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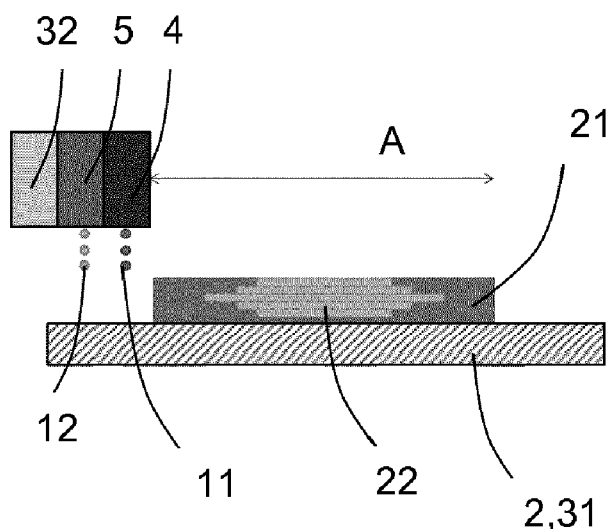


Fig.1c

- (57) **Abstract:** Method for printing a three dimension-
al structure (1), wherein a first printing material being
in a first state (11) is deposited onto a substrate (2) in
a first step, wherein the first printing material is in a
reversible manner at least partially transformable from
being in the first state to being in a second state by a
transformation means, wherein the deposited first
printing material is transformed from being in the first
state to being in the second state by the transformation
means in a second step

DESCRIPTION

TITLE

**5 METHOD FOR PRINTING A THREE DIMENSIONAL STRUCTURE AND
 APPARATUS THEREFORE**

BACKGROUND

10 The present invention relates to a device for printing three-dimensional structures, wherein droplets of printing material are deposited onto a substrate. Such devices comprise usually a printing head that ejects or jets droplets, wherein the printing head scans the substrate several times in order to build up the three-dimensional structure layer by layer.

15 The success of such devices for printing three-dimensional structures, namely 3D-printer printing three-dimensional structure drop by drop, motivates to upgrade those with respect to efficiency, flexibility, safety and costs. In particular there is also a demand of realizing three-dimensional structure having complicated structures such as a cavity or an undercut. However combining depositing the printing material firstly and curing the printing material
20 subsequently leads to the need of additional tools that may influence the flexibility or the cost of the printing process negatively.

SUMMERY

25 It is object of the present invention to provide a method for printing a three-dimensional structure, wherein the printing process is configured such that even complicated structures such as a cavity or an undercut are easily realizable. Additionally it is desirable that the quality of the printed three-dimensional structure is improved with respect to the surface structure for example. Another object is expanding the application area of devices that prints three-dimensional structure.

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 The object is solved by a method for printing a three dimensional structure, wherein a first printing material being in a first state is deposited onto a substrate in a first step, wherein the first printing material is at least partially transformable in a reversible manner between being in the first state and being in a second state by use of a transformation means, wherein the
35 deposited first printing material is transformed from being in the first state to being in the second state by the transformation means in a second step.

It is herewith advantageously possible to realize a three-dimensional structure made from a first printing material, wherein the first printing material is at least partially transformable between being in the first state and being in the second state in a reversible manner. That means that the transformation means substantially decides whether the first printing material is in the first state or in the second state. As a result it is thinkable that the three-dimensional structure is printed and as soon as an improvement is necessary a part of the first printing material being in the second state is retransformed to the first printing material being in the first state. Subsequently the first printing material being in the first state may be removed or newly deposited. As a consequence the surface of the three-dimensional structure may be transformed and retransformed several times in order to improve, in particular to smooth, the surface structure of the three-dimensional structure. In particular it is provided that the transformation means manipulates a physical property of the first printing material such as the temperature and the first printing material is transformed from being liquid (first state) to being solid (second state). Advantageously it is possible to transform, in particular to cure, the first printing material without using chemical reactions or other modifications that may irreversibly change the first printing material. Furthermore it is provided that the first printing material comprises water that is transformed from liquid to ice in order to realize a three-dimensional ice structure. As a consequence ice sculptures may be realized and thus the application area is expanded advantageously. Moreover it is provided that the transformation means is configured such that a first temperature of the first printing material is set for transforming the first printing material from being in the first state to being in the second state, wherein the first temperature is below a melting temperature of the first printing material. Preferably the first temperature is set as below as possible in order to start the transformation of the first printing material from being in the first state to being in the second state immediately after the first printing material is deposited. Furthermore it is provided that a second temperature of the first printing material is set for transforming the first printing material from being in the second state to being in the first state, wherein the first temperature is above a melting temperature of the first printing material. It is also thinkable that a first printing material different from water is used. In particular it is conceivable that a plurality of different first printing materials are deposited onto the substrate forming

- a common layer that comprises the plurality of different first printing materials and/or
- several layers, wherein each layer comprises at least one of the first printing materials included in the plurality of different first printing materials. Moreover it is provided that the first printing means is deposited by ejecting or jetting the first printing material onto the substrate by means of a first printing means, in particular a first printing head having a nozzle.

These and other characteristics, features and advantages of the present invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of the invention. The description is given for the sake of example only, without limiting the scope of the invention. The reference figures quoted below refer to the attached drawings.

According to another embodiment of the present invention it is provided that a second printing material being in a third state is deposited onto the substrate in a third step and wherein the second printing material is transformed from being in the third state to being in a fourth state by a curing means in a fourth step, wherein the three-dimensional structure is substantially formed by the second printing material. Preferably the second printing material being in the fourth state is solid. In particular it is provided that the second printing material is an optical material, i.e. a mainly transparent material that may be used for realizing optical elements such as a prism, lens or the like. It is provided that the second printing material is mainly independent on the transforming means. As a consequence the three-dimensional structure made from the second printing can be separated from the transformation means and therefore the three-dimensional structure retains its form advantageously, even though the first printing material is retransformed from being in the second state to being in the first state.

According to another embodiment of the present invention it is provided that the first and the third step are substantially performed simultaneously and/or the second and the fourth step are substantially performed simultaneously. As a result the whole printing process is accelerated advantageously. In particular the first printing material being in the first state and the second printing material being in the third state are chosen such that an interface between the first printing material and the second printing material is generated after depositing.

According to another embodiment it is provided that the first printing material is retransformed from being in the second state to being in the first state and wherein the first printing material being in the first state is removed from a body formed by the second printing material being in the fourth state in a fifth step. Preferably it is provided that the body is formed such that the second printing material deposited and transformed/cured onto the body realizes a three-dimensional structure having a complicated structured. In particular it is conceivable that the body represents a removable mold for realizing the three-dimensional structure made from the second printing material. The three-dimensional structure may be at least partially formed as a cavity, a kerning or a undercutting for example. In particular it is

possible to reuse the first printing material to form another body. As a consequence different three-dimensional structures may be printed without using different bodies.

According to another embodiment of the present invention it is provided that

- 5 -- the first printing material being in the first state and/or the second printing material being in the third state is configured as a liquid and/or
- the first printing material being in the second state and/or the second printing material being in the fourth state is configured as a solid.

10 According to another embodiment of the present invention it is provided that

- water is included in the first printing material,
- an additive is included in the first printing material,
- the first curing means is a cooling means, wherein the substrate is cooled by the cooling means during at least a period of the second step and/or
- 15 -- the second curing means is a light source, wherein the deposited second printing material is illuminated during at least a further period of the fourth step
- the first printing material is at least partially retransformed from being in the second state to being in the first state by illuminating the first printing material using a further light source. In particular it is provided that the first printing material is an inorganic salt or a metal salt, in particular sodium acetate trihydrate, that includes water inside its crystalline structure,
- 20 wherein the water will be released in the second step, in particular by heating the first printing material, and the metal salt is dissolved by releasing the water. In such a scenario it is provided that the first temperature for transforming the first printing material from being in the first state to being in the second state is set below the melting point of water, in particular
- 25 while water is released from the inorganic salt. As a result the metal salt is able to form crystals and to return in its original state. Moreover it is provided to supercool such a first printing material below its crystallization temperature. As a consequence the first printing material forms crystals, provided that the interface between the substrate and the first printing material is smooth enough. It is also thinkable that the first printing material
- 30 comprises other additives that manipulate the characteristics of the crystallization. In particular the first printing material comprises a solvent carrier for adjusting the viscosity, an inhibitor for improving stability such as aniline, a smoothing agent such as ethylene glycol and/or a catalyst that accelerates crystallization. Alternatively it is also thinkable that the additive is a food coloring that at least partially dyes the three-dimensional structure. The use
- 35 of the light source has the advantage of curing the second printing material in a fast manner. Preferably the light source, in particular a UV-LED, emits UV-light. Moreover the use of the further light source has the advantage of correcting defects immediately. Preferably the

further light source emits IR-light. Preferable the light of the further light source is directed by light guiding means to the defect. Consequently the light of the further light source retransforms the first printing material from being in the second state to being in the first state selectively. Moreover it is provided that the first printing material is transformed from being in the first state to being in the second state immediately after the first printing material is replaced, for instance by immediately cooling the first printing material. As a result the first printing material being again in the first state may be removed or replaced. Concluding the quality of the finished three-dimensional structure, in particular its surface is improved, advantageously.

According to another embodiment of the present invention it is provided that a droplet of the first printing material being in the first state is deposited onto the substrate in the first step and/or wherein a droplet of the second printing material being in the third state is deposited onto the substrate in the third step. It is herewith advantageously possible to realize three-dimensional structure drop by drop. Another advantage is depositing droplets onto the substrate precisely. That reduces the amount of wasted first or second printing material and improves the quality of the three-dimensional structure advantageously.

According to another embodiment of the present invention it is provided that a plurality of droplets of the first printing material being in the first state and/or a plurality of droplets of the second printing material being in the third state is deposited onto the substrate forming a layer in the first step and/or the third step, wherein the layer comprises a first region and/or a second region, wherein the first region includes the first printing material and the second region includes the second printing material, and wherein the first region and/or the second region is cured in the second step and/or the fourth step, wherein the three-dimensional structure is printed layer by layer. It is herewith advantageously possible to determinate the shape of the three-dimensional structure by setting the size and the position of the first and the second region. In particular it is provided that the first printing material being in the first state and the second printing material in the third state are configured such that the first and/or the second printing material of a second layer arranged above a first layer fills a vacancies located in the first layer. As a consequence defects may be corrected and a compact three-dimensional structure is realized. It is also thinkable that the vacancy is arranged in the first layer on purpose in order to realize a specific contour of the interface between the first layer and the second layer. It is also thinkable that a thickness of the layer is detected by a sensor. As a result it is advantageously possible to control and guarantee a homogeneous layer thickness, because deviation regarding the layer thickness may be corrected instantaneously, for example by filling vacancies or retransforming the first printing

material. In particular it is provided that the first printing material being in the second state covers the substrate and subsequently the second printing material is deposited onto the layer formed by the first printing material. In such a scenario the first printing material may be retransformed from being in the second state to being in the first state in order to support releasing the three-dimensional structure made out of the second printing material from the substrate. Furthermore it is provided that the substrate is submerged in a container filled with the first printing material being in the first state and/or the substrate is submerged by using an inlet pipe. It is also thinkable that a scraper or a small drain is used for removing the first printing material being in the first state that excesses the amount of first printing material needed for realizing a layer having a specified thickness. As a result a smooth and homogeneous thick layer out of the first printing material is realized advantageously. Furthermore it is provided that a layer comprising the first printing material is less thick than a layer comprising the second printing material.

According to another embodiment of the present invention it is provided that the first printing material being in the first state and the second printing material being in the third state are deposited such that the second printing material being in the fourth state at least partially wraps the first printing material being in the third state. As a consequence complicated three-dimensional structure structures may be realized easily.

According to another embodiment of the present invention it is provided that a further body is formed by the first printing material being in the second state, wherein the second printing material being in the third state is deposited onto the body in the third step. As a consequence the first printing material being in the second state represents another mold that is removable.

According to another embodiment of the present invention it is provided that the first printing material being in a first state is deposited by a first printing means and wherein the second printing material being in the third state is deposited by a second printing means. Preferably the first printing means is water that mainly not pollute or contaminate the printing means, in particular the printing head having the nozzle. As a consequence the printing means that comprises water as first printing means may be used mainly maintenance-free.

According to another embodiment of the present invention it is provided, that the substrate, the light source, the first printing means and/or the further printing means are arranged inside an encapsulation, wherein the encapsulation comprises the transformation means. In particular it is provided that the transformation means regulates the temperature inside the

encapsulation. As a consequence transformation and retransformation of the first printing material is realized easily. Moreover the encapsulation is a protection against UV –light emitted for curing the second printing means.

- 5 According to another embodiment of the present invention it is provided, that the substrate is moveable, wherein the substrate is moved during the first step, the second step, the third step, the fourth step and/or the fifth step. Preferably the substrate is rotatable and the substrate is rotated during the printing process.
- 10 Another subject of the present invention is a device for printing a three-dimensional structure, wherein the device for printing the three dimensional comprises a printing means for depositing droplets of a first printing material, preferably water, onto a substrate and a transforming mean, preferably a cooling/heating means, wherein the transforming means is configured such that a first printing material is transformed from being in a first state to being
- 15 in a second state, wherein the first printing material is reversibly transformable from being in the first state to being in the second state. Preferable the device comprises an encapsulation that includes the printing means, the substrate and the transformation means. It is herewith advantageously possible to print three-dimensional structures, in particular ice structures.
- 20 Another subject of the present invention is a printed article, wherein the printed article is printed by a method mentioned above.

BRIEF DESCRIPTION OF THE DRAWINGS

- 25 **Figures 1 a-d** show a method for printing a three-dimensional structure according to a first exemplary embodiment of the present invention.

Figures 2 a-c show a method for printing a three-dimensional structure according to a second exemplary embodiment of the present invention.

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Figure 3 shows an exemplary third method for printing a three-dimensional structure according to a third exemplary embodiment of the present invention.

- Figure 4** shows an exemplary fourth method for printing a three-dimensional structure
- 35 according to a fourth exemplary embodiment of the present invention.

DETAILED DESCRIPTION

The present invention will be described with respect to particular embodiments and with the reference to certain drawings but the invention is not limited thereto but only by the claims.

5 The drawings described are only schematic and are non-limiting. In the drawings, the size of some elements may be exaggerated and not drawn on scale for illustrative purposes.

Where an indefinite or definite article is used when referring to a singular noun, e. G. "a", "an", "the", this includes a plurals of the noun unless something else is specifically stated.

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Furthermore, the terms first, second, third and the like in the description and in the claims are used to distinguishing between similar elements and not necessarily for describing a sequential or chronological order. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments of the invention described herein are capable of operation in other sequences than described of illustrated herein.

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In the **figures 1a-d** a method for printing a three-dimensional structure 1 according to a first exemplary embodiment is illustrated, wherein the printing process of the three-dimensional structure 1 is shown by snap shots at four different moments. In the beginning of the printing process a print head 3 is arranged movable above a substrate 2. The print head 3 comprises a first printing means 4, a second printing means 5 and/or a curing means 32. Preferably

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-- the first printing means 4 has a first nozzle for ejecting or jetting droplets 6 of a first printing material being in a first state 11 towards the substrate 2,

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-- the second printing means 5 has a second nozzle for ejecting or jetting droplets 6 of a second printing material in a third state 12 towards the substrate 2 and/or

-- the curing means 32 is a light source, in particular a UV-light source, wherein the light of the light source is configured to transform the second printing material from being in the third state 12 to being in the fourth state 22. In particular the UV-light source emits light having a

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wavelength between 180 nm and 400 nm. As it is illustrated in figure 1a the print head 3 is arranged movable along a printing direction A, wherein the printing direction A is

substantially parallel to a main plane of the substrate 2. It is provided that the droplets 6 of the first printing material being in a first state 11 and the droplets of the second printing material being in a third state 12 are deposited onto the substrate 2, wherein the position of

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the deposited droplet 6 of the first and/or second printing material being in the first or the third state 11 or 13 respectively depends on the position of the print head substantially.

Furthermore it is provided that the substrate 2 comprises a transformation means 31 for

transforming the droplets 6 of the first printing material being in the first state 11 to a first printing material being in a second state 21. Preferably the first printing material being in the first state 11 is liquid and the first printing material being in the second state 21 is solid.

Preferably the transformation means 31 is a cooling means. In particular it is preferably

provided that the cooling means transforms deposited droplets of liquid water or a layer of water to ice. It is thinkable that the substrate 2 comprise a cooling pipe system for example.

Such a cooling pipe system may cool the substrate 2 homogenously across a contact interface between the substrate 2 and the deposited first or the second printing material. In figure 1 a snap shot is shown after a first layer 15 of the first printing material has been

transformed, in particular has been cured, into being in the second state 21. Subsequently a second layer is arranged above the first layer as it is pictured in figure 1 b. It is provided that the first printing material and the second printing material are alternately deposited along the printing direction. In particular the first printing material and the second printing material are deposited and transformed (from the first to the third or from the second to the fourth state

respectively) such that a first region and a second region are realized, wherein the first region comprises the first printing material being in the second state 21 and the second printing material being in the fourth state 22. It is provided that a plurality of layer 15 is

stacked together during the printing process as is illustrated by figure 1 c. Moreover it is

provided that the first printing material being in the first state 21 is removed completely from

the second printing material and thus the three-dimensional structure 1 is realized. Preferably the first printing material is removed by retransforming the first printing material from the

second state 21 to the first state 11. In particular it is provided that the first printing material is retransformed from being solid to being liquid by melting. Retransformation may be for

example realized by separating the three-dimensional structure from the transformation

means. It is also thinkable that the transformation means is configured such that the first

printing material is heated for retransformation. As a consequence the first printing material

melts can be removed fast. The Figure 1 d illustrates the three-dimensional structure 1 after

finishing the printing process.

The **figures 2a to 2c** illustrate a method for printing a three-dimensional structure according to a second exemplary embodiment of the present invention. According to the second

exemplary embodiment firstly a body 8 is printed by depositing droplets of the first printing material being in the first state 11 and by transforming the first printing material from being in the first state 11 to being in the second state 21. It is thinkable that the body 8 was printed

layer 15 by layer 15. In figure 2a the body 8 is illustrated. Secondly the droplets 6 of the printing material being in the third state 12 are deposited onto the body 8. As a consequence the body 8 determinates at least partially the shape of the second printing material, in

particular the second printing material being in the fourth state 22. In figure 2b the second printing material on top of the body 8 is illustrated. Thirdly the first printing material is retransformed from the second state 21 to the first state 12, in particular by melting. As a result the three-dimensional structure shown in figure 2c is realized.

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In **figure 3** a method for printing a three-dimensional structure 1 according to a third exemplary embodiment of the present invention is illustrated. It is provided that the first printing material and the second printing material are deposited and transformed or cured such that the body 8 formed by the second printing material being in the third state at least partially wraps the first printing material being in the second state. In figure 3 the second printing material forms substantially a cavity that includes the first printing material being in the second state 21. It is thinkable that the first printing material is retransformed from being in the second state 21 to being in the first state 11, preferably by melting. Subsequently the first printing material may be removed from the body 8 through an opening 7, wherein the opening 7 could be realized during or after the printing process has been finished.

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In **figure 4** a method for printing a three-dimensional structure 1 according to a fourth exemplary embodiment of the present invention is illustrated. According to this embodiment it is provided that the substrate 2, the first printing means 4, the second printing means 5, the curing means 32 and/or the transformation means 31 are arranged within an encapsulation 40. In particular it is provided that the encapsulation 40 comprises means for regulating the temperature inside the encapsulation 40. For example it is thinkable that a first temperature is set inside the encapsulation 40 for transforming the first printing material from being in the first state 11 to being in the second state 21, whereas a second temperature is set inside the encapsulation 40 for transforming the first printing material from being in the second state 21 to being in the first state 11. Preferably the first temperature is below the melting point of the first printing material and the second temperature is above the melting point of the first printing material. It is also thinkable that a second substrate is removably connected to the substrate 2. In particular it is thinkable that the second substrate 42 is formed by the second printing material being in the fourth state 22. Furthermore it is provided that the first printing material is deposited and transformed such that the first printing material being in the second state 21 wraps the second substrate 42 completely and is connected to the second substrate 42. In particular the first printing material is eatable and the second substrate forms a popsicle, wherein the first printing material being in the second state is connected to the second substrat.

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REFERENCE SIGNS

	1	three-dimensional structure
5	2	substrate
	3	print head
	4	first printing means
	5	second printing means
	6	droplet
10	7	opening
	8	body
	11	first printing material being in a first state
	12	second printing material being in a third state
	15	layer
15	21	first printing material being in a second state
	22	second printing material being in a fourth state
	31	first curing means
	32	second curing means
	40	encapsulation
20	42	second substrate

PATENT CLAIMS

1. Method for printing a three dimensional structure (1), wherein in a first step a first
5 printing material being in a first state (11) is deposited onto a substrate (2), wherein the
first printing material is reversibly transformable between being in the first state (11)
and being in a second state (21) by use of a transformation means (31), wherein in a
second step the deposited first printing material is transformed from being in the first
state (11) to being in the second state (21) by the transformation means (31).
10
2. Method according to claim 1, wherein a second printing material being in a third state
(12) is deposited onto the substrate (2) in a third step and wherein the second printing
material is transformed from the third state (12) to a fourth state (22) by a curing means
(32) in a fourth step, wherein the three-dimensional structure (1) is substantially formed
15 by the second printing material.
3. Method according to claim 2, wherein the first step and the third step are substantially
performed simultaneously and/or the second step and the fourth step are substantially
performed simultaneously.
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4. Method according to claim 2 or 3, wherein the first printing material is retransformed
from being in the second state (21) to being in the first state (11) and wherein in a fifth
step the first printing material being again in the first state (11) is removed from a body
(8) formed by the second printing material being in the fourth state (22).
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5. Method according to any of the preceding claims, wherein
 - the first printing material being in the first state (11) and/or the second printing
material being in the third state (12) is configured as a liquid and/or
 - the first printing material being in the second state (21) and/or the second printing
30 material being in the fourth state (22) is configured as a solid.
6. Method according to any one of the preceding claims,
 - wherein water is included in the first printing material,
 - wherein an additive is included in the first printing material,
 - 35 -- wherein the transformation means is a cooling means, wherein the substrate (2) is
cooled by the cooling means during at least a period of the second step and/or
 - wherein the curing means is a light source, wherein the deposited second printing

material is illuminated during at least a further period of the fourth step

-- wherein the first printing material is at least partially retransformed from being in the second state (21) to being in the first state (11) by illuminating the first printing material using a further light source.

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7. Method according to any one of the preceding claims, wherein a droplet (6) of the first printing material being in the first state (11) is deposited onto the substrate (2) in the first step and/or wherein a droplet (6) of the second printing material being in the third state is deposited onto the substrate (2) in the third step.

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8. Method according to any one of the preceding claims, wherein a plurality of droplets (6) of the first printing material being in the first state (11) and/or a plurality of droplets (6) of the second printing material being in the third state (21) is deposited onto the substrate (2) forming a layer in the first step and/or in the third step, wherein the layer (15) comprises a first region and/or a second region, wherein the first region includes the first printing material and the second region includes the second printing material, and wherein the first region and/or the second region is transformed in the second step and/or in the fourth step, wherein the three-dimensional structure (1) is printed layer (15) by layer (15).

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9. Method according any one of the claim 2 to 8, wherein the first printing material being in the first state (11) and the second printing material being in the third state (21) are deposited such that the second printing material being in the fourth state (22) at least partially wraps the first printing material being in the third state (21) after the second step.

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10. Method according to any one of the preceding claims, wherein a further body is formed by the first printing material being in the second state, wherein the second printing material being in the third state (21) is deposited onto the body in the third step.

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11. Method according to any one of the preceding claims, wherein the first printing material being in a first state (11) is deposited by a first printing means (4) and wherein the second printing material being in the third state (21) is deposited by a second printing means (5).

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12. Method according to any one of the preceding claims, wherein
- the substrate (2), the light source, the first printing means (4) and/or the second

printing means (5) are arranged inside an encapsulation (40), wherein the encapsulation (40) comprises the transformation means (31).

5 13. Method according to any one of the preceding claims, wherein the substrate (2) is moveable, wherein the substrate (2) is moved during the first step, the second step, the third step, the fourth step and/or the fifth step.

10 14. Device for printing a three-dimensional structure (1), wherein the device for printing the three dimensional comprises a first printing means (4) for depositing droplets (6) of a first printing material being in a first state (11) onto a substrate (2), wherein the first printing material is reversibly transformable by a transformation means from being in the first state (11) to being in the second state (22), wherein the device comprises a transformation means (31) that transforms the first printing material from being in the first state (11) to being in the second state (21).

15 15. Printed article, wherein the printed article is printed by a method according to one of the claims 1 to 13.

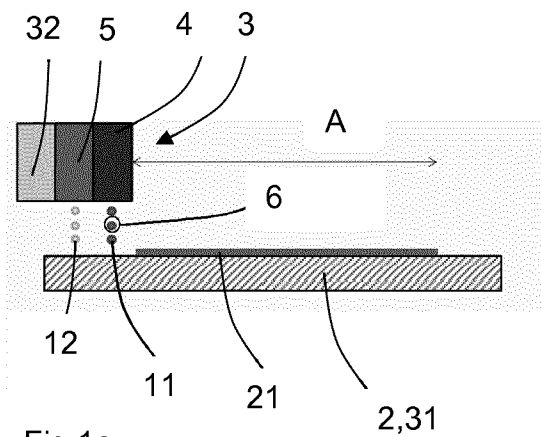


Fig.1a

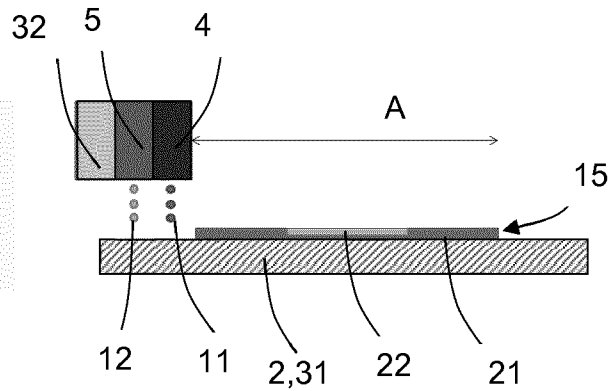


Fig.1b

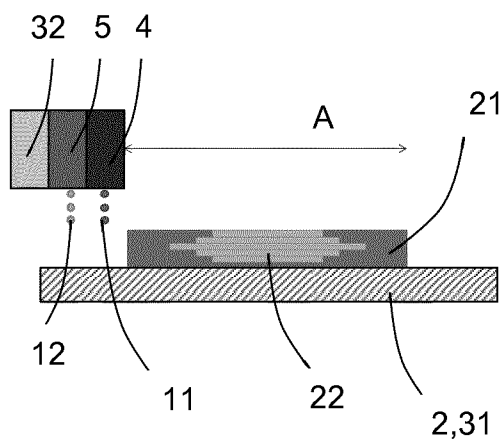


Fig.1c

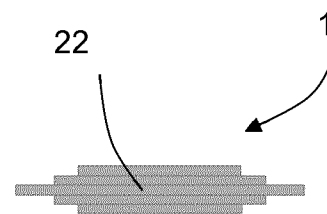


Fig.1d

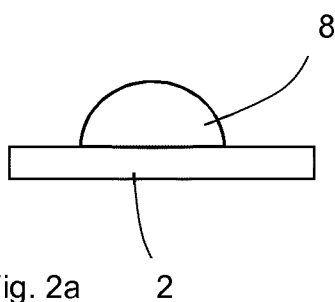
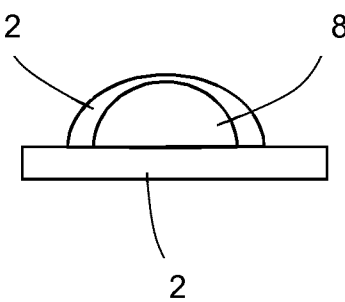


Fig. 2a



2

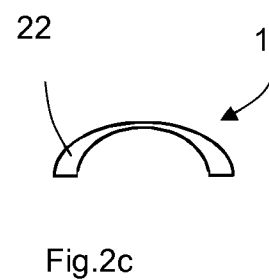
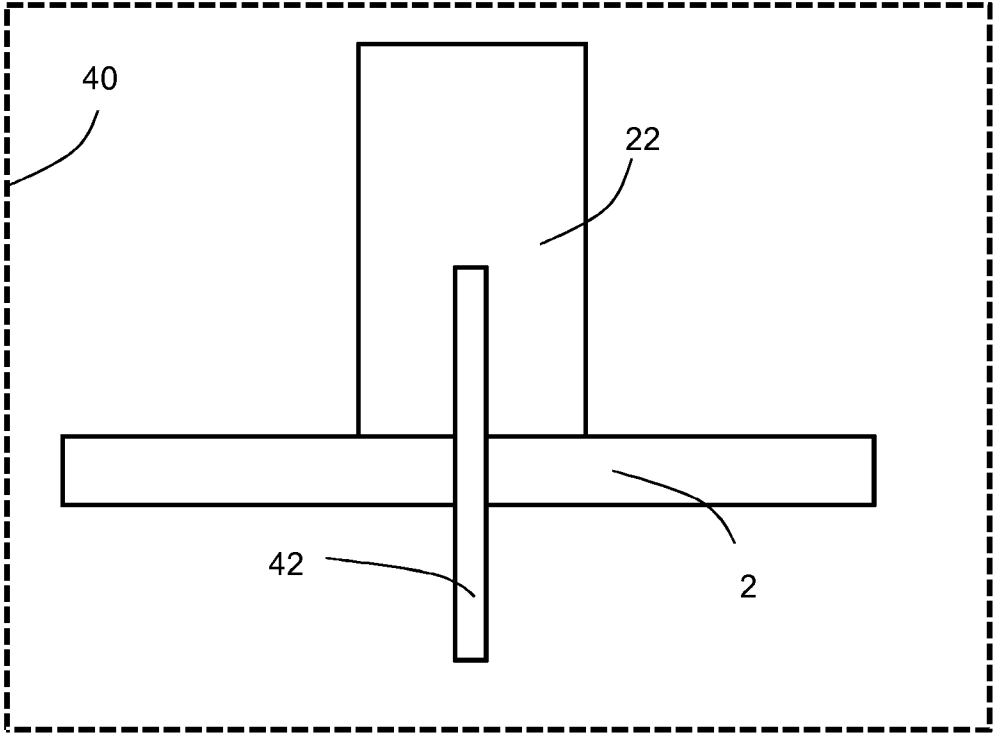
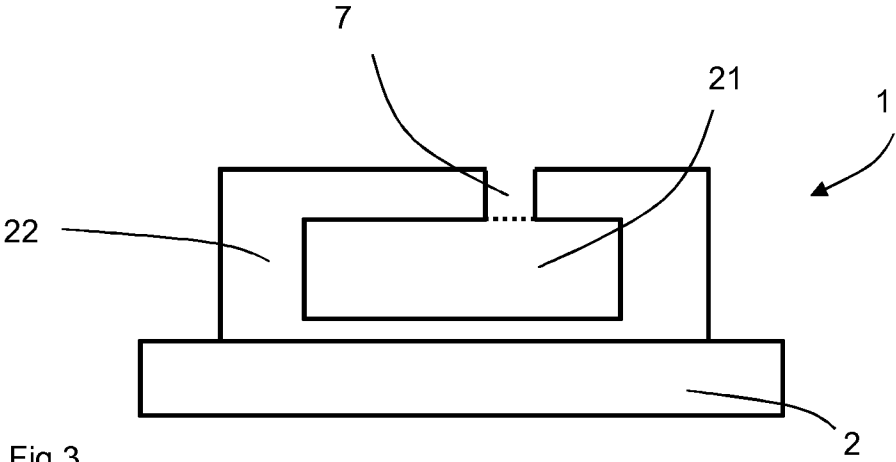


Fig.2c

Fig.2b



INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2014/078863

A. CLASSIFICATION OF SUBJECT MATTER
INV. B29C67/00
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)
B29C

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	US 2003/075836 A1 (FONG JON JODY [US]) 24 April 2003 (2003-04-24) paragraph [0051] - paragraph [0052]; figures 3,4 paragraph [0054] -----	1-5,7,8, 11,13-15 9,10 6,12
X Y	WO 2004/050323 A1 (OBJET GEOMETRIES LTD [IL]; KRITCHMAN ELIAHU M [IL]; GOTHAIT HANAN [IL]) 17 June 2004 (2004-06-17) paragraph [0078] - paragraph [0079]; figures 1, 2d paragraph [0090]; figure 2a -----	1,5,7,8, 14,15 9,10
X	WO 97/17664 A1 (SANDERS PROTOTYPES INC [US]) 15 May 1997 (1997-05-15) page 37, line 5 - line 28; figure 19 -----	1,5,7,8, 14,15



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

24 February 2015

Date of mailing of the international search report

06/03/2015

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2014/078863

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2003075836 A1	24-04-2003	US 2003075836 A1	24-04-2003
		US 2004166187 A1	26-08-2004

WO 2004050323 A1	17-06-2004	AT 411888 T	15-11-2008
		AU 2003286397 A1	23-06-2004
		EP 1590149 A1	02-11-2005
		EP 2199068 A2	23-06-2010
		EP 2295227 A2	16-03-2011
		HK 1089128 A1	31-07-2009
		HK 1145477 A1	15-11-2013
		US 2006054039 A1	16-03-2006
		US 2008110395 A1	15-05-2008
		US 2008118655 A1	22-05-2008
		US 2008121130 A1	29-05-2008
		US 2008121172 A1	29-05-2008
		US 2008124464 A1	29-05-2008
		US 2008124475 A1	29-05-2008
		US 2008166480 A1	10-07-2008
		US 2011241240 A1	06-10-2011
		US 2014175706 A1	26-06-2014
		WO 2004050323 A1	17-06-2004

WO 9717664 A1	15-05-1997	AU 7471896 A	29-05-1997
		US 5740051 A	14-04-1998
		WO 9717664 A1	15-05-1997
