the viscosity number of the PA is in the range from 130 to 185 ml/g and preferably in the range from 140 to 180 ml/g.

EVOH that can be used is any of the EVOHs that appear to the person skilled in the art to be suitable for the inventive use. Examples here are obtainable commercially inter alia with the
 25 trademark EVALTM from EVAL Europe NV, Belgium in a plurality of different embodiments, examples being the grades EVALTM F104B and EVALTM LR171B. Preferred EVOHs have at least one, two, a plurality of, or all of, the following properties:

- ethylene content in a range from 20 to 60 mol%, preferably from 25 to 45 mol%;
- 30 - density in the range from 1.0 to 1.4 g/cm³, preferably from 1.1 to 1.3 g/cm³;
- melting point in the range from above 155 to 235°C, preferably from 165 to 225°C;

- MFR (210°C/2.16 kg if $T_{M(EVOH)} < 230^\circ\text{C}$; 230°C/2.16 kg, if $210^\circ\text{C} < T_{M(EVOH)} < 230^\circ\text{C}$) in the range from 1 to 25 g/10 min, preferably from 2 to 20 g/10 min;
- oxygen permeation rate in the range from 0.05 to $3.2 \text{ cm}^3 \cdot 20 \text{ }\mu\text{m}/\text{m}^2 \cdot \text{day} \cdot \text{atm}$, preferably in the range from 0.1 to $1 \text{ cm}^3 \cdot 20 \text{ }\mu\text{m}/\text{m}^2 \cdot \text{day} \cdot \text{atm}$.

5

According to alternative b. the barrier layer is a metal layer. A suitable metal layer is in principle any of the layers using metals which are known to the person skilled in the art and which can provide high impermeability to light and to oxygen. According to a preferred embodiment the metal layer can take the form of a film or of a deposited layer, e.g. after a physical gas-
 10 phase deposition process. It is preferable that the metal layer is an uninterrupted layer. According to another preferred embodiment, the thickness of the metal layer is in the range from 3 to 20 μm , preferably in the range from 3.5 to 12 μm and particularly preferably in the range from 4 to 10 μm .

15 Metals preferably selected are aluminium, iron or copper. A preferred iron layer can be a steel layer, e.g. in the form of a foil. It is further preferable that the metal layer is a layer using aluminium. The aluminium layer can advantageously consist of an aluminium alloy, for example AlFeMn, AlFe1.5Mn, AlFeSi or AlFeSiMn. Purity is usually 97.5% or higher, preferably 98.5% or higher, based in each case on the entire aluminium layer. In a particular embodiment
 20 the metal layer consists of an aluminium foil. The extensibility of suitable aluminium foils is more than 1%, preferably more than 1.3% and particularly preferably more than 1.5%, and their tensile strength is more than 30 N/mm^2 , preferably more than 40 N/mm^2 and particularly preferably more than 50 N/mm^2 . Suitable aluminium foils exhibit a droplet size of more than 3 mm in the pipette test, preferably more than 4 mm and particularly preferably more than
 25 5 mm. Suitable alloys for the production of aluminium layers or aluminium foils are obtainable commercially as EN AW 1200, EN AW 8079 or EN AW 8111 from Hydro Aluminium Deutschland GmbH or Amcor Flexibles Singen GmbH. A preferred electrically conductive barrier layer is a metal barrier layer, particularly preferably an aluminium barrier layer.

30 When a metal foil is used as barrier layer, there can be an adhesion-promoter layer provided on one or both sides of the metal foil between the metal foil and the closest polymer layer. Ac-

cording to a particular embodiment of the container of the invention, however, there is no adhesion-promoter layer provided on any side of the metal foil between the metal foil and the closest polymer layer.

- 5 It is further preferable to select a metal oxide layer as barrier layer according to alternative c. Metal oxide layers that can be used are any of the metal oxide layers that are familiar to the person skilled in the art and that appear suitable for achieving a barrier effect in relation to light, water vapour and/or gas. In particular, preference is given to metal oxide layers based on the abovementioned metals aluminium, iron or copper and also to metal oxide layers based on
- 10 compounds of titanium or silicon oxide. A metal oxide layer is produced by way of example via deposition of a metal oxide from a vapour onto a plastics layer, for example an oriented polypropylene film. A preferred process for this is physical gas-phase deposition.

- According to another preferred embodiment the metal layer or the metal oxide layer can take
- 15 the form of a layer composite made of one or more plastics layers with a metal layer. This type of layer can be obtained by way of example via vapour deposition of a metal onto a plastics layer, for example an oriented polypropylene film. A preferred process for this is physical gas-phase deposition.

20 Polymer layers

- The following specifications are preferably valid for any of the inner polymer layer, the outer polymer layer and the intermediate polymer layer, or for combinations of at least two of those. However, the composite and the composite precursor may comprise further polymer layers for which the following specifications are also valid. The polymer layer can comprise further constituents. It is preferable that these polymer layers are introduced or, respectively, applied into
- 25 the layer sequence in an extrusion process. The further constituents of the polymer layers are preferably constituents which do not adversely affect the behaviour of the polymer melt when applied as layer. The further constituents can by way of example be inorganic compounds, such as metal salts or further plastics, for example further thermoplastics. However, it is also
- 30 conceivable that the further constituents are fillers or pigments, for example carbon black or metal oxides. Suitable thermoplastics that can be used for the further constituents are in partic-

ular those that are easily processable by virtue of good extrusion properties. Materials suitable in this context are polymers obtained via chain polymerisation, in particular polyesters or polyolefins, particular preference being given here to cyclic olefin copolymers (COC), and polycyclic olefin copolymers (POC), and in particular polyethylene and polypropylene, and very particular preference being given here to polyethylene. Among the polyethylenes, preference is given to HDPE, MDPE, LDPE, LLDPE, VLDPE and PE, and also to mixtures of at least two thereof. It is also possible to use mixtures of at least two thermoplastics. Another preferred polyolefin is an m-polyolefin. The melt flow rate (MFR) of suitable polymer layers is in the range from 1 to 25 g/10 min, preferably in the range from 2 to 20 g/10 min and particularly preferably in the range from 2.5 to 15 g/10 min, their density being in the range from 0.890 g/cm³ to 0.980 g/cm³, preferably in the range from 0.895 g/cm³ to 0.975 g/cm³, and more preferably in the range from 0.900 g/cm³ to 0.970 g/cm³; or in the range from 0.910 g/cm³ to 0.935 g/cm³, preferably in the range from 0.912 g/cm³ to 0.932 g/cm³, and more preferably in the range from 0.915 g/cm³ to 0.930 g/cm³. The polymer layers preferably have at least one melting point in the range from 80 to 155°C, with preference in the range from 90 to 145°C and particularly preferably in the range from 95 to 135°C. A preferred polymer layer is a polyolefin layer, preferably a polyethylene layer or a polypropylene layer or both.

m-Polyolefin

An m-polyolefin is a polyolefin produced by means of a metallocene catalyst. A metallocene is an organometallic compound in which there is a central metal atom arranged between two organic ligands, for example cyclopentadienyl ligands. A preferred m-polyolefin is an m-polyethylene (mPE) or an m-polypropylene or both. A further preferred m-polyethylene 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

In a preferred embodiment the inner polymer layer includes from 10 to 50% by weight, preferably 15 to 45% by weight, more preferably from 20 to 40% by weight, most preferably from 25 to 35% by weight, based in each case on the total weight of the inner polymer layer, of a polymer produced by means of a metallocene catalyst. In another preferred embodiment the

inner polymer layer includes from 20 to 90% by weight, preferably from 30 to 90% by weight, more preferably from 40 to 90% by weight, more preferably from 50 to 90% by weight, more preferably from 60 to 90% by weight, most preferably from 70 to 85% by weight, based in each case on the total weight of the inner polymer layer, of a polymer produced by means of a metallocene catalyst.

It is preferable that the inner polymer layer consists of the polymer blend including an mPE and a further polymer. A preferred further polymer is one selected of a PE, an LDPE and an LLDPE or a combination of those. In a preferred embodiment the polymer blend includes from 10 to 50% by weight, preferably from 15 to 45% by weight, more preferably from 20 to 40% by weight, most preferably from 25 to 35% by weight, of an mPE and at least 50% by weight, preferably at least 55% by weight, more preferably at least 60% by weight, most preferably at least 65% by weight, of a further polymer, based in each case on the total weight of the polymer blend. In another preferred embodiment the polymer blend includes from 20 to 90% by weight, preferably from 30 to 90% by weight, more preferably from 40 to 90% by weight, more preferably from 50 to 90% by weight, more preferably from 60 to 90% by weight, most preferably from 70 to 85% by weight, of an mPE and at least 10% by weight, preferably at least 15% by weight, of a further polymer, based in each case on the total weight of the polymer blend. The proportions of mPE and of further polymer in the polymer blend here are preferably combined in such a way that the sum of the proportions is 100% by weight. In each case the preferred proportions of mPE and of further polymer in the polymer blend are combined in such a way that the sum of the proportions is not more than 100% by weight. It is preferable that the inner surface of the sheetlike composite is a surface of the inner polymer layer that faces away from the barrier layer. The inner surface of the composite here preferably is the surface which in a container to be produced from the composite faces predominantly inwards, i.e. in particular is in direct contact with a food contained in the container.

Outer polymer layer

The outer polymer layer preferably comprises a polyethylene or a polypropylene or both. Here, preferred polyethylenes are LDPE and HDPE or mixtures of those. A preferred outer polymer layer comprises at least 50 % by weight, preferably at least 60 % by weight, more preferably

70 % by weight, more preferably 90 % by weight, most preferably 90 % by weight, in each case based on the weight of the outer polymer layer, of an LDPE.

Melting points

- 5 A preferred m-polyolefin is characterised by at least one first melting point and one second melting point. It is preferable that the m-polyolefin is characterised by a third melting point in addition to the first and the second melting point. A preferred first melting point is in the range from 84 to 108°C, preferably from 89 to 103°C, more preferably from 94 to 98°C. A preferred further melting point is in the range from 100 to 124°C, preferably from 105 to 119°C, more
10 preferably from 110 to 114°C.

Adhesion/adhesion-promoter layer

- There can be an adhesion-promoter layer located between layers of the composite which do not adjoin each other. In particular, there can be an adhesion-promoter layer located between
15 the barrier layer and the inner polymer layer or the carrier layer and the barrier layer. Plastics which can be used as adhesion promoters in an adhesion-promoter layer are any of those which, by virtue of functionalisation by means of suitable functional groups, are suitable to produce a secure bond via formation of ionic bonds or covalent bonds to a surface of a respective adjacent layer. The materials are preferably functionalised polyolefins obtained via copol-
20 ymerisation of ethylene with acrylic acids such as acrylic acid or methacrylic acid, crotonic acid, acrylates, acrylate derivatives or carboxylic anhydrides containing double bonds, for example maleic anhydride, or at least two thereof. 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 marketed by way of example with
25 the trademarks Bynel[®] and Nucrel[®] 0609HSA 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 respective closest layer is at least 0.5 N/15 mm, preferably at
30 least 0.7 N/15 mm and particularly preferably at least 0.8 N/15 mm. In an embodiment of the invention it is preferable that the adhesion between a polymer layer and a carrier layer is at

least 0.3 N/15 mm, preferably at least 0.5 N/15 mm and particularly preferably at least 0.7 N/15 mm. It is further preferable that the adhesion between a barrier layer and a polymer layer is at least 0.8 N/15 mm, preferably at least 1.0 N/15 mm and particularly preferably at least 1.4 N/15 mm. In the event that a barrier layer follows a polymer layer indirectly by way of an adhesion-promoter layer it is preferable that the adhesion between the barrier layer and the adhesion-promoter layer is at least 1.8 N/15 mm, preferably at least 2.2 N/15 mm and particularly preferably at least 2.8 N/15 mm. In a particular embodiment the adhesion between the individual layers is so strong that the adhesion test leads to tearing of a carrier layer, the term used in the event of paperboard as carrier layer being paperboard fibre tear.

Container precursor

A container precursor is a precursor of a closed container produced during the production of a closed container. The container precursor here includes the composite in cut-to-size form. The composite here can be unfolded or folded. A preferred container precursor has been cut to size and is designed for the production of a single closed container. Another term used for a preferred container precursor which has been cut to size and is designed for the production of a single closed container is also referred to a jacket or a sleeve. The jacket or sleeve here includes the folded composite. The jacket or sleeve moreover includes a longitudinal seam and is open in a top region and in a base region. The term tube is often used for a typical container precursor which has been cut to size and is designed for the production of a plurality of closed containers.

A preferred container precursor includes the composite according to the invention in a manner such that the composite has been folded at least once, preferably at least twice, more preferably at least 3 times, most preferably at least 4 times. A preferred container precursor is of a one-piece design. It is particularly preferable that a base region of the container precursor is of a one-piece design with a lateral region of the container precursor.

Container

The closed container of the invention can have a plurality of different shapes, but preference is given to a structure that is in essence a rectangular parallelepiped. It is moreover possible that

the entire area of the container is composed of the composite, or that the container has a two- or multipart structure. In the case of a multipart structure it is conceivable that other materials are also used alongside the composite, an example being plastic, which in particular can be used in the top or base regions of the container. However, it is preferable here that at least 50
5 %, particularly at least 70 % and more preferably at least 90 %, of the area of the container is composed of the composite. The container can moreover comprise a device for the discharge of the contents. This can by way of example be formed from plastic and applied to the external side of the container. It is also conceivable that this device has been integrated into the container via “direct injection moulding”. According to a preferred embodiment the container of
10 the invention has at least one folded edge, preferably from 4 to 22, or even more folded edges, particularly preferably from 7 to 12 folded edges. For the purposes of the present invention the expression folded edge applies to regions produced when an area is folded. Examples of folded edges that may be mentioned are the longitudinal regions where two respective wall areas of the container meet. The container walls in the container are preferably the areas of the contain-
15 er, surrounded by the folded edges. It is preferable that the closed container includes no base that is not of single-piece design with the composite or no lid that is not of single-piece design with the composite, or both.

Foodstuff

20 A preferred closed container of the invention includes a foodstuff. Materials that can be regarded as foodstuff are any of the solid or liquid foodstuffs known to the person skilled in the art for human consumption, and also those for consumption by animals. Preferred foodstuffs are liquid above 5°C, examples being dairy products, soups, sauces, and non-carbonated drinks. There are various methods for filling the container or the container precursor. A first
25 possibility is that the foodstuff and the container or the container precursor are separately, before the filling process, sterilised to the greatest possible extent via suitable measures such as treatment of the container or of the container precursor with H₂O₂, UV irradiation or other suitable high-energy irradiation, plasma or a combination of at least two thereof, and also heating of the food, and that the container or the container precursor is then filled. This filling method
30 is often termed “aseptic filling”, and is preferred according to the invention. In another method that is widely used, in addition to or else instead of aseptic filling, the container or container

precursor filled with foodstuff is heated to reduce the number of germs. This is preferably achieved via pasteurisation or autoclaving. In this procedure it is also possible to use less sterile foodstuffs and containers or container precursors.

5 Hole/opening aid

In order to provide easier opening of the closed container of the invention, a carrier layer can comprise at least one hole. In a particular embodiment the hole has been covered at least by a barrier layer, and preferably a polymer layer, particularly preferably one of the outer polymer layer, the inner polymer layer, and the intermediate polymer layer or combinations of at least
10 two of those, as hole-covering layers. There can moreover be one or more further layers, in particular adhesion-promoter layers, provided between the abovementioned layers. It is preferable here that the hole-covering layers have been joined to one another at least to some extent, preferably at least 30%, with preference at least 70% and with particular preference at least 90% of the area formed by the hole. According to a particular embodiment it is preferable that
15 the hole penetrates through the entire composite and is covered by a closure or opening device that seals the hole. In connection with a preferred embodiment the hole provided in the carrier layer can have any shape that is known to the person skilled in the art and is suitable for various closures, drinking straws or opening aids. Opening of a closed container is mostly achieved by destroying, at least to some extent, the hole-covering layers covering the hole.
20 This destruction can be achieved via cutting, pressing into the container or pulling out of the container. The destruction can be achieved via an openable closure joined to the container and arranged in the region of the hole, mostly above the hole, or via a drinking straw which is forced through the hole-covering layers covering the hole.

25 According to another preferred embodiment the composite is subjected to heat treatment, at least in the region of the at least one hole. The heat treatment can be achieved via irradiation, via hot gas, via thermal contact with a solid material, via mechanical oscillations, preferably via ultrasound, or via a combination of at least two of these measures. It is particularly preferable that the heat treatment is achieved via irradiation, preferably electromagnetic radiation
30 and particularly preferably electromagnetic induction, or else via hot gas. The respective optimal operating parameters to be selected are known to the person of average skill in the art.

Test methods

The following test methods were used for the purposes of the invention. Unless otherwise stated the measurements were made at ambient temperature 25°C, ambient air pressure 100 kPa (0.986 atm) and relative humidity 50%.

MFR value

The MFR value is measured in accordance with the standard ISO 1133-1:2012-03 (unless otherwise stated at 190°C with 2.16 kg).

Density

Density is measured in accordance with the standard ISO 1183-1:2012-05.

Melting point

Melting point is determined according to the DSC method of ISO 11357-1 and -5. The equipment is calibrated in accordance with the manufacturer's instructions with reference to the following measurements:

- indium temperature – onset temperature,
- enthalpy of fusion of indium,
- zinc temperature – onset temperature.

Viscosity number of PA

The viscosity number of PA is measured in accordance with the standard ISO 307 in 95% sulphuric acid.

Oxygen permeation rate

Oxygen permeation rate is determined in accordance with the standard ISO 14663-2 Annex C at 20°C and 65% relative humidity.

Paperboard moisture content

Paperboard moisture content is measured in accordance with the standard ISO 287:2009.

Adhesion of layers

Adhesion between two adjacent layers is determined by fixing these onto 90° peel test equipment, for example a “German rotating wheel fixture” from Instron, on a rotating roll which rotates at 40 mm/min during the measurement. The samples were cut to size in advance, into strips of width 15 mm. At one side of the sample the sublayers are separated from one another, and the separated end is clamped into a vertically upwards oriented tensile apparatus. The tensile apparatus has attached measurement equipment for determining the tensile force. During the rotation of the roll, the force required to separate the sublayers from one another is measured. This force corresponds to the adhesion between the layers, and is stated in N/15 mm. The separation of the individual layers can be achieved by way of example mechanically, or via a specific pretreatment, for example via softening of the sample for 3 min in 30% acetic acid at 60°C.

Molecular weight distribution

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

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).

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L-value in the Lab colour space

The L-value is determined using a spectral photometer having a densitometer function of the type SpectroEyeTM of X-Rite, 8105 Regensburg, Switzerland. For measuring the L-value a sample of dimension 3 cm × 10 cm is cut from the laminate and measured using the spectral photometer according to the manual provided by the manufacturer of the device.

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Surface coverage

Surface coverage is a measure of covering an area of colour appears to the normal observer. The surface coverage may be calculated using the equation of Murray-Davis. All values of surface coverage disclosed in this document have been measured with a spectral photometer (SpectroEyeTM) of the firm X-Rite (8105 Regensburg, Switzerland).

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Surface tension

In order to determine a surface tension of a polymer layer and/or of an outer surface, first a contact angle of wetting with water („water contact angle“) is determined according to the standard ATSM D5946 – 09. Therein, samples of dimension 30 mm × 35 mm are cut from the laminate using a scalpel. 10 measurements are performed at each sample, from which the arithmetic mean is calculated. The samples are prepared as given in section 10.2 of the standard. Further, measurement conditions are chosen in accordance with section 10.4 of this standard. Using the arithmetic mean of the measured water contact angle, the surface tension in dyne/cm (dyne/cm = mN/m) is read from table X2.1 of the annex X2 of the standard.

25

Adhesion strength of colour applications

The term adhesion refers to the resistance of a colour application against forces produced when a strip of adhesive tape is pulled off a surface having the colour application. For the test adhesive tape of the type 4104, 20 mm width of the manufacturer Beiersdorf AG, Hamburg, Ger-

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many is applied. The test sample is placed on a smooth, hard surface with the colour application facing upward. A strip of adhesive tape at least 30 mm in length is applied to the test sample (longitudinally and transversely to the direction of the run) and pressed down evenly with the use of the thumbs. The test is performed within 30 seconds from applying the adhesive tape. Test results may vary if the tape remains on the test sample for a longer period of time. The test is performed either by

- a) pulling back the adhesive tape quickly at an angle of 90°, or
- b) peeling of the adhesive tape slowly at an angle to the surface having the colour application of less than 45°.

Both types of test a) and b) are performed 3 times at different positions of the colour application. The results are classified according to the following scale from 5 to 1.

- 5 - colour application is not removed
- 4 - colour application is removed locally in individual places
- 3 - colour application is clearly removed in individual places
- 2 - colour application is removed over large areas
- 1 - colour application is removed completely

The overall result of the 6 tests of a sample is determined by calculating the arithmetic mean of the 6 individual results.

Mechanical resistance at elevated temperature and moisture

The laminates to be tested are placed in a water bath where they are exposed to temperature and moisture for 60 seconds at 94 °C. The water bath is prepared in a beaker and the water is continuously stirred by a magnetic stirrer in order to obtain a flat special temperature distribution. Temperature is checked for using a thermometer and the time is measured using a stop watch. After 60 seconds, the laminate remains in the water bath and a glass rod having rounded ends is used to apply moderate pressure by rubbing an end of the glass rod over the colour application. Subsequently, the laminate is removed from the water bath und visually inspected

for damages to the colour application with the naked eye. For each sample 3 tests are performed at different positions of the laminate. During these tests, attention should be paid to applying the rubbing for about the same duration and with the same force for each test. Here, each test of a sequence of tests to be compared should be performed by the same person. Assessment of the results is done using the following scale.

- 1 - colour application can be scratched of completely
- 2 - colour application shows strong signs of damage
- 3 - colour application shows less strong but still significant signs of damage
- 4 - colour application shows only slight signs of damage
- 5 - colour application shows no signs of damage

The overall result of the 3 tests of a sample is determined by calculating the arithmetic mean of the 3 individual results.

Staining at elevated temperature

Staining at elevated temperature refers to the ability of hardened colour applications not to adhere to the inner surface of the same laminate on a reel. For the test 4 samples of the same size (dimensions 10 cm x 20 cm) are cut from the laminate. These samples are stacked, wherein in the stack outer surfaces and inner surfaces of the laminates touch each other. The stack is placed between two glass plates (dimensions 20 cm × 30 cm) and transferred to a heating cabinet. A pair of 1 kg weights is placed on top of the stack. The stack remains in the oven for 6 days at a temperature of 70 °C. Then the stack is cooled to room temperature and removed from the heating cabinet. The single layers are separated carefully. Each colour application which has been in contact with an inner surface of another sample in the stack as well as these inner surfaces are visually inspected for transfer of colour from the colour application to the inner surface using the bare eye.

Impairment of taste

Determining the impairment of taste of a foodstuff stored in a closed container includes storing the foodstuff in the container for 90 days at 25 °C. In parallel, the same foodstuff is stored in

glass bottles in a dark room for the same time and at the same temperature. After the storage time the taste of the stored foodstuff is tested by a panel of 10 test persons. Differences between the foodstuffs stored in the laminate container and in the glass bottles are assessed on the following scale.

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- 1 – no sensible difference in taste
- 2 – difference in taste slightly sensible
- 3 – moderate differences in taste
- 4 – severe differences in taste
- 5 – strong differences in taste

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Symbol contrast

The symbol contrast of the 2D-code is determined according to the standard ISO/IEC 15415 : 2011(E).

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Unused error correction parameter

The unused error correction parameter t of the 2D-code is determined according to the standard ISO/IEC 15415 : 2011(E).

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Axial non-uniformity

The axial non-uniformity of the 2D-code is determined according to the standard ISO/IEC 15415 : 2011(E).

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The invention is described in more detail below via Examples and drawings, wherein the Examples and drawings do not imply any restriction of the invention. The drawings are moreover diagrammatic and not true to scale.

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Examples

For the inventive and the comparative samples (non-inventive), laminates with the following layer sequence were produced by means of an extrusion coating system which is standard in laminar extrusion processes.

layer	material	grammage [g/m ²]
outer polymer layer	LDPE 19N430 of Ineos GmbH, Cologne, Germany	15
carrier layer	paper board: Stora Enso Natura T Duplex, double coating layer, Scott-Bond 200 J/m ² , residual moisture 7,5 %	210
intermediate polymer layer	LDPE 19N430 of Ineos GmbH, Cologne, Germany	18
barrier layer	aluminium foil EN AW 8079 of Hydro Aluminium Deutschland GmbH	here: thickness 6 µm
adhesion promoter layer	co-extrudate (1) Escor 6000 HSC of Exxon Mobil Corporation and (2) LDPE 19N430 of Ineos GmbH, Cologne, Germany	(1) – 4 (2) – 22
inner polymer layer	blend of (1) 65 wt.-% LDPE 19N430 of Ineos GmbH, Cologne, Germany and (2) 35 wt.-% Eltex 1315 AZ of Ineos GmbH, Cologne, Germany	10

5 Table 2: layer sequence used in the samples (inventive) and the comparative samples (non-inventive) below

Laminate production

10 Laminates consisting of the given in table 2 below are produced applying an extrusion coating system of the firm Davis Standard. Therein, the extrusion temperature is in the range from about 280 to 310 °C. Temperature variations of ± 6 °C are understood to be within normal tolerances. Grammage variations of ± 3 g/m² are within normal tolerances as well. In a first step, one hole for each container to be produced from the laminate is applied to the carrier layer by

die cutting. Subsequently, the outer polymer layer is applied to the carrier layer, thereby covering the holes. In a following step, the barrier layer is applied to the carrier layer together with the intermediate polymer layer. Subsequently, the adhesion promoter layer and the inner polymer layer are co-extruded onto the barrier layer. In order to allow for applying of the several polymer layers, the polymers are molten in an extruder. For applying a polymer of a layer, the obtained polymer melt is fed via a feed block into a nozzle and from there extruded to the substrate.

The laminates obtained as described above are further processed as follows. First the surface of the outer polymer layer which is facing away from the carrier layer is corona treated. For the corona treatment a device ASOH 21W4-160K-E-EC of the firm Ahlbrand Systems GmbH, Germany is used. Power and voltage of the corona treatment are adjusted to obtain the surface tensions after the first corona treatment as given in table 3 below. Therein, the surface tension needs to be measured immediately after the corona treatment as the surface tension which has been increased by the treatment may decrease again over time, usually on a scale of several days. In a next step, immediately after the first corona treatment a decoration is printed by intaglio printing onto the outer polymer layer. Here, 4 printing inks – each of the type VB67 from Siegwirk Druckfarben AG, Siegburg, Germany, and each ink of a different colour of a four-colour-print system - are printed onto the outer polymer layer. Therein, each ink is printed by a standard intaglio printing unit of the firm Kochsiek, Germany. After each printing the printed ink is dried in a stream of air for 1 minute at 60 °C. Thus, a four-colour print decoration is obtained. The decoration thus obtained does not cover an area of the size of 3 cm × 3 cm of the outer polymer layer. Hence, this area remains unprinted.

In a next step a second corona treatment is applied to the outer surface of the laminate, which is has been partially printed. Power and voltage of the second corona treatment are adjusted to obtain the surface tensions after the second corona treatment as given in table 3 below. Therein, again the surface tension needs to be measured immediately after the corona treatment. In the comparative sample 2 no second corona treatment is applied. Immediately after the second corona treatment, if conducted, a QR-code is printed via an inkjet printer by Konika Minolta of the firm Industrial Inkjet Ltd., Great Britain onto the unprinted area of the outer polymer layer.

Black ink of the type Sunjet ULM from Sun Chemical, USA is used for printing the QR-code. In a next step the inkjet-printed ink is first pre-cured by irradiation with UV-light using a UV-LED-lamp model FireEdge FE300 of Phoseon Technology Inc., USA, and after a delay of 0.19 to 1.9 seconds fully cured by irradiation with UV-light using UV-lamps available from GEW (EC) Ltd., UK.

	surface tension after first corona treatment [dyne/cm]	surface tension after second corona treatment [dyne/cm]
sample 1	40	41
sample 2	40	41
sample 3	39	40
sample 4	38	41
comparative sample 1	38	37
comparative sample 2	40	38

Table 3: values of surface tension of the outer polymer layer measured immediately after corona treatment (samples, off-line measurement with device PG-X+ available from Testing Machines, Inc. (US)).

The printed laminates obtained as described above are tested for quality of the QR-code which demonstrates the effects of two step curing. The results are shown in table 4 below.

	1 st UV treatment	QR Code Overall Grade
Sample 2.1	No	B
Sample 2.2	Yes	A
Sample 3.1	No	A
Sample 3.2	Yes	A
Sample 4.1	No	A
Sample 4.2	Yes	A

Table 4: effects on QR code overall grade and image quality when using a 1st and a 2nd UV treatment

The distance between the 1st and the 2nd UV treatment unit was 1.8 metres. The velocity of the laminate in the inkjet printing process was 250 m/min.

QR Code Overall Grade A – F as defined in DIN 15415:2011 (E).

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In another set of samples, the idle period between the 1st and the 2nd UV curing was varied. See Table 5.

	Velocity of laminate (m/min)	Distance between 1 st and 2 nd UV treatment unit (m)	idle period (sec)	QR Code Overall Grade (A – F)
Sample 5.1	250	1.8	0.43	A
Sample 5.2	190	1.8	0.57	B
Sample 5.3	90	1.8	1.2	B
Sample 5.4	40	1.8	2.7	B
Sample 5.5	10	1.8	10.8	C
Sample 5.6	220	1.8	0.42	A
Sample 5.7	220	1.8	0.54	B
Sample 5.8	220	1.8	0.66	B

Table 5: QR Code overall grade at varied idle periods between 1st and 2nd UV treatment.

10

The rating of the QR Code Overall Grade and the Image Quality are as in Table 4.

Further tests were conducted for adhesion strength of the QR-code, staining of the QR-code at elevated temperature and mechanical resistance of the QR-code at elevated temperature and moisture. Further, the unused error correction parameter of the printed QR-code is measured. The preceding tests are performed as described above in the test methods section. The results are shown in table 6 below.

15

Container production

The printed laminates are creased, thereby obtaining crease lines in the laminates. In particular, longitudinal crease lines are introduced. Further, the laminates are cut into sections, wherein each section is suitable for producing a single container from it. Therein, each of the sections comprises one of the holes mentioned above. From each section a container precursor in form of a sleeve as shown in figure 5 is obtained by folding along the 4 longitudinal crease lines and sealing of overlapping fold areas onto each other, thereby obtaining a longitudinal seam. From this container precursor, a closed container as shown in figure 6 (“brick-type”) is formed using a standard filling machine CFA 712 of SIG Combibloc, Linnich, Germany. Therein, a bottom region is formed by folding and closed by heat sealing. Thus, a cup with an open top region is obtained. The cup is sterilised using hydrogen peroxide. Further, the cup is filled with long-life milk. By further folding and ultrasound sealing the top region of the cup, having the hole, is closed. Thus, a closed and filled container is obtained. Further, an opening aid is attached to the container, covering the hole. The closed containers thus obtained are stored and afterwards the taste of the milk is tested as described above in the test method “impairment of taste”.

Assessment

	adhesion strength of colour applica- tions	mechanical resistance at elevated tem- perature and moisture	staining at elevated tem- perature	impairment of taste of the milk	unused error correction parameter
sample 1	5	5	+++	5	-
sample 2	5	5	+++	3	+
sample 3	5	4	++	2	+
sample 4	4	3	+	1	+
comparative sample 1	2	2	-	1	-
comparative sample 2	1	1	--	1	--

Table 6: Results of measurements for the samples and comparative samples.

- 5 In the above table 6, +++ marks a results which is more desirable than ++, which marks a result which is more desirable than +, which marks a result which is more desirably than -, which marks a result which is still more desirable than --. Therein, as few staining at elevated temperature as possible and an as high as possible unused error correction parameter are desired.

Drawings

- Figure 1 is a diagrammatic cross section through a sheetlike composite of the invention;
- Figure 2 is a diagrammatic top view of the sheetlike composite of figure 1;
- Figure 3 is a diagrammatic cross section through a sheetlike composite precursor applied in a process of the invention;
- Figure 4 is a flow diagram of a process of the invention;
- Figure 5 is a diagrammatic view of a container precursor of the invention; and
- Figure 6 is a diagrammatic view of a closed container of the invention.
- Figure 7 is a schematic of a printing device
- Figure 8 Shows examples of a pattern
- Figure 9 Shows a part of target with a printed pattern
- Figure 10 Shows a printing device
- Figure 11 Shows a modified printing device comprising a buffering unit

Description of the Drawings

- 5 Figure 1 shows a diagrammatic cross section through a sheetlike composite 100 of the invention. The sheetlike composite 100 comprises an outer surface 101 and an inner surface 102. In a direction from the outer surface 101 to the inner surface 102, the sheetlike composite 100 comprises as layers of a layer sequence: an outer polymer layer 103 made of LDPE 19N430 of the firm Ineos GmbH, Cologne (grammage 15 g/m²); a carrier layer 104 made of a cardboard
- 10 Stora Enso Natura T Duplex with double coating layer (Scott-Bond 200 J/m², residual moisture 7.5 %, grammage 210 g/m²); an intermediate polymer layer 105 made of LDPE 19N430 of Ineos GmbH, Cologne (grammage 18 g/m²); a barrier layer 106 made of an aluminium foil EN AW 8079 of Hydro Aluminium Deutschland GmbH (thickness 6 µm); an adhesion promoter layer 107 made of Escor 6000 HSC of the Exxon Mobil Corporation (grammage 4 g/m²) and
- 15 LDPE 19N430 of Ineos GmbH, Cologne (grammage 22 g/m²); and an inner polymer layer 108 made of a blend from 65 % by weight LDPE 19N430 of Ineos Cologne GmbH and 35 % by weight Eltex 1315 AZ of Ineos Cologne GmbH (grammage of the blend 10 g/m²). Further, the sheetlike composite 100 comprises a first composite region 201 and a second composite region

202 (see for both figure 2). In the first composite region 201, the sheetlike composite 100 further comprises a first colour application 109, partially covering the outer polymer layer 103 on a side of the outer polymer layer 103 which is facing away from the inner surface 102 of the sheetlike composite 100. This first colour application 109 is a decoration of the sheetlike composite 100. This decoration consists of matrix dots, obtained by rotogravure printing two different inks of the series VB67 from Siegwirk Druckfarben AG, Siegburg, Germany onto the outer polymer layer 103 in the first composite region 201. Hence, the decoration comprises 2 different colours. Furthermore, in the second composite region 202 the sheetlike composite 100 further comprises a second colour application 110, which covers the outer polymer layer 103 on the side of the outer polymer layer 103 which is facing away from the inner surface 102 of the sheetlike composite 100. Therein, the second colour application 110 is a QR-code obtained by inkjet-printing a black ink Sunjet ULM from Sun Chemical, USA onto the outer polymer layer 103. This QR-code consists of 177×177 graphic elements, including printed black areas and white gaps between those black areas. Therein, the gaps are unprinted area in which the white colour (L-value in the Lab colour space of 91.2) of the layers underneath show through. The graphic elements are a graphic representation of a sequence of 23.648 kbits. The QR-code is characterised by a symbol contrast of 80 %, an axial non-uniformity of 0.02, and an unused error correction parameter of 0.84.

Figure 2 shows a diagrammatic top view of the sheetlike composite 100 of figure 1. Therein, figure 2 shows the first composite region 201 having the first colour application 109, the second composite region 202 having the second colour application 110, and a third composite region 203, which separates the first composite region 201 from the second composite region 202 by framing the second composite region 202. Therein, the third composite region 203 has width of 2 mm. In the third composite region 203 the outer polymer layer 103 is not superimposed by any layer of the sheetlike composite 100 on the side of the outer polymer layer 103 which faces away from the carrier layer 104. In particular, in the third composite region 203 the outer polymer layer 103 is an outermost layer of the sheetlike composite 100. In the first composite region 201 the outer surface 101 has a first surface tension of 44 dyne/cm. The first colour application 109 has a surface coverage of 100 %, based on a surface area of the first composite region 201 which is 80 % of the outer surface 101 of the sheetlike composite 100.

In the second composite region 202 the outer surface 101 has a second surface tension of 40.8 dyne/cm. The second colour application 110 has a surface coverage of 50 %, based on a surface area of the second composite region 202 which is about 4 % of the outer surface 101 of the sheetlike composite 100. In the third composite region 203 the outer surface 101 has a third surface tension of 38 dyne/cm. A surface area of the third composite region 203 is about 3 % of the outer surface 101 of the sheetlike composite 100.

Figure 3 shows a diagrammatic cross section through a sheetlike composite precursor 300 applied in a process 400 of the invention. The sheetlike composite precursor 300 comprises an outer surface 301 and an inner surface 302. In a direction from the outer surface 301 to the inner surface 302, the sheetlike composite precursor 300 comprises as layers of a layer sequence: an outer polymer layer 103; a carrier layer 104; an intermediate polymer layer 105; a barrier layer 106; an adhesion promoter layer 107; and an inner polymer layer 108. Each of the preceding layers of the sheetlike composite 300 correspond to and are identical to layers of the same name of the sheetlike composite 100 shown in figure 1. By treating the outer surface 301 and printing onto the outer polymer layer 103 according to the process 400 of figure 4, the sheetlike composite 100 of figure 1 can be obtained from the sheetlike composite precursor 300.

Figure 4 shows a flow diagram of a process 400 of the invention. The process 400 comprises a process step a) 401 of providing the target 730. In a further process step b) 402 the surface tension of surface 720 of target 730 is increased to 41 dyne/cm by a corona plasma treatment performed by a corona treatment unit 940. Within 30 seconds from the plasma treatment, a pattern 710 of droplets of an ink composition is applied by inkjet printing onto the outer surface 103 in process step c) 403. In a subsequent process step d) 404 the ink composition is partially cured by a first UV-light emitting curing device 910. In a subsequent process step e) 405, the curing is completed by a second UV-light emitting curing device 920. In each of aforementioned curing steps, irradiation with UV-light activates one or more photo-initiators comprised in the ink composition. Accordingly, the curing comprises a crosslinking reaction. During the process steps a) 401 to e) 405, the target 730 is conveyed at a velocity of about 300 m/min via pro-

pelled rollers and deflecting rollers. Process step f) 406 which comprises a form shaping of target 730 is optional.

Figure 5 shows a diagrammatic view of a container precursor 500 of the invention. The container precursor 500 shown here is a sleeve. Further, the sleeve includes a top region 503 and a bottom region 504. The top region 503 and the bottom region 504 respectively include crease lines 506. The top region 503 and the bottom region 504 can respectively be closed by folding along the creases 506 and sealing, and a closed container 600 as shown in Figure 6 can thus be obtained from the sleeve. Accordingly, the container precursor 500 is a precursor produced in the process for producing the closed container 600. The container precursor 500 here includes a cut-to-size section of the sheetlike composite 100 of Figure 1. In the container precursor 500 the sheetlike composite 100 has been folded; here it includes 4 longitudinal folds 501, which are also 4 longitudinal edges 501 of the container precursor 500. The sleeve moreover includes a longitudinal seam 502 along which end regions of the section of the sheetlike composite 100 have been sealed to one another. The container precursor 500 further comprises a hole 505 in the carrier layer 104. This hole 505 is covered by the outer polymer layer 103 (not shown here), the intermediate polymer layer 105 (not shown here), the barrier layer 106, the adhesion promoter layer 107 (not shown here) and the inner polymer layer 108 (not shown here) as hole-covering layers. As can be seen in figure 5, the outer surface 101; having the first composite region 201 with the first colour application 109 (decoration), the second composite region 202 with the second colour application 110 (QR-code), and the third composite region 203 framing the second composite region 202; is facing outward, hence to the environment of the container precursor 500.

Figure 6 shows a diagrammatic view of a closed container 600 of the invention. The closed container 600 can be obtained via folding of the container precursor 500 of figure 5 along the crease lines 506 and sealing of folded regions to seal the top region 503 and the bottom region 504. Accordingly, the closed container 600 includes a cut-to-size section of the sheetlike composite 100 of Figure 1. The closed container 600 further includes at least 12 edges, 4 of which are the longitudinal edges 501 mentioned in the context of the figure 5. The closed container 600 surrounds an interior which includes a foodstuff 601. The foodstuff can be liquid, but can also include solid constituents. The closed container 600 shown in Figure 6 is of one-piece design. The closed container 600 can moreover be provided with a fitment to improve ease of opening. Here, the hole 505 in the carrier layer 104 of the sheetlike composite 100 is covered by a cap 602 with an opening aid which is attached to the closed container 600.

Figure 7 shows a printing device 700 of the invention with which a pattern 710 can be printed on a surface 720 of a target 730. The printing device 700 comprises an inkjet printing unit 701 with a print head 702 and a support 703. The target 730 is passed between the support 703 and the print head 702.

Figure 8 shows for examples 1) – 4) of a pattern 710. Pattern 710, variant 1) is a combination of letters, numerals and the like; variant 2) is a bar code, variant 3) is a 2D code.

Figure 9 shows a target 730 which has a surface 731. After printing a pattern 710 on the surface 720 using the process of the invention, the surface 720 further comprises the pattern 710.

Figure 10 shows a printing device 700. A target 730 in form of a web is supplied from a supply roll 901 at a speed of 300 m/min and conveyed via a propelled deflector roll 903 and an unpropelled deflector roll 904 to a support roll 930 where the target 730 is in physical contact with the support roll 930. Downstream of support roll 930, the web is conveyed via further deflector rolls 905 and 906, of which 906 is propelled, and stored on a product roll 902. Where the target 500 is in physical contact with the support roll 930, an ink jet printing unit 701 comprising a print head 702 is positioned on the opposite site of the target 730 in a distance of

about 0.5 mm to 1.0 mm. A first UV treatment unit 910 is positioned downstream of support roll 930, in the figure positioned between the print head 701 and deflector roll 905. Here, the fixation unit has UV-LEDs. Further, the position of deflector roll 903 can be adjusted during operation. This has an effect on the tension of the web in the printing device 700, in particular at the support 703 where the printing is conducted. Further, a plasma treating unit 940 is positioned upstream of the print head 702 and configured to pre-treat the surface 720 of the moving target 730 prior to the printing.

Figure 11 shows a modified printing device 700. After passing the first UV treatment unit 910, the moving target 730 passes a so-called buffering unit 950, comprising further deflector rolls 907, 908 and 909, before being subjected to a another UV curing at the second UV treatment unit 920. Deflector roll 909 can be moved back and forth, thereby reducing or increasing the length of the path of the target 730 between the first and the second UV treatment unit. The buffering unit is used to prolong the time between the first and second UV treatment.

List of Reference Numerals

100	sheetlike composite of the invention
101	outer surface of the sheetlike composite
102	inner surface of the sheetlike composite
103	outer polymer layer
104	carrier layer
105	intermediate polymer layer
106	barrier layer
107	adhesion promoter layer
108	inner polymer layer
109	first colour application
110	second colour application
201	first composite region
202	second composite region
203	third composite region
300	sheetlike composite precursor
301	outer surface of the sheetlike composite precursor
302	inner surface of the sheetlike composite precursor
400	process of the invention
401	process step a)
402	process step b)
403	process step c)
404	process step d)
405	process step e)
406	process step f)
500	container precursor of the invention
501	longitudinal fold / longitudinal edge
502	longitudinal seam
503	top region
504	bottom region

505	hole
506	crease line
600	closed container of the invention
601	foodstuff
602	cap with opening aid
700	Printing device
701	Ink jet printing unit
702	Print head
703	Support
710	Pattern
720	Surface S
730	Target
901	Supply roll
902	Product roll
903	Deflector roll, optionally propelled
904, 905, 906, 907, 908	Deflector rolls
909	Deflector roll
910	1 st UV treatment unit
920	2 nd UV treatment unit
930	Support roll
940	Plasma treating unit
950	Buffering unit
MD	Minimum distance

Claims

1. A printing device (700) for printing a pattern (710) on a surface S (720) of a target (730) using a radiation curable ink composition, comprising in direction of a treatment path of the target at least:

- 5 a. a plasma treating unit (940);
 b. at least an inkjet printing unit (701) downstream of the plasma treating unit (940);
 c. a 1st UV treatment unit (910) downstream of the inkjet printing unit (940);
 d. a 2nd UV treatment unit (920) downstream of the 1st UV treatment unit (910);

10 wherein the output power of the 1st UV treatment unit (910) is less than the output power of the 2nd UV treatment unit (920).

2. The printing device (700) according to the preceding claim, wherein the 1st UV treatment unit (910) is configured to emit UV light of a peak wavelength in the range of from 100 to
15 420 nm.

3. The printing device (700) according to any one of the preceding claims, wherein the 1st and 2nd UV treatment units (910, 920) are configured to emit UV light of a spectral distribution wherein the spectral distribution of the 1st UV treatment unit (910) is narrower than the
20 spectral distribution of the 2nd UV treatment unit (920).

4. The printing device (700) according to any one of the preceding claims, wherein the 2nd UV treatment unit (920) is configured to emit UV light in a band in the range from 100 to
25 420 nm.

5. The printing device (700) of any one of the preceding claims, wherein the plasma treatment unit (940) is designed and positioned to modify the surface tension σ of the surface S (720) of the target (730) to a value in the range of from 37 to 45 dyn.

6. The printing device (700) according to any one of the preceding claims, wherein the printing device (700) is configured for a target (730) of a width in the range of from 500 to 1800mm, preferred 500 to 815mm.
- 5 7. The printing device (700) according to any one of the preceding claims, wherein the printing device (700) is configured for processing the target (730) at a speed in the range of from 150 to 400 m/min., preferred 150 to 350m/min.
- 10 8. The printing device (700) according to any one of the preceding claims, wherein the 1st UV treatment unit (910) comprises one or more UV-LEDs.
9. The printing device (700) according to any one of the preceding claims, wherein the 1st UV treatment unit (910) is arranged downstream in a distance in the range of from 200 to 1000
15 mm from the inkjet printing unit (701).
10. The printing device (700) according to any one of the preceding claims, wherein the shortest distance between the surface S (720) of the target (730) and the 1st UV treatment unit (910) is in the range from 1 to 10 cm.
- 20 11. The printing device (700) of any one of the preceding claims, wherein no inkjet unit is arranged between the 1st and the 2nd UV treatment unit (910, 920).
12. The printing device (700) of any one of the preceding claims, wherein a buffering unit
25 (950) is arranged between the 1st and the 2nd UV treatment unit (910, 920).
13. The printing device (700) of claim 12, wherein the buffering unit (950) is configured and positioned to host in a range of from 0.1 to 5 m of the target (730).
- 30 14. A process (400) of printing a pattern (710) on a surface S (720) of a target (730), comprising at least these process steps:
- a) providing the target (730) having the surface S (720);

- b) modifying the surface tension of at least a part of surface S (720) to a first value;
- c) applying a pattern (710) of droplets of at least one ink composition onto the surface S (720);
- 5 d) curing at least a part of the ink composition(s); and
- e) further curing the rest of the ink composition(s).

15. The process (400) of claim 14, wherein step d) is performed under irradiation with UV light of a peak wavelength in the range from 100 to 420 nm.

16. The process (400) according to any one of claims 14 to 15, wherein the curing in step d) is performed at the interface of the droplets and the target (730).

17. The process (400) of claim 14 or 16, wherein step e) is performed under irradiation with UV light in band in the range from 100 to 420 nm.

18. The process (400) of any one of claims 14 to 17, wherein step d) is performed under irradiation with UV light which has a narrower spectral distribution than the UV light irradiated in step e)

19. The process (400) of any one of claims 14 to 18, wherein the surface tension of the surface S (720) of the target (730) is modified in step b) to a value in the range of from 37 to 45 dyn.

20. The process (400) of any one of claims 14 to 19, wherein step b) is performed by a plasma treatment.

21. The process (400) of any one of claims 14 to 20, wherein the pattern (710) is printed on a white area of a target (730), wherein the target (730) has a printed decor.

22. The process (400) of any one of claims 14 to 21, wherein the ink composition has an UV activation wavelength in the range of from 100 to 420 nm.

23. The process (400) of any one of claims 14 to 22, wherein the ink composition comprises volatile organic compounds in an amount of less than 8 wt.%, the wt.% based on the total weight of the ink composition.

24. The process (400) according to any one of claims 14 to 23, wherein the speed of the target (730) in direction of the treatment path is in the range of from 150 to 400 m/min.

25. The process (400) according to any one of claims 14 to 24, wherein the time between end of step c) and beginning of step d) is in the range of from 0.046 to 0.69 s.

26. The process (400) according to any one of claims 14 to 25, wherein the time between end of step d) and beginning of step e) is in the range of from 0.3 to 5.0 s.

27. The process (400) according to any one of claims 14 to 26, comprising an upstream printing step preceding step c).

28. The process (400) of any one of claims 14 to 27, wherein the pattern (710) comprises a 2D-code, a 3D-code, a barcode, an arrangement of characters and numbers, one or more pictograms.

29. The process (400) of any one of claims 14 to 28, further comprising a process step downstream of step e):

f) form shaping of the target (730).

30. The process (400) of any one of claims 14 to 29, wherein the process is performed by employing a device according to any one of claims 1 to 13.

31. A target (730) comprising a surface S (720), which carries a printed pattern (710), obtainable by a process (400) according to any one of claims 14 to 29.

32. A container (600) comprising a target (730) according to claim 31.
33. A use of an inkjet printing unit (701) and a 1st and a 2nd UV treatment unit (910, 920) to
5 manufacture a printed pattern (710) on a surface S (720) of a target (730) wherein the
printed pattern (710) has an enhanced resistance against chemicals, an improved data stor-
age capacity per area, and wherein the printed pattern (710) can be varied from print to
print.
- 10 34. The use of claim 33, wherein an upstream printing step is performed preceding the inkjet
printing unit (701).

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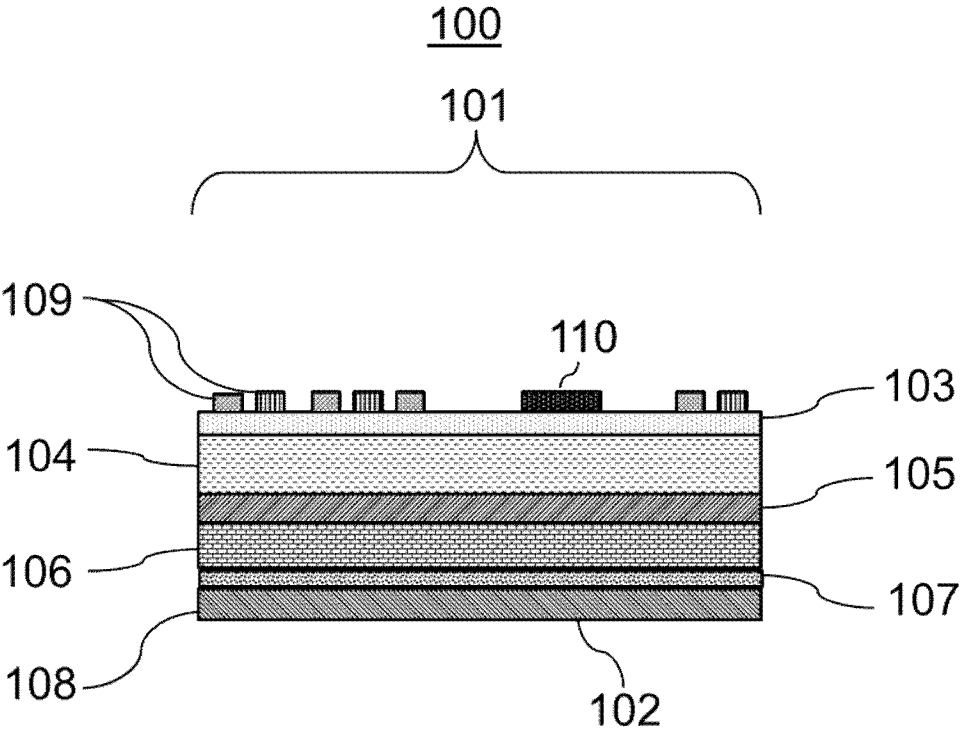


Fig. 1

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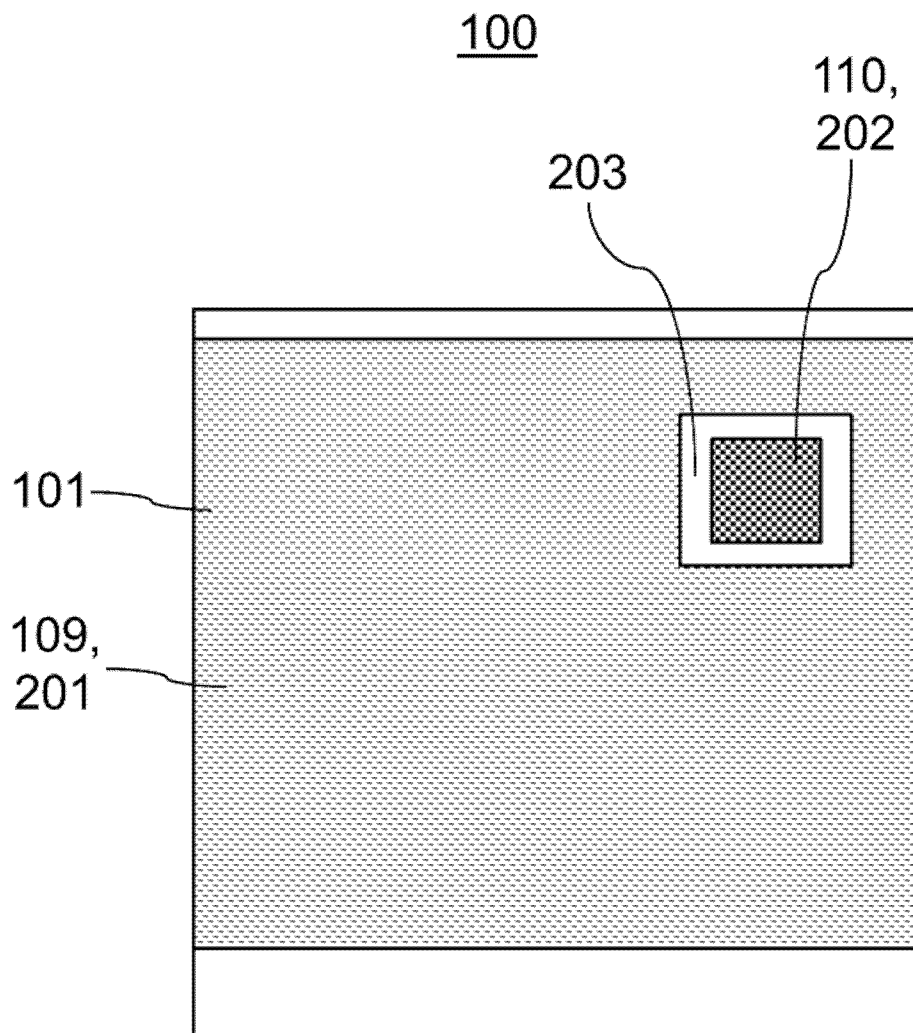


Fig. 2

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300

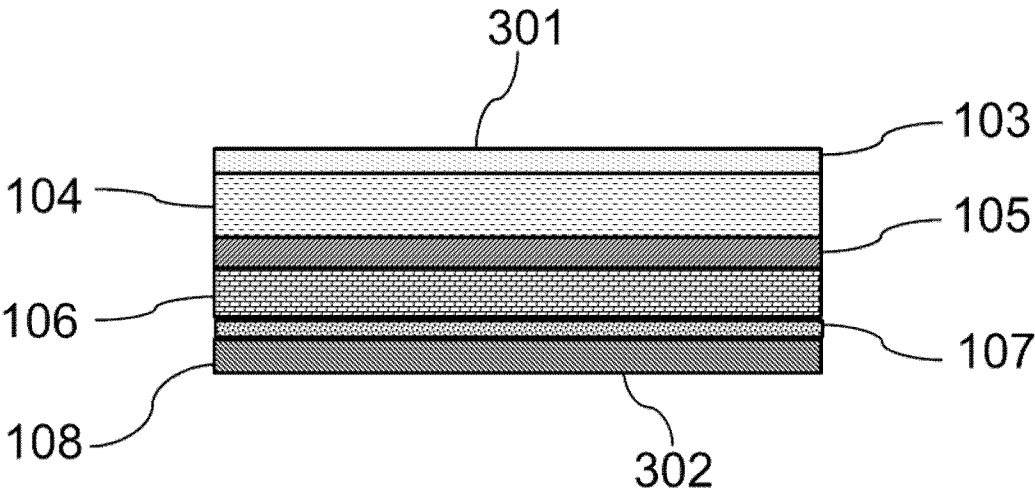
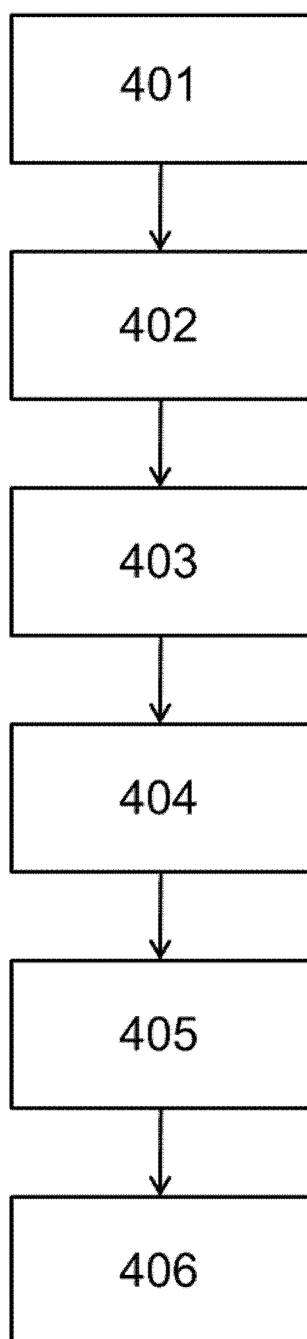


Fig. 3

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400**Fig. 4**

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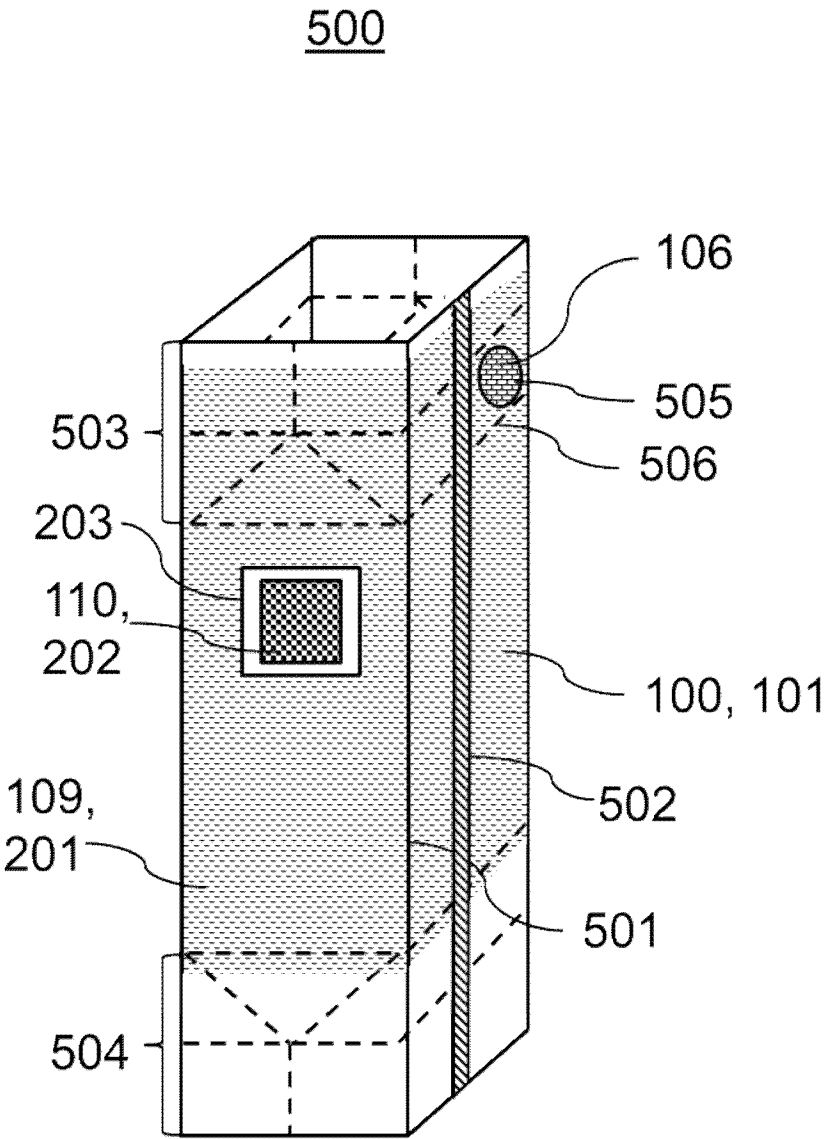


Fig. 5

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600

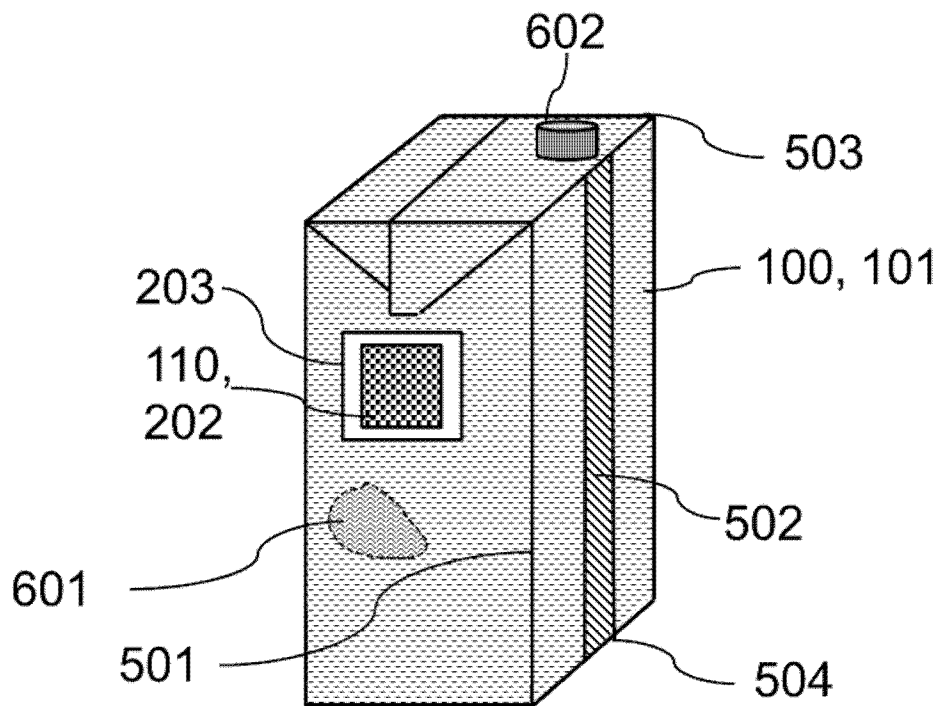


Fig. 6

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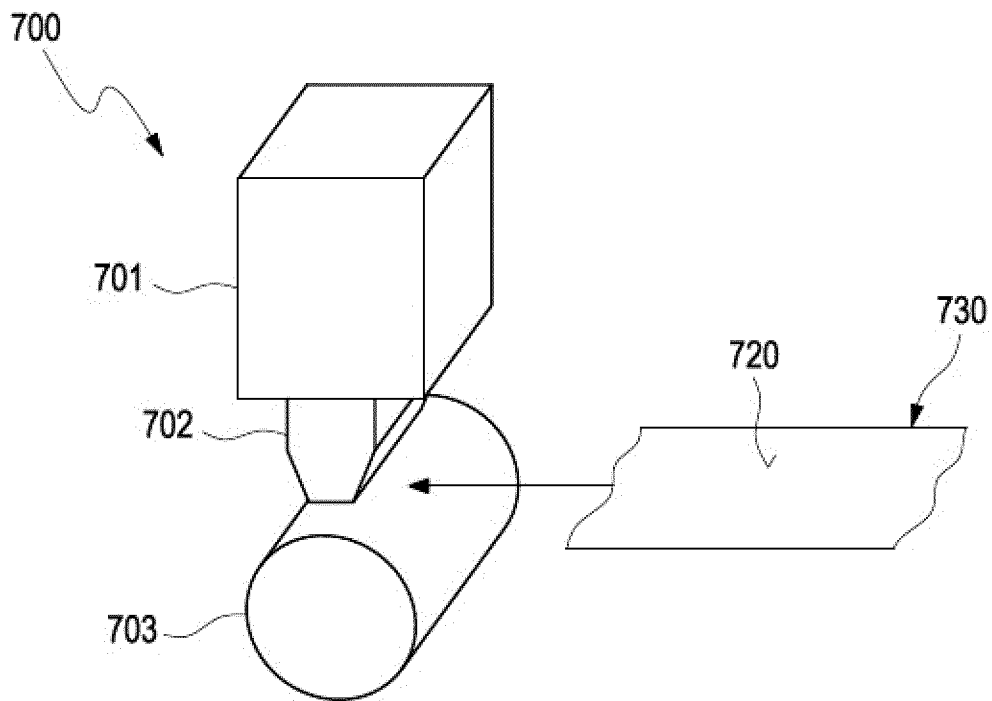
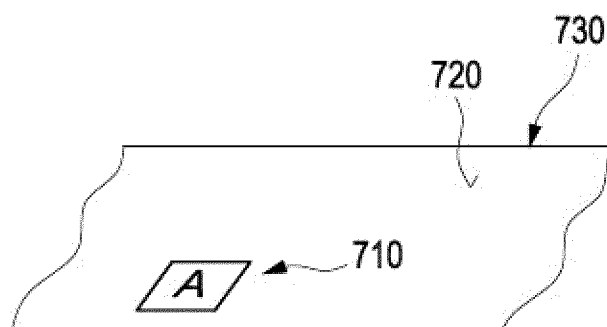


Fig. 7



Fig. 8

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**Fig. 9**

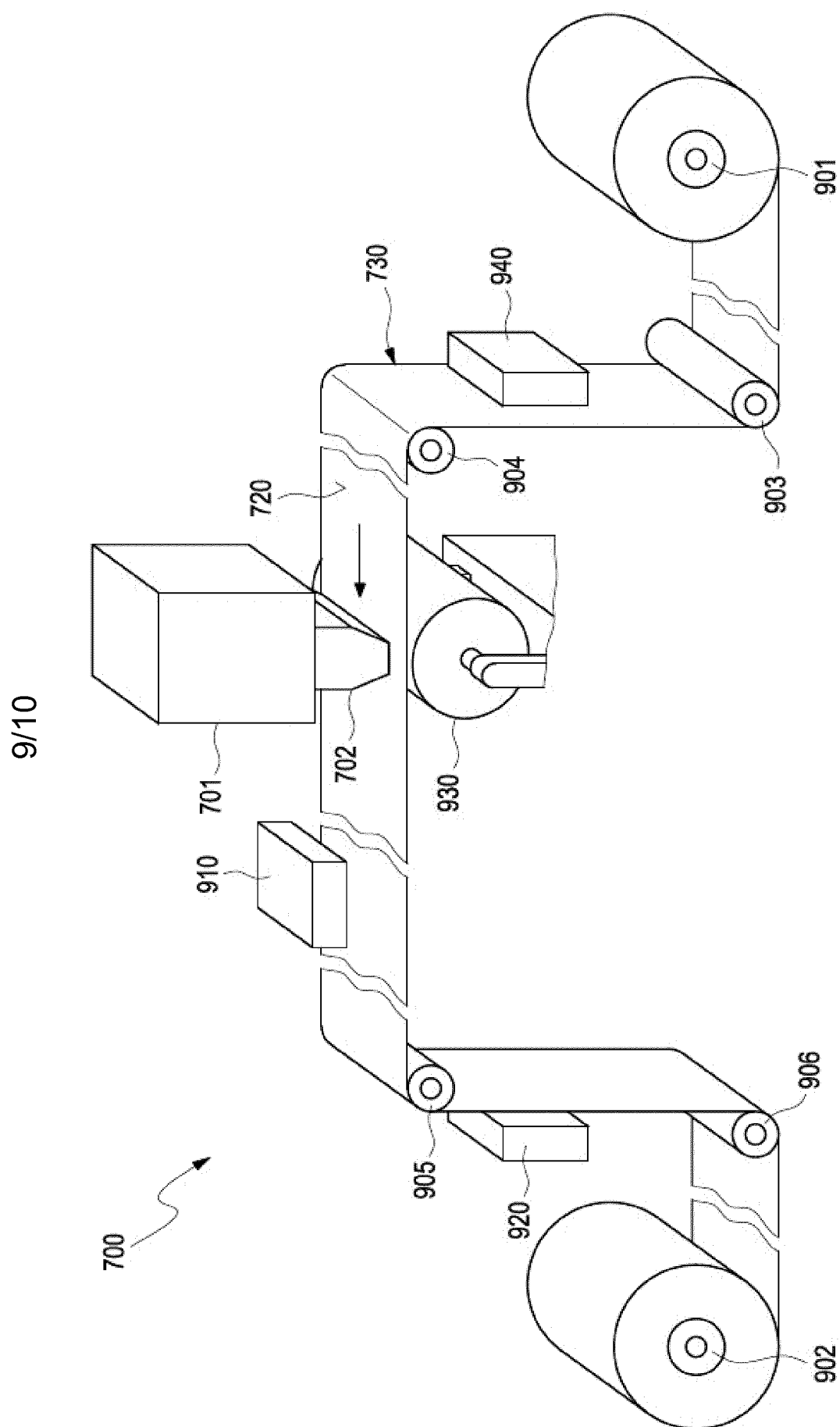


Fig. 10

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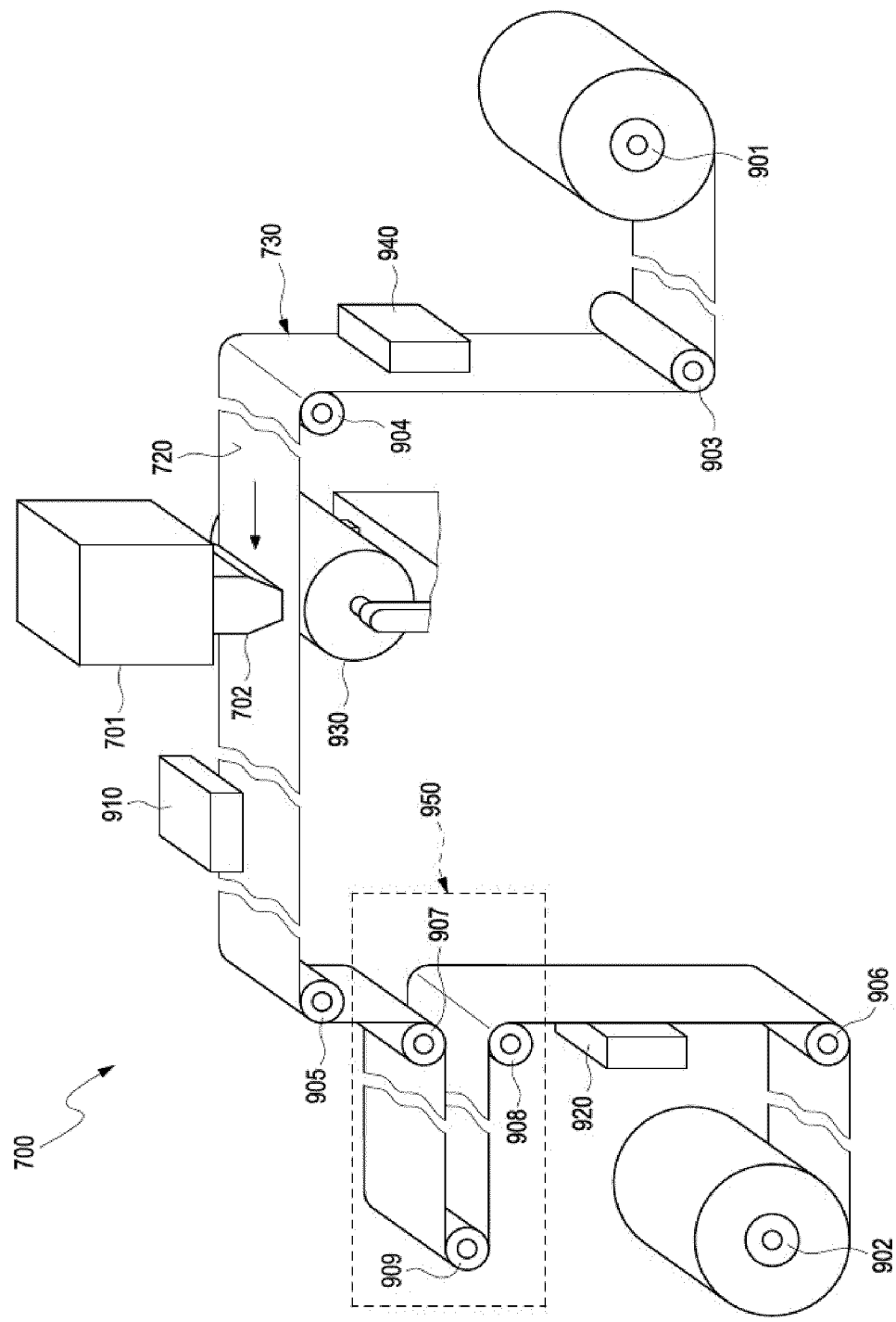


Fig. 11

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2018/067989

A. CLASSIFICATION OF SUBJECT MATTER
INV. B41J11/00
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)
B41J B65B B41M B65D

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	US 2015/030823 A1 (STAMATOUKOS GEORGE [US] ET AL) 29 January 2015 (2015-01-29) paragraph [0019] - paragraph [0024] paragraph [0027] -----	1-11, 14-28, 30,31, 33,34
X	EP 1 428 669 A2 (KONICA MINOLTA HOLDINGS INC [JP]) 16 June 2004 (2004-06-16) paragraph [0026] - paragraph [0042] -----	1-11, 14-34
X	EP 3 132 937 A1 (MIMAKI ENG CO LTD [JP]) 22 February 2017 (2017-02-22) paragraph [0016] - paragraph [0032] ----- -/-	1-26,28, 31,33,34



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

7 September 2018

Date of mailing of the international search report

17/09/2018

Name and mailing address of the ISA/

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Authorized officer

Curt, Denis

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2018/067989

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	US 2013/333579 A1 (GERBER MARCEL [CH] ET AL) 19 December 2013 (2013-12-19) paragraph [0106] paragraph [0126] paragraph [0133] -----	1-11, 14-25,31
X	WO 2010/150023 A2 (SERICOL LTD [GB]; GOULD NIGEL [GB]; MCGREGOR BARRY MICHAEL [GB]) 29 December 2010 (2010-12-29) page 1 - page 21; figure 1 -----	1-25

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2018/067989

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