DESCRIPTION

3D screen printing system for printing three-dimensionally shaped structures

The invention relates to a printing system for printing three-dimensionally shaped structures on substrates, in particular printed circuit boards, wafers, solar cells, carrier substrates, printing tables, carrier plates, sintering plates or the like, which has at least one printing device having a print head which has a scraper device and a screen receptacle associated with the scraper device for receiving a printing screen. It is in particular a 3D screen printing system for printing three-dimensionally shaped structures.

Printing systems of the type mentioned at the outset are known from the prior art. 3D printing methods enjoy an ever increasing popularity, because complex three-dimensional structures can be produced cost-effectively in a short time, wherein such printing methods are not only limited to prototypes but are also applied to the production of finished products in the meantime. Thereby, different techniques are used. Frequently, lasers are used for the layer-by-layer molding of plastic structures. For the production of electrically conductive structures from metallic materials, carrying out screen printing processes is known. For this purpose, a printing material in a suitable form is applied to a printing screen, which is pressed by means of a scraper blade of a scraper device through the screen onto a substrate. DE 20 2013 004 745 U1 already discloses a system for the production of three-dimensional screen printing.

The task of the invention is to provide an improved printing system, by means of which even complex three-dimensional structures can be produced in a simple and timely manner.

Summary

In an aspect, the present disclosure refers to a printing system for printing three-dimensionally shaped structures, in particular on substrates such as printed circuit boards, wafers, solar cells, carrier substrates, printing tables, carrier plates, sintering plates or the like, comprising at least one printing device which has a print head having a scraper device and a screen receptacle which is associated with the scraper device magazine for receiving a printing screen, characterized by a screen provisioning device which has at least one screen magazine for storing multiple printing screens and a transport device for transporting a printing screen from the screen magazine to the

screen receptacle and from the screen receptacle to the screen magazine.

The task underlying the invention is achieved by a printing system having the features of the above aspect. This has the advantage that a complex three-dimensional structure can be produced without a plurality of printing devices being necessary for this purpose, and without the substrate carrying the structure having to be removed from a printing device for producing the complete structure and inserted in another printing device. As a result, the production time is shortened and resources, in particular also with respect to the space required for the production, are saved. According to the invention, this is achieved in that the printing system comprises a screen provisioning device which has a screen magazine for storing a plurality of print screens and a transport device for transporting a printing screen from the screen receptacle to the screen magazine, on the one hand, and a selected printing screen from the screen magazine to the screen

receptacle, on the other hand. The printing device is thus capable of selecting different printing screens from a screen magazine and forming the basis of the printing process, whereby different and highly complex three-dimensional structures can be printed in a simple manner with the same printing device using differently designed printing screens. For this purpose, for example, a selected printing screen is first removed from the screen magazine by means of the transport device and is arranged in the screen receptacle, and a first printing process is carried out. The printing screen is removed from the screen receptacle and fed back to the screen magazine, so that in the second step the transport device removes a second printing screen from the screen magazine and places it in the screen receptacle. The subsequent second printing process has a second printing layer, which differs from the first printing layer, for example on account of the design of the printing screen, so that three-dimensionally shaped structures are produced. In this case, the number of printing layers can be freely selected and their height can also be variable. Of course, two or more printing processes can also be carried out with one and the same printing screen directly one behind the other.

In order for the distance between the printing screen and the substrate to be as low as possible during a printing process, the printing table carrying the substrate and/or the printing head are preferably adjustable in height in order to be able to vary the distance between the printing screen and the printing table. By increasing the height after each printing process, the printing layers can thus be layered on top of each other in a simple manner.

Furthermore, it is preferably provided that the transport device is arranged on the printing table or on a housing carrying the printing table or assigned to the printing table. In a first example, the transport device is thus arranged on the printing device, in particular on the printing table or the printing head, or on a housing of the printing device. The transport device is preferably arranged on the printing device. The actuation and the actuator system for moving the printing screens on the printing device itself are thus provided. This has the advantage that, for example, a screen magazine can also be replaced without interfering with the operation of the printing device. The printing device can thus also access different printing magazines. For this purpose, the printing system preferably has a plurality of printing magazines. This increases the variety of different printing screens.

According to an alternative example, the transport device is

arranged on the screen magazine. The transport device can thus be entrained with the screen magazine. The printing device itself can thereby be designed to be more space-saving. Furthermore, this results

in the advantage that an existing printing device can also be supplemented subsequently by the screen magazine with transport device, in order to enable automated screen replacement for already existing screen printing devices.

In another example, it is preferably provided that the transport device is arranged between the screen bearing and the printing table and is formed separately therefrom. The transport device is thus present in a manner both detached from the printing device and detached from the screen magazine, and interacts with both. A simple adaptation of the printing system to different installation space conditions is thereby possible in a particularly simple manner.

A preferred example provides for the transport device to have at least one movable, in particular a multi-link arm, for transporting a printing screen in each case. The arm, which as such can also be called a robot arm, ensures a simple and targeted transport of the printing screen from the screen magazine to the print head or from the print head from the screen magazine. In particular, a plurality of screen magazines can be operated by the movable arm. It is also conceivable to operate a plurality of printing devices for screen exchange by means of the transport device.

In a preferred example, the screen magazine has a plurality of screen bearings stacked on top of each other for receiving a respective printing screen. The printing screens are thus held in the screen magazine in printing bearings. The fact that the screen bearings are arranged or stacked on top of one another results in an advantageous utilization of installation space.

The screen magazine preferably has at least one sliding device for advancing a screen bearing or a printing screen from one of the screen bearings. By means of the sliding device, the printing screen can be advanced at least to such an extent that the transport device can grip the printing screen and feed it to the printing device. By means of the sliding device, it is achieved that the selected printing screen can be removed more simply from the affected screen bearing by the transport device. Alternatively, the transport device alone removes the printing screen from the selected screen bearing.

In a preferred example, the transport device has a lifting device

for moving the screen bearings in height. As a result, it is achieved, for example, that the transport

device always removes the printing screen from the same height from the printing magazine by displacing the screen bearings correspondingly in height. The printing screens stored in the screen magazine can thereby be protected particularly advantageously. In particular, it is provided that the screen magazine has a housing which is at least essentially closed and has at least one removal opening, through which the respectively selected printing screen can be pushed through the sliding device or directly removed by the transport device. Preferably, the removal opening is only slightly larger here than one of the printing screens to be removed, so that access to the interior of the screen magazine is particularly small, as a result of which the contamination of the screens located in the screen bearing is advantageously prevented.

In a preferred example, the sliding device is designed to displace a selected printing screen from one of the screen bearings into the screen receptacle and/or vice versa. In particular in conjunction with the aforementioned lifting device, the transport device can thereby for example first displace a selected printing screen to the removal height and feed it directly to the screen receptacle of the printing device by means of the pushing device. The printing device then preferably likewise has a pushing device, or the pushing device of the transport device is also designed as a drawing device, by means of which the printing screen located in the screen receptacle can be moved back into the screen magazine. As a result, the movable transport arm can be completely dispensed with.

Furthermore, the screen magazine is preferably arranged on the printing device. As a result, the screen magazine forms part of the printing device and can be entrained overall therewith. A particularly compact unit of the printing system can thereby be created.

Alternatively, the screen magazine is preferably arranged next to and at a distance from the printing table. As a result, it forms a separate unit and can be transported and mounted detached therefrom.

Furthermore, it is preferably provided that the transport device has at least one controllable gripper for holding and transporting a printing screen, in particular at a free end of the transport arm. The respective printing screen can thereby be reliably moved by the transport device.

Furthermore, it is preferably provided that the screen magazine has a conditioning device for air-conditioning or conditioning the printing screens in the screen bearings. The conditioning device is designed, in particular, to air-condition or condition the printing screens in such a way that printing materials remaining on the printing screens do not dry as residues and can be reused again during a

CLAIMS

1. Printing system for printing three-dimensionally shaped structures, in particular on substrates such as printed circuit boards, wafers, solar cells, carrier substrates, printing tables, carrier plates, sintering plates or the like, comprising at least one printing device which has a print head having a scraper device and a screen receptacle which is associated with the scraper device magazine for receiving a printing screen, **characterized by a** screen provisioning device which has at least one screen magazine for storing multiple printing screens and a transport device for transporting a printing screen from the screen magazine to the screen receptacle and from the screen receptacle to the screen magazine.

2. Printing system according to claim 1, **characterized** in that the printing head and/or a printing table can be adjusted in height in order to produce a plurality of printing layers one above the other with identical or different printing screens.

3. Printing system according to one of the preceding claims, **characterized** in that the transport device is arranged on the printing device, in particular on the print head or on the printing table, or on a housing of the printing device.

4. Printing system according to one of the preceding claims, **characterized** in that the transport device is arranged on the screen magazine.

5. Printing system according to one of the preceding claims, **characterized** in that the transport device is arranged between the screen magazine and the printing table and is embodied separately therefrom.

6. Printing system according to one of the preceding claims, **characterized** in that the transport device has at least one movable, in particular multi-link, transport arm for transporting in each case one printing screen.

7. Printing system according to one of the preceding claims, **characterized** in that the screen magazine has multiple screen bearings arranged stacked on top of each other for receiving a printing screen in each case.

8. Printing system according to one of the preceding claims, **characterized** in that the screen magazine has at least one sliding device for advancing a screen bearing or a printing screen from one of the screen bearings.

9. Printing system according to one of the preceding claims, **characterized** in that the transport device has a lifting device, in particular for moving the screen bearings or the transport arm in height.

10. Printing system according to one of the preceding claims, **characterized** in that the sliding device is designed to displace a selected printing screen from one of the screen bearings into the screen receptacle and/or vice versa.

11. Printing system according to one of the preceding claims, **characterized** in that the screen magazine is arranged on the printing device.

12. Printing system according to one of the preceding claims, **characterized** in that the screen magazine is arranged next to and at a distance from the printing device.

13. Printing system according to one of the preceding claims, **characterized** in that the transport device has at least one controllable gripper, in particular at a free end of the transport arm, for holding and transporting a printing screen.

14. Printing system according to one of the preceding claims, **characterized** in that the screen magazine has a conditioning device for air-conditioning the printing screens in the screen magazine.

15. Printing system according to one of the preceding claims, **characterized by** a plurality of identical and/or different printing screens.