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(54) **A RECIPIENT FOR CONTAINING A BEVERAGE SUPPORTING A CAUSTIC GENERATOR AND A METHOD FOR GENERATING A CAUSTIC IMAGE FROM A RECIPIENT FOR CONTAINING A BEVERAGE**

(57) The present invention is directed to a recipient for containing a beverage comprising a printed caustic generator on its outer surface.

In addition, the present invention is directed to a method of generating a caustic image from a recipient

for containing a beverage, comprising printing a caustic generator on at least part of the recipient's outer surface.

In particular the recipient for containing a beverage is a carbonated beverage container.

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a recipient for containing a beverage supporting a caustic generator, in particular a carbonated beverage glass container or metal can. In addition, the present invention relates to a method for generating a caustic image from a recipient for containing a beverage.

BACKGROUND OF THE INVENTION

[0002] In product marketing, eye-catching packaging design is of tremendous importance, as well as making logos, brandnames etc, a striking appearance. A recently developed technique in product packaging design is generating a caustic design by providing a caustic generator into the packaging which enhances the attractiveness and visibility of the product.

[0003] Recently, recipients such as perfume or whiskey bottles were presented incorporating a caustic generator. The combination of computer algorithms for designing a recipient in which a caustic generator is integrated and high-precision molding delivers a perfume cap or whiskey bottle redirecting incident light thereby creating a brand logo or photograph on a receiver such as a table, a wall, a screen.

[0004] However, a main problem is that in packaging industry, and certainly in beverage container decoration, there is a clear trend moving towards flexibility and personalization. It is obvious that in such context using molding techniques for manufacturing beverage containers supporting a caustic generator will not suffice.

[0005] Another problem is that molding techniques are limited to be used for plastics and glass, excluding for example metal or carton beverage containers supporting a caustic generator.

[0006] A further problem related to molding techniques, is that, in order to obtain a glass container suitable for carbonated beverages having a strength, and minimum internal burst pressure, comparable to a blown glass container for carbonated beverage, one is obliged to use significantly higher amounts of glass to achieve higher wall thicknesses.

[0007] Besides molding, also 3D printing is proposed to produce recipients supporting a caustic generator ([http://web.media.mit.edu/~neri/MATTER.MEDIA/Theses/JohnKleinMITMScThesisSubmission%20\(1\).pdf](http://web.media.mit.edu/~neri/MATTER.MEDIA/Theses/JohnKleinMITMScThesisSubmission%20(1).pdf)). However, the speed and manufacturing cost of 3D printing of articles, in particular beverage containers, is not comparable to the speed, manufacturing cost, and efficiency achieved with mass production facilities.

[0008] Considering the above, it is an object of the present invention to extend the range of material types that can be used for manufacturing recipients for containing a beverage being adapted to generate a caustic.

[0009] In particular it is an object to provide conven-

tional recipients for containing a beverage being adapted for generating a caustic.

[0010] In addition, it is an object of the present invention to provide a method for obtaining recipients comprising a caustic generator in comparatively inexpensive, quick and flexibly modifiable way, and moving its manufacturing process towards digitalization.

[0011] Further, it is an object of the present invention to provide a method enabling a caustic design to become usable design elements for carbonated beverage containers, in particular for blown carbonated beverage containers of conventional glass wall thickness, strength, and minimum internal burst pressure values.

[0012] Another object of the present invention is to provide a method enabling the manufacturing of metal recipients supporting a caustic generator, in particular carbonated beverage cans, and carton recipients such as beverage bricks

SUMMARY OF THE INVENTION

[0013] The present invention is directed to a recipient for containing a beverage comprising a printed caustic generator on its outer surface.

[0014] In addition, the present invention is directed to a method of generating a caustic image from a recipient for containing a beverage, comprising printing a caustic generator on at least part of the recipient's outer surface.

[0015] In particular, the recipient for containing a beverage is a carbonated beverage container.

DETAILED DESCRIPTION OF THE INVENTION

[0016] Caustics are captivating light patterns created by materials focusing or diverting incident light by refraction or reflection. Caustics are known as random side effects, appearing, for example, at the bottom of a swimming pool, or generated by many glass objects, like drinking glasses or bottles. However, methods are known in the art to control caustic patterns to form a desired shape by optimizing the three-dimensional geometry of the reflective or refractive surface generating the caustic, in this whole text referred to as the caustic generator.

[0017] In the context of the present invention, a recipient for containing a beverage may be any type of bottle, drinking glass, can, of any type of shape, material, or size. The beverage contained, or intended to be contained may be any type of beverage, and in particular carbonated beverages, such as sparkling water, soft drinks and beer.

[0018] A caustic, or caustic design, generated by a method or recipient of the present invention may comprise any type of picture, logo, text, graphic art, coding (QR-code, barcode) projected on a receiver such as a wall, a table, a screen, and the like.

[0019] In a first embodiment according to the present invention, a recipient for containing a beverage is provided comprising a printed caustic generator on at least part

of its outer surface. By providing on the recipient a caustic generator which is printed, any type of recipient, preferably made from inexpensive material, such as glass, plastic, metal, paperboard, and produced at industrial scale, can be flexibly modified in a quick and efficient way, addressing the trend in beverage container decoration of moving towards flexibility and personalization.

[0020] A recipient for containing a beverage in accordance with the present invention may have a curved outer surface, i.e. at least the part supporting the caustic generator may have a certain degree of curvature. Such curvature may be at least partially of a cylindrical, conical, or spherical form, or any form used in beverage drinking glasses or containers. Since the refractive and/or reflective behavior of a curved surface is different from the refractive and/or reflective behavior of a flat surface, the geometry of a printed caustic generator on a curved outer surface may be adapted versus a printed caustic generator on a flat outer surface in order to generate a comparable, or substantially the same caustic design.

[0021] In an embodiment of the present invention, a recipient for containing a beverage is providing wherein the printed caustic generator generates a caustic predominantly by reflection or predominantly by refraction, or by a combination of both.

[0022] The caustic generator may generate a caustic by refracting and/or reflecting the visible light spectrum. Also predominantly part of the visible spectrum may be used. In such case, for example the caustic generator material or the recipients outer surface may absorb the part of the spectrum which is not refracted or reflected. In case of a visibly non-transparent recipient such as a metal beverage can, or a ceramic drinking cup, the caustic generator may predominantly reflect the visible spectrum, whereas in case of visibly transparent recipients such as drinking glasses and glass bottles, the caustic generator may predominantly refract the visible spectrum.

[0023] In an embodiment of the present invention, the printed caustic generator may comprise any type of material which is suitable for being three-dimensionally printed forming a refractive and/or reflective geometry onto a recipient for containing a beverage, i.e. any material which can be printed on such recipient by a suitable three-dimensionally digital printing technique. Examples thereof are three-dimensional printing techniques based on extrusion deposition, photopolymerization, or inkjet printing or laser ablation, laser sintering or other powder bed printing techniques, etc. Examples of materials may be thermoplastics, metallic alloys, photopolymers, resins, or compositions thereof, or inkjet inks.

[0024] Preferably, the caustic generator is printed from inkjet ink. An advantage of an inkjet printed caustic generator may be that it has initially a smoother surface after printing compared to other three-dimensional printing techniques, so that expensive and time-consuming steps of post processing as for example polishing can be avoided.

[0025] A caustic generator printed on a recipient according to the present invention may comprise one or more layers of ink, preferably energy-cured ink such that the recipient can be exposed to heat treatment, such as pasteurization, without damaging the caustic generator. Providing a heat resistant caustic generator is in particular of importance for pasteurized beverage bottles and cans, and for hot-fill beverage containers.

[0026] In a further embodiment in accordance with the present invention, a recipient for containing a beverage may be provided wherein between the printed caustic generator and the outer surface a printed image is present. Such printed image may comprise any type of picture, logo, text, legal text, graphic art, coding (QR-code, barcode). So the recipient may support a printed image of any type, and simultaneously generate an identical caustic design, or a caustic design of any other type.

[0027] The printed caustic generator preferably comprises colorless transparent inks for obtaining optimal refraction, though translucent colored inks are also possible, the latter might generate a colored caustic design.

[0028] Not only the three-dimensional geometry of the caustic generator, but also the reflective and refractive characteristics of the ink, or combination of inks, influences the caustic design generated.

[0029] Therefore, in embodiment of the present invention, the caustic generator may comprise a combination of more reflective and more refractive inks.

[0030] In addition, also a mix of inks with different refractive indices may be present in the caustic generator.

[0031] Alternatively, or in combination with foregoing embodiments, the caustic generator may comprise a layer of more reflective material, e.g. a (partially) metallic ink or a foil, underneath a three-dimensional geometry of more transparent ink. Or, the caustic generator may comprise a three-dimensional geometry of more transparent ink, with on top a at least partial layer of more reflective coating.

[0032] In general, a recipient, or at least the part of the outer surface supporting the caustic generator, may be made of any type of material on which a caustic generator can be printed, in particular inkjet printed, such as carton, glass, plastic, metal (in particular steel or aluminum), or a combination thereof.

[0033] In an embodiment of the present invention, a method is provided of generating a caustic image from a recipient for containing a beverage, comprising printing a caustic generator on at least part of the recipient's outer surface.

By printing the caustic generator onto the recipient, any type of recipient for containing a beverage, preferably made from inexpensive material, such as glass, plastic, metal, paperboard, and produced at industrial scale, can be flexibly modified in a quick and efficient way, addressing the trend in beverage container decoration of moving towards flexibility and personalization. In particular, conventionally used recipients for carbonated beverage can be easily modified for generating a caustic, without jeopardizing the trend in beverage container decoration of moving towards flexibility and personalization.

ardizing on critical characteristics such strength, minimum internal burst pressure values, oxygen diffusion, etc.

In particular, a glass container supporting a caustic generator may be obtained having an internal burst pressure of at least 7 bar, or at least 8 bar, or at least 9 bar.

[0034] Any technique suitable for printing a three-dimensional geometric structure on a recipient for containing beverage may be used, such as for example three-dimensional printing techniques based on extrusion deposition, photopolymerization, or inkjet printing.

[0035] Depending on its topography, transparency, reflective and refractive properties, and whether the generation of a caustic image is intended in filled or empty condition, the caustic generator's geometry and/or the material used to be printed may be adapted.

[0036] As already explained higher in this description, the outer surface on which the caustic generator is to be printed may have a certain degree of curvature depending on the type of the recipient. Since the geometry of a caustic generator on a curved surface differs from the geometry on a flat surface, not only the printing equipment requires to be suitable for printing on curved surfaces, but also the printing process and process parameters require to be suitable for printing three-dimensional caustic generator structures that are more demanding as compared to caustic generators computed to be printed on a flat surface.

[0037] In order to achieve necessary process speed and throughput as required in industrial processes, a cylindrical curvature may be preferred, because recipients with such cylindrical curvature, e.g. bottles, glasses, cans with a cylindrical body or at least cylindrical where the caustic generator has to be printed, may be very suitable for being processed in rotational industrial printing tools, as mentioned further in his text.

[0038] In addition, as already shortly explained above, three-dimensional printing is a digital printing technique, i.e. customized manufacturing of recipients generating a caustic image may be obtained by simple selection of the desired caustic image and corresponding printing parameters from a library of computed caustic generators. In a preferred embodiment in accordance with the present invention, printing the caustic generator is done by inkjet printing.

[0039] A benefit of inkjet printing is that it allows printing of a relatively flat three-dimensional caustic generator structure compared to printing a caustic generator generating the same caustic with an alternative three-dimensional printing technique, so that expensive and time-consuming steps of post-polishing for enhancing the optical properties can be avoided.

[0040] Moreover, a smoother structure might be suffering less from abrasion upon manipulating the recipient, which is in particular of importance for beverage bottles and cans manipulated in filling lines.

[0041] Since in inkjet printing tiny droplets of ink are jetted onto the surface, it may be possible to smoothen

edges and other geometric irregularities in the surface during actual printing by the placement of compensation droplets after curing a printed layer, as is described in US2015093544 (A1).

[0042] In a method in accordance with the present invention, a combination of more reflective and more refractive inks may be used by printing from a plurality of different ink sources, and/or by means of plurality of print heads.

[0043] Similarly, also a mix of inks with different refractive indices may be printed.

[0044] In alternative embodiment, a method in accordance with the present invention may comprise deposition of a reflective layer via printing or by adding a foil, or any other technique, before printing a three-dimensional geometry of transparent inks. Or, first a three-dimensional geometry of transparent inks may be printed which subsequently is then (at least partially) coated with a reflective layer.

[0045] In order to obtain a three-dimensional structure, the caustic generator may be inkjet printed on the recipient layer by layer. Non curing solvent or water-based inkjet inks may be used, however energy-curable ink is preferred, i.e. each layer of ink may be cured in any suitable manner, for example, radiation-cured by any suitable type of radiation like, for instance, ultraviolet, electron beam, or the like, or thermally-cured by convection oven, infrared lamps, or the like, or a combination of both radiation and thermal energy.

[0046] Inkjet printing techniques as used in the present invention may be piezoelectric inkjet printing, continuous type and thermal, electrostatic and acoustic drop on demand type.

[0047] In accordance with the present invention, three-dimensional inkjet printing processes may be used as for example described in WO2012093086 (A1), or WO2013167685.

[0048] In an embodiment of a method in accordance with the present invention, also industrial inkjet printing tools may be used for printing the caustic generator as for example disclosed in WO2012022746 (A1) and WO201552240 describing a device for printing containers by means of inkjet printing on a rotating machine, a plurality of treatment stations having the print heads and optionally further devices which are required for the pre-treatment and post-treatment of the containers.

[0049] Another example is WO2015036334 describing a device for printing rotationally asymmetrical containers preferably by means of digital printing.

[0050] In an embodiment of a method according to the present invention, the caustic generator to be printed may be computed from the desired caustic design to be generated, in other words one has to reconstruct the surface geometry of a real object given only an image of its caustic, so called inverse caustic design computing.

[0051] An example of a method for computing a caustic generator is described in US2013301139 (A1) comprising: segmenting a target image into a plurality of image

patches, each image patch corresponding to a lens patch in a two-dimensional array of lens patches on a refractive surface; then for each image patch, determining a plurality of regions in a source image which match a visual appearance of the image patch, and determining, for the corresponding lens patch, a mapping for each of the plurality of determined regions that refracts light through the refractive surface towards a viewer's eye, assigning a match score to each of the plurality of mappings, and assigning one of the plurality of mappings to the image patch.

[0052] Another method of inverse caustic design computing is given in WO2016000926, herewith incorporated by reference, describing a methodology of designing a refractive surface, comprising providing a refractive object having a refractive surface with an initial geometry, determining a refraction of incident illumination through the refractive surface with the initial geometry to create a source irradiance distribution on a receiver; and determining a shape of the refractive surface of the refractive object such that a resulting irradiance distribution on the receiver matches a desired target irradiance.

[0053] In a particular embodiment of a method for generating a caustic design from a recipient containing a beverage, the caustic generator is computed for generating a caustic from a filled container. In such case, optical properties not only of the recipient and the ink but also of the beverage to be contained has to be taken into account. For example, light incident on the caustic generator may already be refracted and/or reflected to a certain extent depending on alcohol content, glucose content, etc...

[0054] The caustic generator may further be designed for projecting a caustic image on a vertical plane such as a screen or a wall, or on a horizontal plane such as a table.

[0055] In a further embodiment of a method in accordance with the present invention, the method may further comprise a step of printing an image on the recipient, and the caustic generator may be printed over the image in a common printing process step. Preferably, energy-curable inkjet printing is used for the reasons given earlier and for the reason that applying this embodiment via industrial inkjet printers may results in a high speed and highly efficient caustic generator printing process on decorated recipients.

[0056] In particular in case of generating a caustic image from a carbonated beverage glass bottle supporting a cold-end-coating (CEC), a method in accordance with the present invention may comprise the step of removing the CEC before inkjet printing the caustic generator. Adhesion as well as print quality of the caustic generator may be improved compared to print quality on a glass substrate from which the CEC was not at least partially removed. Without being bound by any theory, the assumed reason for an improved print quality is that by removing at least part of the CEC layer to a level wherein the CEC is substantially completely removed, or wherein

the remaining CEC layer has a thickness of less than 20 nm, the surface homogeneity is increased and results in a reduced tendency of the mobile and lower-viscous inkjet inks to move on the surface before solidification.

[0057] In a preferred embodiment, the CEC may be at least partially water soluble and can be at least partially removed by rinsing with tap water, technical water, purified water or distilled water. Depending on the rinsing time and temperature, the level of remaining CEC may then be varied or optimized from less than 20 nm to two or one monolayers, or to a level that only separated traces remain on the surface, or up to complete removal.

[0058] In another embodiment of the present invention, a primer layer may be provided between the recipient's outer surface and the caustic generator to be inkjet printed in order to enhance adhesion of the ink, i.e. on a CEC or on a hot-end-coating (HEC), or on a pyrosil. Such primer may be preferably transparent and may comprise an adhesion promotor. Such primer may also be oxidized by flame, corona, or plasma treatment to enhance adhesion of the inkjet ink.

Claims

1. A recipient for containing a beverage comprising a printed caustic generator on its outer surface.
2. A recipient according to claim 1, wherein at least the part of the outer surface supporting the caustic generator is cylindrical.
3. A recipient according to claim 1, wherein the printed caustic generator comprises uv-cured inkjet inks.
4. A recipient according to claim 1, wherein the printed caustic generator comprises transparent and/ or translucent ink.
5. A recipient according to claim 1, wherein between the printed caustic generator and the outer surface of the recipient a printed image is present.
6. A recipient according to claim 1, wherein said part supporting the caustic generator is made of refractive and/or reflective glass, refractive and/or reflective plastic, reflective metal, carton or a combination thereof.
7. A recipient according any of the above claims, being a carbonated beverage glass container, or a carbonated beverage metal can.
8. A recipient according any of the above claims, being a carbonated beverage glass container with a minimum internal burst pressure of at least 7 bar.
9. A recipient according any of the above claims, being

a carbonated beverage glass container having no CEC, or a CEC of less than 20 nm between its outer surface and the printed caustic generator.

10. A method of generating a caustic image from a recipient for containing a beverage, comprising printing a caustic generator on at least part of the recipient's outer surface. 5
11. A method according to claim 10, wherein at least the part of the outer surface to be printed upon is cylindrical. 10
12. A method according to claim 10, wherein the caustic generator is inkjet printed. 15
13. A method according to claim 10, wherein the caustic generator is printed on refractive and/or reflective glass, refractive and/or reflective plastic, reflective metal, or a combination thereof. 20
14. A method according to claim 10, wherein the caustic generator is printed as computed by inverse caustic design computing. 25
15. A method according to claim 10, wherein the transparent recipient provided is a carbonated beverage glass container supporting a CEC at its outer surface, and wherein the method further comprising the step of removing the CEC to a level of less than 20 nm thickness. 30

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EUROPEAN SEARCH REPORT

Application Number
EP 16 19 8172

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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