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(54) APPARATUS FOR INKJET PRINTING AND CURING INTEGRATION PROCESS

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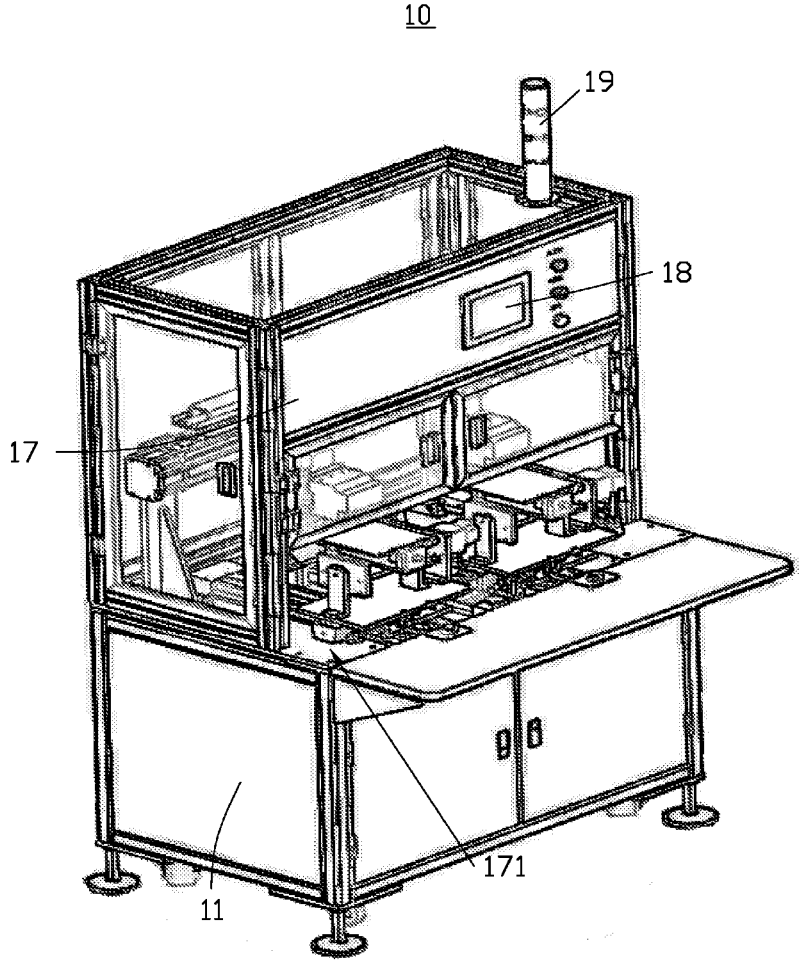
(57) **ABSTRACT**

An apparatus for inkjet printing and curing process for performing on more than one side of a workpiece in one continuous sequential process, the workpiece is shaped as a cube configured with a first surface, a second surface opposite to the first surface, and side surfaces connected between the first surface and the second surface. The apparatus for inkjet printing and curing integration process comprises a base, a supporting module, a printing module, a rotary module, and a transporting module, wherein the transporting module moves the workpiece under the printing module for being printed and cured on one side, then the rotary module rotates the workpiece such that a different side is presented for inkjet printing and curing. The printing module thus performs a continuous inkjet printing and curing process on more than one side of a workpiece, and the working efficiency is improved.



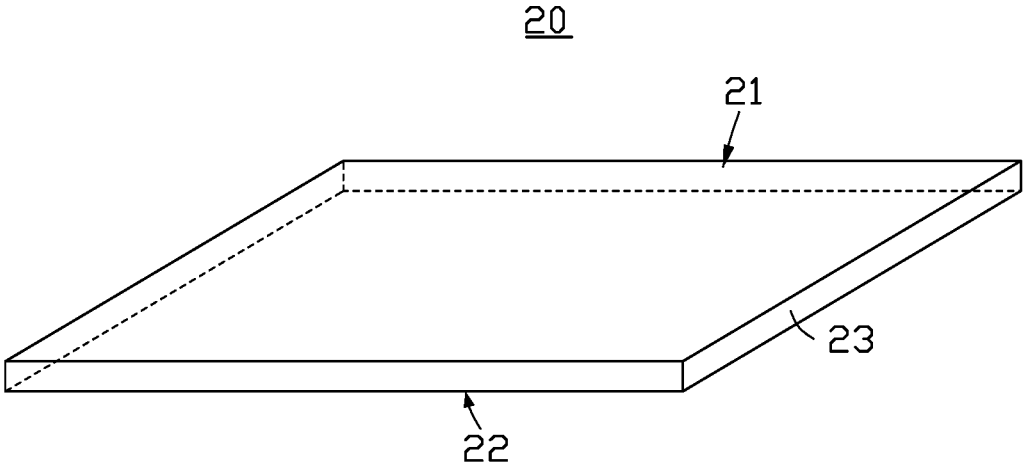


FIG. 1

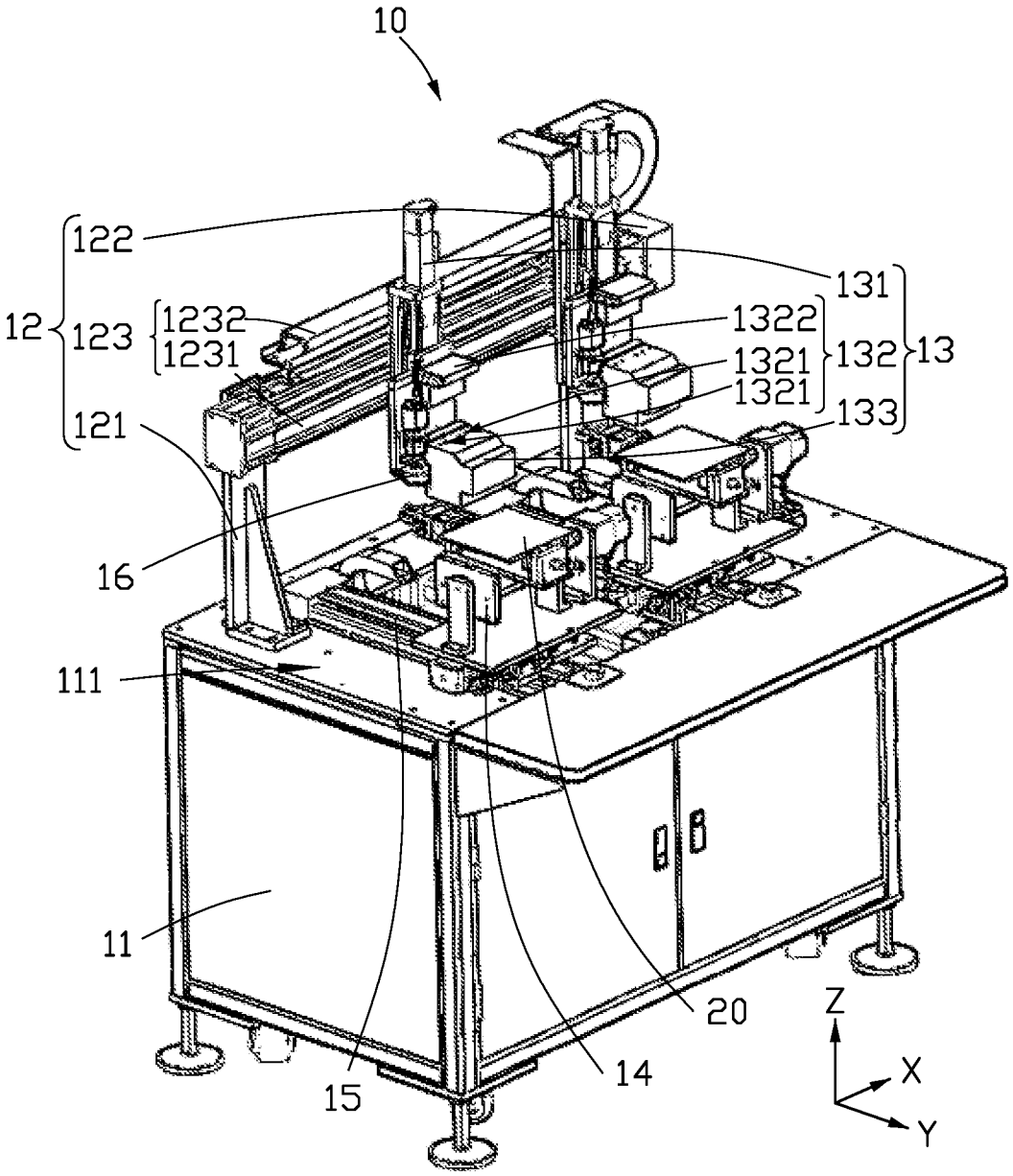

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FIG. 2

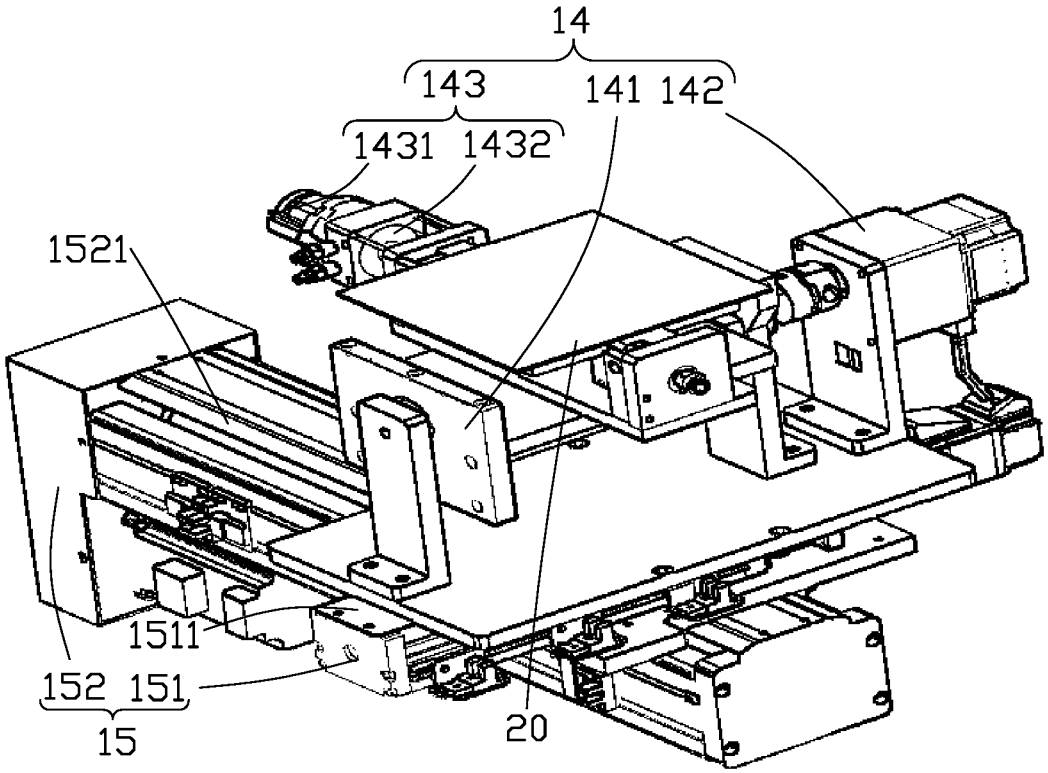

FIG. 3

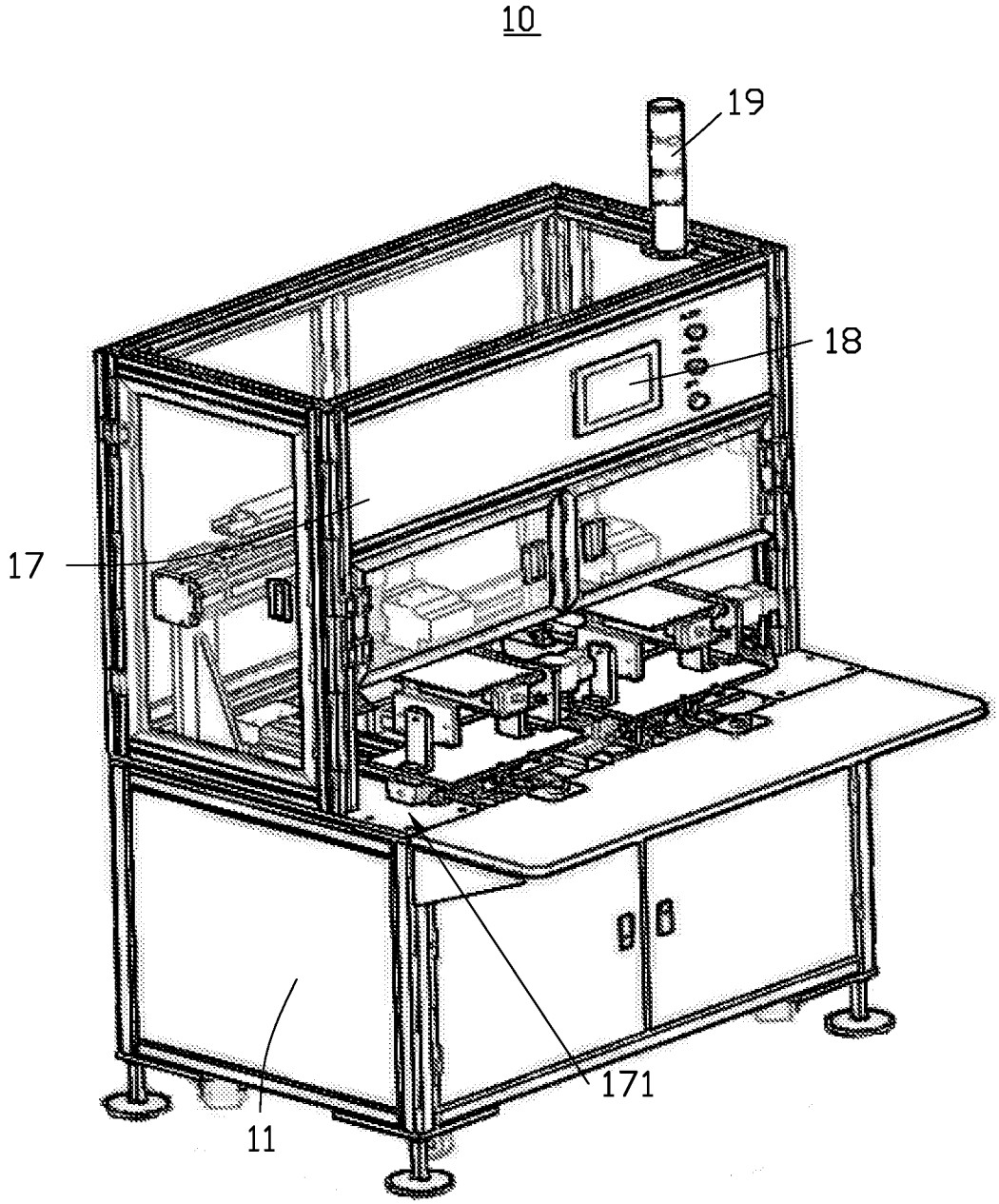

FIG. 4

APPARATUS FOR INKJET PRINTING AND CURING INTEGRATION PROCESS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to China Application No. 202110864730.6, having a filing date of Jul. 29, 2021, filed in China State Intellectual Property Administration, the entire contents of which is hereby incorporate by reference.

FIELD

[0002] The subject matter relates to inkjet printing and ink-curing technologies, and more particularly, to an apparatus for inkjet printing and curing integration process.

BACKGROUND

[0003] Inkjet printing on surfaces of workpieces, such as the shell of the electronic equipment, is generally carried out one side at a time, that is, the ink is applied to one side of the workpiece and then cured, and the workpiece is turned over, for printing and then curing of the other side of the workpiece.

[0004] However, such inkjet printing and curing operation is discontinuous for different sides of the workpieces, which reduces the working efficiency.

SUMMARY

[0005] An objective of the present disclosure is achieved by providing an apparatus for inkjet printing and curing integration process for printing on a workpiece, which performs a continuous inkjet printing and curing process on more than one side of a workpiece and improves the working efficiency.

[0006] In order to achieve the purpose, technical solutions adopted by the present disclosure are as follows:

[0007] An aspect of the present disclosure provides an apparatus for inkjet printing and curing integration process for printing on a workpiece, the workpiece is shaped as a cube configured with a first surface, a second surface opposite to the first surface, and more than one side surfaces connected between the first surface and the second surface;

[0008] the apparatus for inkjet printing and curing integration process comprises:

[0009] a base,

[0010] a supporting module arranged on the base,

[0011] a printing module mounted on the supporting module, the printing module slides on the supporting module along a X axis, sprays ink along a Z axis on the second surface and the side surfaces of the workpiece, and cures the ink sprayed on the workpiece,

[0012] a rotary module positioned relative to the printing module, the rotary module is configured for rotating the workpiece to present more than one side of the workpiece to face the printing module between the second surface and the side surfaces; and

[0013] a transporting module arranged on the base, the transporting module moves along the X axis and a Y axis, the rotary module is connected to the transporting module for moving with it; wherein

[0014] each two of the X axis, the Y axis, and the Z axis are perpendicular to each other.

[0015] Preferably, the supporting module comprises

[0016] a frame mounted on the base;

[0017] a guider provided on the frame, the guider extends along the X axis; and

[0018] a first driver connected to the guider; wherein

[0019] the printing module is connected to the guider for being driven by the first driver to move along the guider.

[0020] Preferably, the printing module comprises

[0021] a second driver connected to the guider;

[0022] a printing element connected to the second driver, for spraying ink on the second surface and the side surface of the workpiece;

[0023] a curing device connected to the second driver, for curing the ink on the workpiece; wherein

[0024] the second driver drives the printing element and the curing device to move along the Z axis.

[0025] Preferably, the printing element comprises

[0026] a plurality of inkjet heads, each inkjet head is used for spraying ink of one color;

[0027] a plurality of control valves, each of the control valves is connected to one of the inkjet heads for controlling the spray time and the spray quantity of the connected inkjet head, to coat the second surface or the side surface with gradient.

[0028] Preferably, the apparatus for inkjet printing and curing integration process further comprises

[0029] a calibrator configured for acquiring image of the workpiece, the calibrator is electrically connected to the second driver and the first driver for actuating the second driver and the first driver according to the acquired image.

[0030] Preferably, the rotary module comprises

[0031] a supporting base;

[0032] a first rotating member arranged on the supporting base; and

[0033] a second rotating member configured for attaching the workpiece by vacuum-attraction of the first surface, wherein

[0034] the first rotating member is connected to the second rotating member for rotating the second rotating member and the workpiece thereon around the X axis, the second rotating member is configured for rotating the workpiece around the Y axis.

[0035] Preferably, the second rotating member comprises

[0036] a motor and a suction element connected to the motor, wherein

[0037] the suction element is connected to the motor for creating a vacuum for attaching and rotating the attached workpiece, the second rotating member is connected to the first rotating member through the motor.

[0038] Preferably, the transporting module comprises:

[0039] a third driver and a fourth driver arranged on the base, the supporting base is mounted on the third driver for being driven to move along the X axis, the third driver is arranged on the fourth driver for being driven to move along the Y axis.

[0040] Preferably, the apparatus further comprises

[0041] a shell configured for receiving the supporting module and the printing module, the shell is arranged on the base and is configured with an opening for passage of the workpiece.

[0042] Preferably, the apparatus for inkjet printing and curing integration process further comprises

[0043] a displayer arranged on the shell, the displayer is connected to the printing module the rotary module, and the transporting module for displaying processing information of the workpiece; and

[0044] a signal light connected to the printing module, the rotary module, and the transporting module for indicating processing phase of the workpiece.

[0045] In operation, the transporting module moves the workpiece to be under the printing module for being printed and cured on one side, then the rotary module rotates the workpiece such that the side facing the printing module is switched and the printing module can operate on another side of the workpiece. Thereby, the printing module can perform a continuous inkjet printing and curing process on more than one side of a workpiece, and the working efficiency is improved.

[0046] Preferably, the apparatus for inkjet printing and curing integration process can be used for printing on magnesium alloys, such as wrought magnesium alloys, die casting magnesium alloys, and magnesium alloys made from other methods.

[0047] It should be noted that, the apparatus can be used for performing inkjet printing and curing integration process on other materials than magnesium alloy, such as aluminum alloys, glasses, or any other material suitable for shells of electronical devices.

BRIEF DESCRIPTION OF THE DRAWINGS

[0048] Implementations of the present technology will now be described, by way of example only, with reference to the attached figures.

[0049] FIG. **1** is a schematic view of an example workpiece according to an embodiment of the present disclosure.

[0050] FIG. **2** is a schematic view of the workpiece and an apparatus for inkjet printing and curing process according to an embodiment of the present disclosure.

[0051] FIG. **3** is a schematic view of a rotatory module, a transporting module, and the workpiece according to an embodiment of the present disclosure.

[0052] FIG. **4** is a schematic view of a workpiece and an apparatus for inkjet printing and curing process according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0053] It will be appreciated that for simplicity and clarity of illustration, where appropriate, reference numerals have been repeated among the different figures to indicate corresponding or analogous components. The description is not to be considered as limiting the scope of the embodiments described herein. The drawings are not necessarily to scale and the proportions of certain parts may be exaggerated to better illustrate details and features of the present disclosure.

[0054] It should be understood that, the terms "first" and "second" are used to distinguish elements and are not used to denote a particular order or imply a number of technical features, therefore, unless being specifically defined, features described as "first" and "second" may expressly or implicitly include one or more of the stated features. In the description of the present application, "plurality" means two or more, unless otherwise expressly and specifically defined.

[0055] In addition, numerous specific details are set forth in order to provide a thorough understanding of the embodiments described herein. However, it will be understood by those of ordinary skill in the art that the embodiments described herein can be practiced without these specific details. In other instances, methods, procedures, and components have not been described in detail so as not to obscure the related relevant feature being described.

[0056] The term "comprising," when utilized, means "including, but not necessarily limited to"; it specifically indicates open-ended inclusion or membership in the so-described combination, group, series, and the like.

[0057] In order to achieve the purpose, an apparatus for inkjet printing and curing integration process is provided, the apparatus comprises a base, a supporting module, a printing module, a rotary module, and a transporting module, the workpiece is shaped as a cube configured with a first surface, a second surface opposite to the first surface, and side surfaces connecting the first surface and the second surface, the transporting module moves the workpiece to be under the printing module for being printed and cured on one side, then the rotary module rotates the workpiece such that a different side is presented for inkjet printing and curing. Thereby, the printing module can perform a continuous inkjet printing and curing process on more than one side of a workpiece, and the working efficiency is improved. In operation, the workpiece can be a shell or housing of a mobile phone, a pad, a notebook or any other electronic device, the ink supplied to the printer is tinted and can be cured by UV

[0058] A detailed description of the hereinafter described embodiments of the disclosure are presented herein by way of exemplification and not limitation with reference to the Figures.

[0059] Referring to FIG. **1**, a workpiece **20** is shown, the workpiece **20** is made of die casting magnesium alloy and substantially cube shaped, and is configured with a first surface **21**, a second surface **22** opposite to the first surface **21**, and four side surfaces **23** connected between the first surface **21** and the second surface **22**. It should be noted that, the workpiece **20** can be arranged with more or less than four side surfaces.

[0060] Referring to FIG. **2**, an apparatus for inkjet printing and curing integration process **10** is provided, the apparatus **10** comprises a base **11**, a supporting module **12**, a printing module **13**, a rotary module **14**, and a transporting module **15**, wherein the supporting module **12** is supported on the base **11**, the printing module **13** is mounted on the supporting module **12** and slides on the supporting module **12** along a first direction, for spraying inks in a second direction on the second surface **22** and the side surface **23** of the workpiece **20** and curing the ink printed on the workpiece **20**, the rotary module **14** is positioned relative to the printing module **13** and is configured for supporting the workpiece **20** by the first surface **21**. In particular, the printing module **13** is positioned above the rotary module **14**. The rotary module **14** is configured for rotating the workpiece **20**, therefore the side of the workpiece **20** facing the printing module **13** switches between the second surface **22** and the side surfaces **23**. The transporting module **15** is arranged on the base **11** and moves in the first direction and a third direction, the rotary module **14** is connected to the transporting module **15** for moving with it, wherein each two of the first

direction, the second direction, and the third direction are perpendicular to each other.

[0061] It should be noted that, the term "first direction" means the extension direction of the guide rail **1231**, that is the direction of the X axis shown in FIG. **2**, the term "second direction" means direction of the Z axis shown in FIG. **2**, and the term "third direction" means the extension direction of the second rail **1521**, that is direction of the Y axis shown in FIG. **2**.

[0062] In operation, the transporting module **15** moves the workpiece **20** into spray range of the printing module **13**, then the printing module **13** sprays ink on the second surface **22** or the side surface **23** of the workpiece **20** and cures the ink printed on the workpiece **20**, then the rotary module **14** rotates the workpiece **20** such that the side of the workpiece **20** facing the printing module **13** can be switched between the second surface **22** and the side surface **23**, therefore, the inkjet printing and curing process performed on the workpiece **20** by the printing module **13** is continuous, the workpiece **20** can be processed continuously on more than one sides.

[0063] It should be noted that the apparatus **10** can be arranged with one or more of the printing module **13**, rotary module **14**, and transporting module **15**. The apparatus **10** illustrated in FIG. **2** is arranged with two printing modules **13**, two rotary modules **14**, and two transporting modules **15** to perform inkjet printing and curing process on two workpieces **20** synchronously.

[0064] According to a further embodiment, the supporting module **12** comprises a frame **121**, a first driver **122**, and a guider **123**, wherein the frame **121** is mounted on the base **11**, the first driver **122** is connected to the guider **123**, the guider **123** extends along the X axis and is provided on the frame **121**, the printing module **13** is connected to the guider **123** for being driven by the first driver **122** to move along the guider **123**.

[0065] According to a further embodiment, the guider **123** comprises a guide rail **1231** and a slider **1232**, wherein the guide rail **1231** is mounted on the frame **121** and extends along the X axis the slider **1232** is driven by the first driver **122** to slide along the guide rail **1231** for moving the printing module **13** along the X axis.

[0066] Referring to FIG. **2**, according to a further embodiment, the printing module **13** comprises a second driver **131**, a printing element **132**, and a curing device **133**, wherein the printing element **132** is connected to the guider **123** through the second driver **131** for being driven to move along the Z axis and to spray ink on the second surface **22** and the side surface **23** of the workpiece **20**, the curing device **133** is connected to the second driver **131** for being driven to move along the Z axis and to cure the ink on the workpiece **20**. Therefore, the distance between the workpiece **20** and the printing element **132**/curing device **133** along the Z axis can be regulated by the second driver **131**.

[0067] According to a further embodiment, the printing element **132** comprises a control valve **1322** and a plurality of inkjet heads **1321** connected to the control valve **1322**, each inkjet head **1321** is used for spraying inks of one color, the second surface **22** and the side surface **23** can be coated with gradient by controlling the spray time and the spray quantity of each inkjet head **1321** through the control valve **1322**.

[0068] In this embodiment, the inkjet heads **1321** are mounted on the curing device **133** for being driven by the second driver **131**, the control valve **1322** is arranged on the second driver **131** for controlling the inkjet heads **1321** by electrical connection.

[0069] According to a further embodiment, the plurality of inkjet heads **1321** are connected directly to inks with different colors. In operation, driven by the second driver **131**, the inkjet head **1321** connected to ink of a first color sprays on the second surface **22** or the side surface **23** to form a foundation or primer, then the inkjet head **1321** connected to ink of a second color sprays on the foundation to form a tint or gradient of colors.

[0070] According to a further embodiment, the curing device **133** is a UV-emitting light, the light emitted travels along the Y axis for curing the ink on the workpiece **20**.

[0071] Referring to FIG. **2**, according to the embodiment, the apparatus **10** further comprises a calibrator **16** configured for acquiring image of the workpiece **20**, the calibrator **16** is arranged on the second driver **131** and is electrically connected to the second driver **131** and the first driver **122**, therefore, the second driver **131** and the first driver **122** can actuated by the calibrator **16** based on the acquired image.

[0072] According to a further embodiment, the calibrator **16** is configured as an image capturing element with primary image processing function, for example, the calibrator **16** compares the captured image with pre-stored standard image of corresponding position, then the calibrator **16** is moved by the second driver **13** and the first driver **122** along the X axis and the Z axis, respectively, to an appropriate image capturing position.

[0073] It should be understood that, the calibrator **16** can be any element with primary image processing function.

[0074] Referring to FIG. **3**, according to a further embodiment, the rotary module **14** comprises a supporting base **141**, a first rotating member **142** arranged on the supporting base **141**, and a second rotating member **143** connected to the first rotating member **142**, wherein the second rotating member **143** is configured for attaching the workpiece **20** by applying suction against the first surface **21** and rotating the workpiece **20** around the Y axis, the first rotating member **142** is configured for rotating the second rotating member **143** and the workpiece **20** thereon around the X axis.

[0075] According to a further embodiment, the second rotating member **143** comprises a motor **1431** and a suction element **1432** arranged on the motor **1431**, wherein the suction element **1432** is connected to the motor **1431** for being driven to attach and rotate the attached workpiece **20** by suction force, the second rotating member **143** is connected to the first rotating member **142** through the motor **1431**.

[0076] According to a further embodiment, the suction element **1432** is configured as a vacuum suction element, the first rotating member **142** and the motor **1431** are both servo motors.

[0077] According to a further embodiment, the transporting module **15** comprises a third driver **151** and a fourth driver **152** arranged on the base **11**, wherein the supporting base **141** is mounted on the third driver **151** for being driven to move along the X axis, the third driver **151** is arranged on the fourth driver **152** for being driven to move along the Y axis.

[0078] According to a further embodiment, the third driver **151** is configured with a first rail **1511**, the supporting base **141** is mounted on the third driver **151** through the first rail **1511**, the fourth driver **152** is configured with a second

rail **1521**, the third driver **151** is arranged on the fourth driver **152** through the second rail **1521**.

[0079] According to a further embodiment, the third driver **151** and the fourth driver **152** are both servo motors.

[0080] It should be noted that, the calibrator **16** can be connected to all of the second driver **131**, the first driver **122**, the first rotating member **142**, the motor **1431**, and the fourth driver **152**, for being moved along the X axis, the s Z axis, and the Y axis.

[0081] Referring to FIG. **4**, according to a further embodiment, the apparatus **10** comprises a shell **17** arranged on the base **11**, the supporting module **12** and the printing module **13** are received in the shell **17**, the shell **17** is configured with an opening **171** for passage of the workpiece **20**.

[0082] According to a further embodiment, the shell **17** is configured with a cavity for receiving the supporting module **12** and the printing module **13**, therefore the inkjet printing and curing operations are performed in the cavity to avoid escape of or contamination by the ink from the printing module **13**.

[0083] According to a further embodiment, the apparatus **10** comprises a displayer **18** arranged on the shell and a signal light **19**, the displayer **18** is connected to the printing module **13**, the rotary module **14**, and the transporting module **15** for displaying processing information of the workpiece **20**, the signal light **19** is connected to the printing module **13**, the rotary module **14**, and the transporting module **15** for indicating processing phase of the workpiece **20**.

[0084] According to a further embodiment, the processing information of the workpiece **20** comprises at least one of the spray time, incline angle, the spraying position of the inkjet head, and any other data relevant to the inkjet printing and curing processes.

[0085] According to a further embodiment, the processing phase of the workpiece **20** comprises phase of processing, phase of waiting, and phase of completion, the signal light **19** comprises a 3-colored LED lights: red, yellow, and green. In operation, when the workpiece **20** is in the phase of under process, the signal light **19** is red, when the workpiece **20** is in the phase of waiting, the signal light **19** is yellow, when the workpiece **20** is in the phase of being completed, the signal light **19** is green. Therefore, the signal light **19** indicates processing phase of the workpiece **20**.

[0086] According to a further embodiment, the displayer **18** is a touch screen, which facilitates operation of workers.

[0087] Referring to FIGS. **1-4**, the process of the operation of the apparatus **10** is as follows:

[0088] Firstly, the workpiece **20** is attached to the suction element **1432** via the first surface **21**, for being rotated by the first rotating member **142** and the motor **1431** such that the second surface **22** face upwards, then the workpiece **20** is moved by the third driver **151** and the fourth driver **152** through the opening **171** to be under the inkjet head **1321** of the printing element **132**, and the calibrator **16** regulates the position of the workpiece **20**.

[0089] Secondly, the control valve **1322** actuates the inkjet head **1321** and the curing device **133** to spray inks to the second surface **22** according to a pre-designed pattern and emits UV light to the ink on the second surface **22** for curing. After the ink is cured, the workpiece **20** is rotated by 90° around the X axis by the first rotating member **142** and the motor **1431**, such that one of the side surfaces **23** of the workpiece **20** faces the inkjet head **1321** for being sprayed and cured. After that, the workpiece **20** is rotated back to its original orientation and further rotated by 90° around the X axis, such that another side surface **23** of the workpiece **20** faces the inkjet head **1321** for being sprayed and cured.

[0090] At last, similarly, the workpiece **20** is rotated around the Y axis by the motor **1431** and sprayed and cured, such that remaining two side surfaces **23** of the workpiece **20** can be sprayed and cured.

[0091] It should be noted that, during the printing process mentioned above, the spraying orders and spraying time of each inkjet head is controlled by the control valve **1322** to form gradient on the second surface **22** and the side surfaces **23**.

[0092] It should be noted that, in further embodiments, the workpiece **20** can be made of other materials, such as wrought magnesium alloy, casting magnesium alloy, aluminum alloys, glasses, or any other material suitable for shells of electronic devices.

[0093] While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily understood for the skilled in the art that the invention is not limited to such disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alterations, substitutions, or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the invention. Additionally, while various embodiments of the invention have been described, it is to be understood that aspects of the invention may include only some of the described embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description, but is only limited by the scope of the appended claims.

What is claimed is:

1. An apparatus for inkjet printing and curing integration process, which performs a continuous inkjet printing and curing process on more than one side of a workpiece, wherein

the workpiece shaped as a cube configured with a first surface, a second surface opposite to the first surface, and more than one side surfaces connected between the first surface and the second surface;

the apparatus comprises:

a base,

a supporting module arranged on the base,

a printing module mounted on the supporting module, the printing module slides on the supporting module along a X axis, sprays ink along a Z axis on the second surface and the side surfaces of the workpiece, and cures the ink sprayed on the workpiece,

a rotary module positioned relative to the printing module, the rotary module is configured for rotating the workpiece to present more than one side of the workpiece to face the printing module between the second surface and the side surfaces; and

a transporting module arranged on the base, the transporting module moves along the X axis and a Y axis, the rotary module is connected to the transporting module for moving with it; wherein

each two of the X axis, the Y axis and the Z axis are perpendicular to each other.

2. The apparatus for inkjet printing and curing integration process of claim **1**, wherein the supporting module comprises

a frame mounted on the base;

a guider provided on the frame, the guider extends along the X axis; and

a first driver connected to the guider; wherein

the printing module is connected to the guider for being driven by the first driver to move along the guider.

3. The apparatus for inkjet printing and curing integration process of claim **2**, wherein the printing module comprises

a second driver connected to the guider;

a printing element connected to the second driver, for being driven to spray ink on the second surface and the side surface of the workpiece;

a curing device connected to the second driver, for curing the ink on the workpiece; wherein

the second driver drives the printing element and the curing device to move along the Z axis.

4. The apparatus for inkjet printing and curing integration process of claim **3**, wherein the printing element comprises

a plurality of inkjet heads, each inkjet head is used for spraying inks of one color;

a plurality of control valves, each of the control valves is connected to one of the inkjet heads for controlling the spray time and the spray quantity of the connected inkjet head, to coat the second surface or the side surface with gradient.

5. The apparatus for inkjet printing and curing integration process of claim **3**, further comprises

a calibrator configured for acquiring image of the workpiece, the calibrator is electrically connected to the second driver and the first driver for actuating the second driver and the first driver according to the acquired image.

6. The apparatus for inkjet printing and curing integration process of claim **1**, wherein the rotary module comprises

a supporting base;

a first rotating member arranged on the supporting base; and

a second rotating member configured for attaching the workpiece by the vacuumattraction of the first surface, wherein

the first rotating member is connected to the second rotating member for rotating the second rotating member and the workpiece thereon around the X axis, the second rotating member is configured for rotating the workpiece around the Y axis.

7. The apparatus for inkjet printing and curing integration process of claim **6**, wherein the second rotating member comprises

a motor and a suction element connected to the motor, wherein

the suction element is connected to the motor for creating a vacuum for attaching and rotating the attached workpiece, the second rotating member is connected to the first rotating member through the motor.

8. The apparatus for inkjet printing and curing integration process of claim **1**, wherein the transporting module comprises

a third driver and a fourth driver arranged on the base, the supporting base is mounted on the third driver for being driven to move along the X axis, the third driver is arranged on the fourth driver for being driven to move along the Y axis.

9. The apparatus for inkjet printing and curing integration process of claim **1**, further comprises

a shell configured for receiving the supporting module and the printing module, the shell is arranged on the base and is configured with an opening for passage of the workpiece.

10. The apparatus for inkjet printing and curing integration process of claim **9**, further comprises

a displayer arranged on the shell, the displayer is connected to the printing module, the rotary module, and the transporting module for displaying processing information of the workpiece; and

a signal light connected to the printing module, the rotary module, and the transporting module for indicating processing phase of the workpiece.

11. The apparatus for inkjet printing and curing integration process of claim **1**, wherein the apparatus can be used for printing on magnesium alloys, aluminum alloys, glasses, and other materials suitable for shells of electronical devices.

* * * * *