

## METHOD OF PRINTING OUT PRODUCT BY 3D-PRINTING SYSTEM

### CROSS-REFERENCE TO RELATED APPLICATION

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This application claims the benefit of Chinese Patent Application No. CN201410791175.9 filed on December 18, 2014 in the State Intellectual Property Office of China, the whole disclosure of which is incorporated herein by reference.

### 10 BACKGROUND OF THE INVENTION

#### Field of the Invention

15 The present invention relates to a method of printing out a product by a 3D-printing system in high efficiency.

#### Description of the Related Art

20 In prior art, a 3D-printing system generally comprises a robot and a print head mounted on an end arm of the robot. The robot moves the print head along a predetermined path based on a preset program. Meanwhile, material, for forming a product to be printed, is ejected from the print head to a carrying table, so as to print out the product held on the carrying table.

25 Printing out the product by the 3D-printing system is different from machining out the product by a conventional machine. In the 3D-printing of the product, the product is formed by adding material. While, in the conventional machining of the product, the product is formed by removing material.

30 In the prior art, the robot for manipulating the print head is only movable in X-direction, Y-direction and Z-direction, which are perpendicular to each other, and the carrying table for carrying the material is stationary. Thereby, in the prior art, the product to be printed is firstly divided into a plurality of two-dimensional horizontal layers along the Z-direction; then, the robot manipulating the print head to move in a horizontal plane defined by the X-direction and the Y-direction, and print out the plurality of two-dimensional horizontal layers one by one. In this way, the whole product may be formed by stacking the plurality of  
35 two-dimensional horizontal layers in the Z-direction.

In the prior art, in order to ensure the accuracy of the printed product, generally, a print head with high resolution (or high precision) is used to perform the printing. Since the nozzle of the print head with high resolution has a very small diameter, the speed of ejecting

the material from the nozzle is very slow. As a result, the printing speed is very slow, greatly decreasing the printing efficiency.

Furthermore, in the prior art, the print head is only movable relative to the carrying table in the X-direction, the Y-direction and the Z-direction. As a result, only the space position of the print head relative to the carrying table may be adjusted, but an angle of the print head relative to the carrying table cannot be adjusted. In this way, in 3D-printing in the prior art, the print head only can move along a two-dimensional plane or a two-dimensional curve, and cannot move along a three-dimensional plane or a three-dimensional curve. Thereby, its application is limited.

## **SUMMARY OF THE INVENTION**

Embodiments of the present invention have been made to overcome or alleviate at least one aspect of the above mentioned disadvantages.

According to an embodiment of the present invention, there is provided a method of printing out a product by a 3D-printing system, which increases the printing efficiency without decreasing the printing precision.

According to another embodiment of the present invention, there is provided a method of printing out a product by a 3D-printing system, in which a print head is movable along a three-dimensional plane or a three-dimensional curve.

According to an aspect of the present invention, there is provided a method of printing out a product by a 3D-printing system, comprising steps of:

S100: performing a fast speed print with a first print head having a first resolution, so as to print out a substrate of the product;

S200: scanning the substrate printed out in the fast speed print and constructing an actual 3D-digital model of the substrate printed out in the fast speed print;

S300: comparing the actual 3D-digital model of the substrate printed out in the fast speed print with a pre-constructed ideal 3D-digital model of the product;

S400: based on a comparing result in the step S300, determining whether an error between the actual 3D-digital model of the substrate printed out in the fast speed print and the pre-constructed ideal 3D-digital model of the product is less than or equal to a predetermined value, if the determining result is yes, then returning to the step S100, if the determining result is no, then performing following step;

S500: performing a low speed print of the product by a second print head having a second resolution higher than the first resolution;

S600: scanning the substrate printed out in the low speed print and constructing an actual 3D-digital model of the substrate printed out in the low speed print;

S700: comparing the actual 3D-digital model of the substrate printed out in the low speed print with the pre-constructed ideal 3D-digital model of the product;

S800: based on a comparing result in the step S700, determining whether an error between the actual 3D-digital model of the substrate printed out in the low speed print and the pre-constructed ideal 3D-digital model of the product is less than or equal to the predetermined value, if the determining result is yes, then returning to the step S500, if the determining result is no, then performing following step; and

S900: performing an ultra low speed print of the product by a third print head having a third resolution higher than the second resolution.

10 In another exemplary embodiment of the present invention, a diameter of a nozzle of the first print head is larger than that of a nozzle of the second print head; and the diameter of the nozzle of the second print head is larger than that of a nozzle of the third print head.

15 In another exemplary embodiment of the present invention, a flow rate of material, for forming the product, ejected from the first print head is higher than that of the material, for forming the product, ejected from the second print head; and the flow rate of the material, for forming the product, ejected from the second print head is higher than that of the material, for forming the product, ejected from the third print head.

20 In another exemplary embodiment of the present invention, the substrate is carried on a carrying table, the carrying table is movable relative to the print head in a first direction, a second direction and a third direction, which are perpendicular to each other, and the carrying table is rotatable relative to the print head about axes in at least two of the first, second and third directions.

25 In another exemplary embodiment of the present invention, the substrate is scanned by a 3D-scanner located above the carrying table, and the carrying table is rotatable relative to the 3D-scanner about axes in at least two of the first, second and third directions.

In another exemplary embodiment of the present invention, the 3D-scanner is stationary or rotatable about axes in at least two of the first, second and third directions.

30 In another exemplary embodiment of the present invention, the carrying table is mounted on a first manipulating mechanism, and the first manipulating mechanism is configured to rotate the carrying table about axes in at least two of the first, second and third directions.

35 In another exemplary embodiment of the present invention, the print head is mounted on the second manipulating mechanism, and the second manipulating mechanism is configured to move the print head in the first direction, the second direction and the third direction.

In another exemplary embodiment of the present invention, the first manipulating mechanism and the second manipulating mechanism each comprises a multi-freedom robot.

In another exemplary embodiment of the present invention, the first manipulating

mechanism and the second manipulating mechanism each comprises a planar articulated robot, a 6-axis robot, a cartesian robot, a serial robot, a parallel robot or a hybrid robot.

In another exemplary embodiment of the present invention, the first manipulating mechanism comprises a spherical mechanism.

5 In another exemplary embodiment of the present invention, the carrying table is mounted on the spherical mechanism, and the carrying table is rotatable about an axis in the first direction and an axis in the second direction.

In another exemplary embodiment of the present invention, the spherical mechanism comprises: a first rotation driver having an output shaft being rotatable about an axis in the first direction; a second rotation driver having an output shaft being rotatable about an axis in the second direction; a first 1/4 circular plate having one end connected to the output shaft of the first rotation driver; a second 1/4 circular plate, one end of which is pivotally connected to carrying table, and the other end of which is pivotally connected to the other end of the first 1/4 circular plate; and a third 1/4 circular plate, one end of which is connected to the output shaft of the second rotation driver, and the other end of which is pivotally connected to the carrying table, wherein a pivotal axis of a pivotal joint of the first 1/4 circular plate and the second circular plate, a pivotal axis of a pivotal joint of the second circular plate and the carrying table, a pivotal axis of a pivotal joint of the third circular plate and the carrying table, a rotation axis of the output shaft of the first rotation driver and a rotation axis of the output shaft of the second rotation driver converge at the same one point.

In another exemplary embodiment of the present invention, the same one point is a geometric center point of the carrying table.

In another exemplary embodiment of the present invention, the first rotation driver and the second rotation driver are fixed on a first installation plate and a second installation plate on a base, respectively.

In another exemplary embodiment of the present invention, the material, for forming the product, ejected from the print head is supplied from a material supplying device mounted on the second manipulating mechanism.

30 In another exemplary embodiment of the present invention, the material, for forming the product, ejected from the print head is supplied from a material supplying device far away from the second manipulating mechanism.

In another exemplary embodiment of the present invention, a gripper, adapted to grip different sizes of print heads, is provided on the second manipulating mechanism.

35 In another exemplary embodiment of the present invention, the actual 3D-digital model of the substrate and the ideal 3D-digital model of the product are constructed by CAD software.

In practical applications, accuracy requirements of different parts of a product are not the same, for example, generally, only exposed outside surface layer of the product is

required to be printed in high resolution or ultra high resolution, and the inner part of the product is not required to be printed in high resolution. Sometimes, different products have different accuracy requirements, for the product with lower accuracy requirement, it is not necessary to use high precision printing.

5 In the above various methods of the present invention, at the beginning of the printing of the product, performing a fast speed print by a print head with low resolution and precision, in order to improve the printing speed and efficiency of the product. Thereafter, detecting whether the accuracy of the substrate of the product printed out in the fast speed print reaches a predetermined accuracy requirement, if the detecting result is no, then  
10 performing a low speed print by a print head with high resolution and precision. In this way, it may avoid using the print head with high resolution or ultra high resolution in the whole printing process of the product at low speed or ultra low speed. Thereby, it greatly improves the printing speed and efficiency of the product.

Furthermore, in some embodiments the present invention, the carrying table is movable  
15 relative to the print head in a first direction, a second direction and a third direction, which are perpendicular to each other, and the carrying table is rotatable relative to the print head about axes in at least two of the first, second and third directions. As a result, the print head not only may adjust a space position of the print head relative to the carrying table, but also may adjust an angle of the print head relative to the carrying table. Thereby, the print head  
20 may move relative to the carrying table along a three-dimensional plane or a three-dimensional curve, and may print out a complex three-dimensional plane or a complex three-dimensional curve.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

25 The above and other features of the present invention will become more apparent by describing in detail exemplary embodiments thereof with reference to the accompanying drawings, in which:

Fig.1 is an illustrative perspective view of a 3D-printing system according to an exemplary embodiment of the present invention.

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### **DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION**

Exemplary embodiments of the present disclosure will be described hereinafter in detail with reference to the attached drawings, wherein the like reference numerals refer to the like  
35 elements. The present disclosure may, however, be embodied in many different forms and should not be construed as being limited to the embodiment set forth herein; rather, these embodiments are provided so that the present disclosure will be thorough and complete, and will fully convey the concept of the disclosure to those skilled in the art.

In the following detailed description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the disclosed embodiments. It will be apparent, however, that one or more embodiments may be practiced without these specific details. In other instances, well-known structures and devices are schematically shown in order to simplify the drawing.

According to a general concept of the present invention, there is provided a method of printing out a product by a 3D-printing system, comprising steps of:

S100: performing a fast speed print with a first print head having a first resolution, so as to print out a substrate of the product;

S200: scanning the substrate printed out in the fast speed print and constructing an actual 3D-digital model of the substrate printed out in the fast speed print;

S300: comparing the actual 3D-digital model of the substrate printed out in the fast speed print with a pre-constructed ideal 3D-digital model of the product;

S400: based on a comparing result in the step S300, determining whether an error between the actual 3D-digital model of the substrate printed out in the fast speed print and the pre-constructed ideal 3D-digital model of the product is less than or equal to a predetermined value, if the determining result is yes, then returning to the step S100, if the determining result is no, then performing following step; and

S500: performing a low speed print of the product by a second print head having a second resolution higher than the first resolution.

Fig.1 is an illustrative perspective view of a 3D-printing system according to an exemplary embodiment of the present invention.

In an exemplary embodiment of the present invention, there is disclosed a 3D-printing system. As shown in Fig.1, the 3D-printing system mainly comprises a print head 200, a carrying table 300, a first manipulating mechanism 500, a second manipulating mechanism 100, and a 3D-scanner 600.

As shown in Fig.1, a substrate 400 of a product printed out is carried on the carrying table 300. In an embodiment, the carrying table 300 is movable relative to the print head 200 in a first direction X, a second direction Y and a third direction Z, which are perpendicular to each other. The carrying table 300 is rotatable relative to the print head 200 about axes in at least two of the first, second and third directions X, Y, Z.

Referring to Fig.1, the 3D-scanner 600 is located above the carrying table 300, and the carrying table 300 is rotatable relative to the 3D-scanner 600 about axes in at least two of the first, second and third directions X, Y, Z.

In the illustrated embodiment, the 3D-scanner 600 is stationary. But the present invention is not limited to this, the 3D-scanner 600 may be rotatable about an axis in at least one of the first, second and third directions X, Y, Z or movable in at least one of the first, second and third directions X, Y, Z.

In an embodiment, as shown in Fig.1, the first manipulating mechanism (to be described hereafter) 500 and the second manipulating mechanism (or referred as a robot) 100 are fixed on a base 10. The print head 200 is mounted on an end arm of the second manipulating mechanism 100. The carrying table 300 is mounted on the first manipulating mechanism 500.

In an embodiment, the second manipulating mechanism 100 has at least three freedoms; for example, the second manipulating mechanism 100 may move the print head 200 in the first direction X, the second direction Y and the third direction Z, so as to print out the product by the print head as necessary on the carrying table 300.

In an embodiment, as shown in Fig.1, the first direction X and the second direction Y define a horizontal plane, and the third direction Z is a vertical direction perpendicular to the horizontal plane.

In an embodiment, the first manipulating mechanism 500 may have at least two freedoms; for example, the first manipulating mechanism 500 may rotate the carrying table 300 about at least two axes in at least two directions, so that an angle of the print head 200 relative to the carrying table 300 may be adjusted. In this way, by operating the first manipulating mechanism 500 and the second manipulating mechanism 100, the print head 200 may be moved relative to the carrying table 300 and/or the substrate 400 on the carrying table 300 along a 3D-surface or a 3D-curve.

In an embodiment, the second manipulating mechanism 100 may be a robot with at least three freedoms. For example, the second manipulating mechanism 100 may comprise a planar articulated robot, a 6-axis robot, a cartesian robot, a serial robot, a parallel robot or a hybrid robot.

In an embodiment, as shown in Fig.1, the first manipulating mechanism 500 comprises a spherical mechanism. The carrying table 300 is mounted on the spherical mechanism. The spherical mechanism is a three-dimensional rotation mechanism, all members of the spherical mechanism are rotatable about the same one point.

In an embodiment, as shown in Fig.1, the carrying table 300 is rotatable about an axis in the first direction X and an axis in the second direction Y.

Referring to Fig.1, in an embodiment, the spherical mechanism mainly comprises a first rotation driver 510, a second rotation driver 520, a first 1/4 circular plate 501, a second 1/4 circular plate 502, and a third 1/4 circular plate 503. As shown in Fig.1, an output shaft of the first rotation driver 510 is rotatable about an axis in the first direction X. An output shaft of the second rotation driver 520 is rotatable about an axis in the second direction Y. One end of the first 1/4 circular plate 501 is connected to the output shaft of the first rotation driver 510. One end of the second 1/4 circular plate 502 is pivotally connected to the carrying table 300, and the other end of the second 1/4 circular plate 502 is pivotally connected to the other end of the first 1/4 circular plate 501. One end of the third 1/4 circular

plate 503 is connected to the output shaft of the second rotation driver 520, and the other end of the third 1/4 circular plate 503 is pivotally connected to the carrying table 300.

As shown in Fig.1, in an embodiment, a pivotal axis of a pivotal joint of the first 1/4 circular plate 501 and the second circular plate 502, a pivotal axis of a pivotal joint of the second circular plate 502 and the carrying table 300, a pivotal axis of a pivotal joint of the third circular plate 503 and the carrying table 300, a rotation axis of the output shaft of the first rotation driver 510 and a rotation axis of the output shaft of the second rotation driver 520 converge at the same one point. For example, the same one point is a geometric center point of the carrying table 300.

In the embodiment shown in Fig.1, the spherical mechanism has two freedoms. The spherical mechanism may rotate the carrying table 300 about an axis in the first direction X and an axis in the second direction Y, so as to change the posture of the carrying table 300. But the present invention is not limited to this, the spherical mechanism may have three freedoms, that is, the spherical mechanism may rotate the carrying table 300 about an axis in the first direction X, an axis in the second direction Y and an axis in the third direction Z, thereby obtaining more freedoms in a predetermined operation space.

In an embodiment, as shown in Fig.1, the first rotation driver 510 and the second rotation driver 520 are fixed on a first vertical installation plate 11 and a second vertical installation plate 12 which are mounted on a base 10, respectively.

As shown in Fig.1, in an embodiment, the first rotation driver 510 and the second rotation driver 520 each may comprise a motor.

Please be noted that the first manipulating mechanism 500 is not limited to the spherical mechanism shown in Fig.1. The first manipulating mechanism may comprise a robot with at least two freedoms.

In an embodiment, the material, for forming the product, ejected from the print head 200 is supplied from a material supplying device mounted on the second manipulating mechanism 100, as long as the second manipulating mechanism 100 may carry the material supplying device and the material contained in the material supplying device.

In another embodiment, the material, for forming the product, ejected from the print head 200 is supplied from a material supplying device far away from the second manipulating mechanism 100.

In the embodiment shown in Fig.1, the print head 200 is moved by the second manipulating mechanism 100, and the carrying table 300 is rotated by the first manipulating mechanism 500. Thereby, by operating the first manipulating mechanism 500 and the second manipulating mechanism 100, the print head 200 may be moved relative to the carrying table 300 along a 3D-surface or a 3D-curve.

Hereafter, it will describe in detail a method of printing out a product by a 3D-printing system according to an exemplary embodiment of the present invention with

reference to Fig. 1. The method may comprise steps of:

S100: performing a fast speed print with a first print head 201 having a first resolution, so as to print out a substrate 400 of the product;

5 S200: scanning the substrate 400 printed out in the fast speed print and constructing an actual 3D-digital model of the substrate 400 printed out in the fast speed print;

S300: comparing the actual 3D-digital model of the substrate 400 printed out in the fast speed print with a pre-constructed ideal 3D-digital model of the product;

10 S400: based on a comparing result in the step S300, determining whether an error between the actual 3D-digital model of the substrate 400 printed out in the fast speed print and the pre-constructed ideal 3D-digital model of the product is less than or equal to a predetermined value, if the determining result is yes, then returning to the step S100, if the determining result is no, then performing following step; and

S500: performing a low speed print of the product by a second print head 202 having a second resolution higher than the first resolution.

15 In an embodiment of the present invention, the above method may further comprise steps of:

S600: scanning the substrate 400 printed out in the low speed print and constructing an actual 3D-digital model of the substrate 400 printed out in the low speed print;

20 S700: comparing the actual 3D-digital model of the substrate 400 printed out in the low speed print with the pre-constructed ideal 3D-digital model of the product;

S800: based on a comparing result in the step S700, determining whether an error between the actual 3D-digital model of the substrate 400 printed out in the low speed print and the pre-constructed ideal 3D-digital model of the product is less than or equal to the predetermined value, if the determining result is yes, then returning to the step S500, if the determining result is no, then performing following step; and

25 S900: performing an ultra low speed print of the product by a third print head 203 having a third resolution higher than the second resolution.

30 In the above embodiment, among the first print head 201, the second print head 202 and the third print head 203, the first print head 201 has the lowest resolution, the lowest print precision and the quickest print speed (referred as fast speed print), the second print head 202 has a medium resolution, a medium print precision and a medium print speed (referred as low speed print), the third print head 203 has the highest resolution, the highest print precision and the lowest print speed (referred as ultra low speed print).

35 In the above embodiments, although it has described three kinds of print heads with different resolutions, the present invention is not limited to this. For example, if necessary, four or more kinds of print heads with different resolutions may be used. Different print heads are not only used to perform different prints with different resolutions, but also used to support different materials. In this case, the 3D-printing system may be used in a two

injection molding process.

In the above embodiments, for a product with low accuracy, it may use only the first print head 201 with low resolution to complete the whole printing of the product in high speed. For a product with high accuracy, it may firstly use the first print head 201 with low resolution to print out a part of the product with low precision requirement in high speed; then it may use the second and the third print heads 202, 203 with high resolution to print out the other part of the product with high precision requirement. In this way, it greatly increases the printing efficiency of the product.

In the above embodiments, the resolution of the first print head 201 is lower than that of the second print head 202, and the resolution of the second print head 202 is lower than that of the third print head 203. Thereby, a diameter of a nozzle of the first print head 201 is larger than that of a nozzle of the second print head 202, and the diameter of the nozzle of the second print head 202 is larger than that of a nozzle of the third print head 203. Moreover, a flow rate of material, for forming the product, ejected from the first print head 201 is higher than that of the material, for forming the product, ejected from the second print head 202; and the flow rate of the material, for forming the product, ejected from the second print head 202 is higher than that of the material, for forming the product, ejected from the third print head 203.

As shown in Fig.1, in an embodiment, the first print head 201, the second print head 202 and the third print head 203 have different sizes. In order to easily replace different sizes of print heads, in an embodiment, a gripper, adapted to grip different sizes of print heads 201, 202, 203, may be provided on the second manipulating mechanism 100.

In the above embodiments, the actual 3D-digital model of the substrate 400 and the ideal 3D-digital model of the product may be constructed by computer aided design and manufacturing software, for example, CAD software.

It should be appreciated for those skilled in this art that the above embodiments are intended to be illustrated, and not restrictive. For example, many modifications may be made to the above embodiments by those skilled in this art, and various features described in different embodiments may be freely combined with each other without conflicting in configuration or principle.

Although several exemplary embodiments have been shown and described, it would be appreciated by those skilled in the art that various changes or modifications may be made in these embodiments without departing from the principles and spirit of the disclosure, the scope of which is defined in the claims and their equivalents.

As used herein, an element recited in the singular and proceeded with the word "a" or "an" should be understood as not excluding plural of said elements or steps, unless such exclusion is explicitly stated. Furthermore, references to "one embodiment" of the present invention are not intended to be interpreted as excluding the existence of additional

embodiments that also incorporate the recited features. Moreover, unless explicitly stated to the contrary, embodiments "comprising" or "having" an element or a plurality of elements having a particular property may include additional such elements not having that property.

What is claimed is,

1. A method of printing out a product by a 3D-printing system, comprising steps of:

S100: performing a fast speed print with a first print head having a first resolution, so as to print out a substrate of the product;

S200: scanning the substrate printed out in the fast speed print and constructing an actual 3D-digital model of the substrate printed out in the fast speed print;

S300: comparing the actual 3D-digital model of the substrate printed out in the fast speed print with a pre-constructed ideal 3D-digital model of the product;

S400: based on a comparing result in the step S300, determining whether an error between the actual 3D-digital model of the substrate printed out in the fast speed print and the pre-constructed ideal 3D-digital model of the product is less than or equal to a predetermined value, if the determining result is yes, then returning to the step S100, if the determining result is no, then performing following step;

S500: performing a low speed print of the product by a second print head having a second resolution higher than the first resolution;

S600: scanning the substrate printed out in the low speed print and constructing an actual 3D-digital model of the substrate printed out in the low speed print;

S700: comparing the actual 3D-digital model of the substrate printed out in the low speed print with the pre-constructed ideal 3D-digital model of the product;

S800: based on a comparing result in the step S700, determining whether an error between the actual 3D-digital model of the substrate printed out in the low speed print and the pre-constructed ideal 3D-digital model of the product is less than or equal to the predetermined value, if the determining result is yes, then returning to the step S500, if the determining result is no, then performing following step; and

S900: performing an ultra low speed print of the product by a third print head having a third resolution higher than the second resolution.

2. The method according to claim 1,

wherein a diameter of a nozzle of the first print head is larger than that of a nozzle of the second print head; and

wherein the diameter of the nozzle of the second print head is larger than that of a nozzle of the third print head.

3. The method according to claim 1,

wherein a flow rate of material, for forming the product, ejected from the first print

head is higher than that of the material, for forming the product, ejected from the second print head; and

wherein the flow rate of the material, for forming the product, ejected from the second print head is higher than that of the material, for forming the product, ejected from the third print head.

4. The method according to claim 1,

wherein the substrate is carried on a carrying table,

wherein the carrying table is movable relative to the print head in a first direction (X), a second direction (Y) and a third direction (Z), which are perpendicular to each other, and

wherein the carrying table is rotatable relative to the print head about axes in at least two of the first, second and third directions (X, Y, Z).

5. The method according to claim 4,

wherein the substrate is scanned by a 3D-scanner located above the carrying table, and

wherein the carrying table is rotatable relative to the 3D-scanner about axes in at least two of the first, second and third directions (X, Y, Z).

6. The method according to claim 5,

wherein the 3D-scanner is stationary or rotatable about axes in at least two of the first, second and third directions (X, Y, Z).

7. The method according to claim 5,

wherein the carrying table is mounted on a first manipulating mechanism, and

wherein the first manipulating mechanism is configured to rotate the carrying table about axes in at least two of the first, second and third directions (X, Y, Z).

8. The method according to claim 7,

wherein the print head is mounted on the second manipulating mechanism, and

wherein the second manipulating mechanism is configured to move the print head in the first direction (X), the second direction (Y) and the third direction (Z).

9. The method according to claim 8,

wherein the first manipulating mechanism and the second manipulating mechanism each comprises a multi-freedom robot.

10. The method according to claim 9,

wherein the first manipulating mechanism and the second manipulating mechanism

each comprises a planar articulated robot, a 6-axis robot, a cartesian robot, a serial robot, a parallel robot or a hybrid robot.

11. The method according to claim 7,  
wherein the first manipulating mechanism comprises a spherical mechanism.

12. The method according to claim 11,  
wherein the carrying table is mounted on the spherical mechanism, and  
wherein the carrying table is rotatable about an axis in the first direction (X) and an axis in the second direction (Y).

13. The method according to claim 12,  
wherein the spherical mechanism comprises:  
a first rotation driver having an output shaft being rotatable about an axis in the first direction (X);  
a second rotation driver having an output shaft being rotatable about an axis in the second direction (Y);  
a first 1/4 circular plate having one end connected to the output shaft of the first rotation driver;  
a second 1/4 circular plate having one end pivotally connected to carrying table, and the other end pivotally connected to the other end of the first 1/4 circular plate; and  
a third 1/4 circular plate having one end connected to the output shaft of the second rotation driver (520), and the other end pivotally connected to the carrying table,  
wherein a pivotal axis of a pivotal joint of the first 1/4 circular plate and the second circular plate, a pivotal axis of a pivotal joint of the second circular plate and the carrying table, a pivotal axis of a pivotal joint of the third circular plate and the carrying table, a rotation axis of the output shaft of the first rotation driver and a rotation axis of the output shaft of the second rotation driver converge at the same one point.

14. The method according to claim 13,  
wherein the same one point is acted as a geometric center point of the carrying table.

15. The method according to claim 14,  
wherein the first rotation driver and the second rotation driver are fixed on a first installation plate and a second installation plate on a base, respectively.

16. The method according to claim 8,  
wherein the material, for forming the product, ejected from the print head is supplied

from a material supplying device mounted on the second manipulating mechanism.

17. The method according to claim 8,  
wherein the material, for forming the product, ejected from the print head is supplied from a material supplying device far away from the second manipulating mechanism.

18. The method according to claim 8,  
wherein a gripper, adapted to grip different sizes of print heads, is provided on the second manipulating mechanism.

19. The method according to claim 1,  
wherein the actual 3D-digital model of the substrate and the ideal 3D-digital model of the product are constructed by CAD software.