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AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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(54) Title: ASSEMBLING METHOD, MANUFACTURING METHOD, DEVICE AND ELECTRONIC APPARATUS OF FLIP-DIE

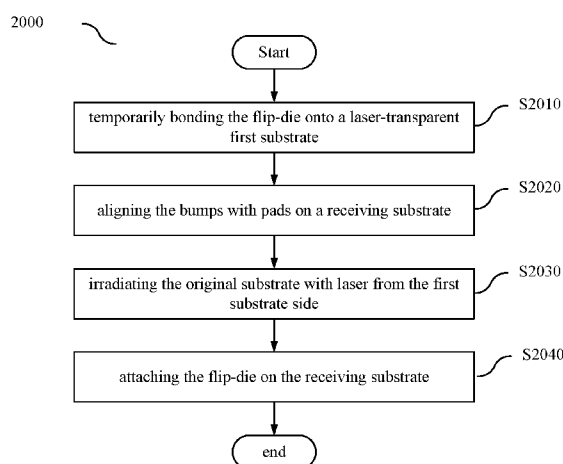


FIG. 2

(57) Abstract: An assembling method, a manufacturing method, a device and an electronic apparatus of flip-die are disclosed. The method for assembling a flip-die, comprises: temporarily bonding the flip-die (205) onto a laser-transparent first substrate (204), wherein bumps (202) of the flip-die (205) are located on the side of the flip-die (205) opposite to the first substrate (204); aligning the bumps (202) with pads (206) on a receiving substrate (207); irradiating the original substrate with laser (208) from the first substrate side to lift-off the flip-die (205) from the first substrate (204); and attaching the flip-die (205) on the receiving substrate (207). A faster assembly rate, a smaller chip size, and a lower profile can be achieved.

ASSEMBLING METHOD, MANUFACTURING METHOD, DEVICE AND ELECTRONIC APPARATUS OF FLIP-DIE

FIELD OF THE INVENTION

The present invention relates to the field of manufacturing electronics device, and more specifically, relates to a method for assembling a flip-die, a method for manufacturing a flip-die device, a flip-die device and an electronics apparatus containing the flip-die device.

BACKGROUND OF THE INVENTION

In the flip-chip assembly technique of the prior art, a pick-up head is used to assemble an un-encapsulated die onto a receiving substrate. For example, generally, in the electronics field, an un-encapsulated device that has already been completely formed can be referred to as “die”, and an encapsulated device can be referred to as “chip”. The un-encapsulated device can, for example, be a semiconductor device. For the clarity reason of description, in the context of this specification, the un-encapsulated flip device (un-encapsulated flip-chip) that has already been completely formed is referred as “flip-die”, and the encapsulated flip device can be referred to as “flip-chip”.

Figures 1A-1E show an example of assembling a die onto a receiving substrate by using a pick-up head.

As shown in Figure 1A, a die 102 is picked-up by a pick-up head 101. The die 102 is of a flip- structure, in which the bumps thereof are located on one side. As shown in Figure 1B, flux 104 is coated on the bumps 103 of the die 102. Then, as shown in Figure 1C, the die 102 is placed on the receiving substrate 105. As shown in Figure 1D, the bumps 102 are bonded onto the receiving substrate 105 through reflow. In Figure 1D, underfill 107 is dispensed at the bottom of the die 102 by using a dispenser 106. As shown in Figure 1E, the underfill 107 is cured, to finish the assembly of the die onto the receiving substrate.

The inventor of this invention has found that in the assembling method of the prior art, dies are picked-up and placed one by one. Thus, for a massive die array/matrix assembly (such as a micro-LED array for display), this approach is time-consuming. Generally, up to a few

thousands of units, such as 2,000 units, can be assembled per hour by using a pick-up head. This assembly rate can in turn cause a cost issue.

Furthermore, the inventor of this invention has also found that the size of processed die is limited due to the capability of the pick-up and placement approach. For example, the size of
5 dies that can be picked-up is equal to or larger than 150 μ m.

SUMMARY OF THE INVENTION

One object of this invention is to provide a new technical solution for assembling a flip-die.

According to an embodiment of the present invention, there is provided a method for
10 assembling a flip-die, comprising: temporarily bonding the flip-die onto a laser-transparent first substrate, wherein bumps of the flip-die are located on the side of the flip-die opposite to the first substrate; aligning the bumps with pads on a receiving substrate; irradiating the original substrate with laser from the first substrate side to lift-off the flip-die from the first substrate; and attaching the flip-die on the receiving substrate, for finishing the assembling.

15 Preferably, the method further comprises: forming a device wafer with bumps on one side. Preferably, the step of temporarily bonding the flip-die onto a laser-transparent first substrate further comprises: temporarily bonding the device wafer onto the first substrate on the other side of the flip-die; and singulating the device wafer into the flip-die.

Preferably, the method further comprises: testing the flip-die on the first substrate to
20 determine a known-good-device for lift-off.

Preferably, the step of aligning the bumps with pads on a receiving substrate further comprises: flipping over the first substrate.

Preferably, the step of singulating the device wafer is performed by laser scribing, mechanical blade sawing, or etching.

25 Preferably, the bumps are solder bumps, and the step of attaching the flip-die on the receiving substrate further comprises: attaching the flip-die on the receiving substrate by using flux.

Preferably, the step of attaching the flip-die on the receiving substrate further comprises: attaching the flip-die on the receiving substrate by means of the action of gravity.

Preferably, the step of attaching the flip-die on the receiving substrate further comprises: attaching the flip-die on the receiving substrate by means of the action of electrostatic force.

5 Preferably, the electrostatic force is applied by applying voltage to the pads.

Preferably, the flip-die contains magnetic substance, and the step of attaching the flip-die on the receiving substrate further comprises: attaching the flip-die on the receiving substrate by means of the action of electromagnetic force.

10 Preferably, the bumps are solder bumps, and the method further comprises: reflowing the solder bumps to bond the flip-die with the receiving substrate; and underfilling the bottom of the flip-die.

Preferably, the step of attaching the flip-die on the receiving substrate further comprises: attaching the flip-die on the receiving substrate through an anisotropic conductive layer. Preferably, the method further comprises: processing the anisotropic conductive layer to bond the
15 flip-die with the receiving substrate.

Preferably, the anisotropic conductive layer is at least one of an anisotropic conductive film, an anisotropic conductive paste and an anisotropic conductive tape.

Preferably, the flip-die is temporarily bonded on the first substrate through a temporary bonding layer, and the method further comprising: removing the temporary bonding layer.

20 According to another embodiment of the present invention, there is provided a method for manufacturing a flip-die device, comprising assembling a flip-die to a receiving substrate by using the method according to the present invention.

According to another embodiment of the present invention, there is provided a flip-die device, which is manufactured by using the method according to the present invention.

25 According to another embodiment of the present invention, there is provided an electronic apparatus, containing a flip-die device according to the present invention.

In addition, it should be understood by a person skilled in the art that, although a lot of problems exist in the prior art, the solution of each embodiment or each claim could just improve in one or several aspects, and it is not necessary for it to solve all the technical problems listed in

the Background of the Invention or in the prior art. It should be understood by a person skilled in the art that content which is not mentioned in a claim should not be regarded as a limitation to said claim.

Further features of the present invention and advantages thereof will become
5 apparent from the following detailed description of exemplary embodiments according to the present invention with reference to the attached drawings.

BRIEF DISCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention and, together with the description
10 thereof, serve to explain the principles of the invention.

Figures 1A-1E show an example of assembling a flip-die of prior art.

Figure 2 shows a flow chart of an illustrative embodiment of the method according to the present invention.

Figures 3A-3E show an example of assembling a flip-die according to the present
15 invention.

Figure 4 shows an example of assembling a flip-die according to the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Various exemplary embodiments of the present invention will now be described in
20 detail with reference to the drawings. It should be noted that the relative arrangement of the components and steps, the numerical expressions, and numerical values set forth in these embodiments do not limit the scope of the present invention unless it is specifically stated otherwise.

The following description of at least one exemplary embodiment is merely
25 illustrative in nature and is in no way intended to limit the invention, its application, or uses.

Techniques, methods and apparatus as known by one of ordinary skill in the relevant art may not be discussed in detail but are intended to be part of the specification

where appropriate.

In all of the examples illustrated and discussed herein, any specific values should be interpreted to be illustrative only and non-limiting. Thus, other examples of the exemplary embodiments could have different values.

5 Notice that similar reference numerals and letters refer to similar items in the following figures, and thus once an item is defined in one figure, it is possible that it need not be further discussed for following figures.

Embodiments and examples of the present invention will be described below with reference to the drawings.

10 Fig. 2 shows a flow chart of an illustrative embodiment of the method for assembling a flip-die according to the present invention.

As shown in Figure 2, at step S2010, the flip-die is temporarily bonded onto a laser-transparent first substrate. The bumps of the flip-die are located on the side of the flip-die opposite to the first substrate, for assembly onto a receiving substrate. The first substrate is a
15 sapphire substrate, for example.

For example, a device wafer with bumps on one side can be formed in advance. The device wafer is temporarily bonded onto the first substrate on the other side of the flip-die. The device wafer is singulated into the flip-die. For example, the singulation of the device wafer is performed by laser scribing, mechanical blade sawing, or etching.

20 In an example, the flip-die on the first substrate is tested to determine a known-good-device for lift-off. Since the flip-die can be tested on the first substrate rather than a receiving substrate, only a known-good-device can be selectively assembled to the receiving substrate by laser irradiation. In this aspect, the present invention is advantageous.

At step S2020, the bumps are aligned with pads on a receiving substrate.

25 For example, the first substrate can be flipped over to align the bumps of the flip-die with the pads.

At step S2030, the original substrate is irradiated with laser from the first substrate side to lift-off the flip-die from the first substrate.

Generally, the laser lift-off technology is used in forming a semiconductor device. The laser lift-off technology has not been used in the assembly of dies in the prior art. This is because it is generally deemed that the die forming and the die assembly are two different technologies. For example, in the forming of a die, after the process of lifting-off, other processes such as forming various layers, electrodes and so on thereon will further be performed on a semiconductor wafer. However, for example, for the die assembly, the die is generally a complete chip.

At step S2040, the flip-die is attached on the receiving substrate.

For example, in case that the bumps are solder bumps, the flip-die can be attached on the receiving substrate by using flux. In this case, the step S2040 can be performed before the step S2030.

For example, the flip-die can be attached on the receiving substrate by means of the action of gravity. For example, when the flip-die is lifted-off from the first substrate by using laser, the flip-die is dropped off or is left on the receiving substrate because of the action of gravity.

For example, the flip-die can be attached on the receiving substrate by means of the action of electrostatic force. For example, the electrostatic force can be applied by applying voltage to the pads.

For example, in case that the flip-die contains magnetic substance (for example, the bumps contain magnetic substance), the flip-die can be attached on the receiving substrate by means of the action of electromagnetic force. For example, a magnet can be provided on the bottom of the receiving substrate to provide a suitable electromagnetic field.

In this invention, in case that the bumps are solder bumps, the solder bumps can be reflowed to bond the flip-die with the receiving substrate, and underfilling the bottom of the flip-die.

For example, in this invention, the flip-die can be attached on the receiving substrate through an anisotropic conductive layer. Then, the anisotropic conductive layer is processed to bond the flip-die with the receiving substrate. For example, the anisotropic conductive layer can

be at least one of an anisotropic conductive film, an anisotropic conductive paste and an anisotropic conductive tape.

For example, the flip-die can be temporarily bonded on the first substrate through a temporary bonding layer. In this situation, the temporary bonding layer can be removed after the lift-off of the flip-die. However, it shall be understood by a person skilled in the art, the temporary bonding layer is not necessary in every situation. For example, the part that is temporarily bonded with the first substrate can be a part of the flip-die.

Obviously, according the description above, a person skilled in art shall understand that although the steps S2010, S2020, S2030 and S2040 are listed as the above sequence, the steps can be performed in a sequence that is different from it. For example, the flip-die can be attached on the receiving substrate (S2040) before the irradiation of the first substrate with laser (S2030). Furthermore, the flip-die can be bonded on the receiving substrate before the irradiation of the first substrate with laser (S2030).

In another embodiment, the present invention further includes a method for manufacturing a flip-die device. The manufacturing method comprises assembling a flip-die to a receiving substrate by using the method according to the present invention, to form a flip-die device. For example, the receiving substrate is a display screen panel or a display substrate. For example, the flip-die device is a display apparatus.

In another embodiment, the present invention further includes a flip-die device, such as a display screen device or an encapsulated chip. The flip-die device can be manufactured by using the method for manufacturing a flip-die device according to the present invention. A die with smaller size than that of the prior art can be contained in the flip-die device according to the present invention.

In another embodiment, the present invention further includes an electronic apparatus. The electronic apparatus contains a flip-die device according to the present invention. For example, the electronic apparatus can be a mobile phone, a pad computer, a television, a printer and so on.

In the solution of the present invention, compared with the prior art of using a pick-up head, the solution of the present invention can assemble a device of relatively small

size. For example, a flip-die smaller than 150 μ m (for example, 10 μ m) can be assembled. That is, a smaller chip size can be achieved by using the present invention.

Alternatively, compared with the device assembled by the prior art approach, the flip-die assembled by using the present invention can be much thinner. That is, a lower
5 profile can be achieved by using the present invention.

Alternatively, an assemble rate of 200,000 units per hour can be achieved by using the present invention. Therefore, compared with the prior art of using a pick-up head, the assemble rate of the present invention is faster and thus the cost thereof is lower.

The inventor of the present invention has found that the laser lift-off has not been
10 used in the die assembly in the prior art. Furthermore, a person skilled in the art has not conceived the technical effect brought out by such a technology. In another word, there is no stimulation for a person skilled in the art to make such an improve in this aspect.

An example for assembling a flip-die according to the present invention will be described below with reference to Figs. 3A to 3E.

15 As shown in Figure 3A, a device wafer 201 is temporarily bonded with a laser-transparent first substrate 204 such as a sapphire substrate through a temporary bonding layer 203. The device wafer 201 has bumps 202 on the side opposite to the first substrate.

As shown in Figure 3B, for example, the device wafer 201 is singulated into
20 flip-dies 205 by laser scribing, mechanical blade sawing, or etching such as wet etching or dry etching.

The flip-die 205 on the first substrate can be tested to determine known-good-devices, for assembly onto a receiving substrate.

As shown in Figure 3C, the first substrate 204 is flipped over. Then, the bumps 202
25 are aligned with the pads 206 on the receiving substrate 207. The flip-die 205 is selectively irradiated with laser 208, to lift-off the flip-die 205.

In this example, the flip-die 205 can be attached onto the receiving substrate 207 before the irradiation of laser. The flip-die 205 can further be bonded onto the receiving substrate 207 before the irradiation of laser.

As shown in 3D, the first substrate 204 is lifted up, leaving the flip-die on the receiving substrate 207.

In case that the bumps are solder bumps, the flip-die 205 can be bonded with the receiving substrate 207 through reflow.

5 As shown in 3E, the bottom of the flip-die 205 is filled with underfill 209. Then, the underfill 209 is cured.

Another example for assembling a flip-die according to the present invention will be described below with reference to Figure 4.

10 In the example of Figure 4, the flip-die 205 are bonded with the receiving substrate 207 through an anisotropic conductive layer. The steps similar with those in Figures 3A-3E are omitted in Figure 4.

Although some specific embodiments of the present invention have been demonstrated in detail with examples, it should be understood by a person skilled in the art that the above examples are only intended to be illustrative but not to limit the scope of the present invention. It should be understood by a person skilled in the art that the above
15 embodiments can be modified without departing from the scope and spirit of the present invention. The scope of the present invention is defined by the attached claims.

CLAIMS

What is claimed is:

1. A method for assembling a flip-die, comprising:

temporarily bonding the flip-die onto a laser-transparent first substrate, wherein bumps

5 of the flip-die are located on the side of the flip-die opposite to the first substrate;

aligning the bumps with pads on a receiving substrate;

irradiating the original substrate with laser from the first substrate side to lift-off the
flip-die from the first substrate; and

attaching the flip-die on the receiving substrate for finishing the assembling.

10

2. The method according to claim 1, further comprising:

forming a device wafer with bumps on one side;

wherein the step of temporarily bonding the flip-die onto a laser-transparent first
substrate further comprises:

15 temporarily bonding the device wafer onto the first substrate on the other side of the
flip-die; and

singulating the device wafer into the flip-die.

3. The method according to claim 1 or claim 2, further comprising:

20 testing the flip-die on the first substrate to determine a known-good-device for lift-off.

4. The method according to claim 1 or claim 2, wherein the step of aligning the bumps
with pads on a receiving substrate further comprises: flipping over the first substrate.

25 5. The method according to claim 2, wherein the step of singulating the device wafer is
performed by laser scribing, mechanical blade sawing, or etching.

6. The method according to claim 1, wherein the bumps are solder bumps, and the step of attaching the flip-die on the receiving substrate further comprises:

attaching the flip-die on the receiving substrate by using flux.

5 7. The method according to claim 1, wherein the step of attaching the flip-die on the receiving substrate further comprises: attaching the flip-die on the receiving substrate by means of the action of gravity.

10 8. The method according to claim 1, wherein the step of attaching the flip-die on the receiving substrate further comprises: attaching the flip-die on the receiving substrate by means of the action of electrostatic force.

 9. The method according to claim 8, wherein the electrostatic force is applied by applying voltage to the pads.

15

 10. The method according to claim 1, wherein the flip-die contains magnetic substance, and the step of attaching the flip-die on the receiving substrate further comprises: attaching the flip-die on the receiving substrate by means of the action of electromagnetic force.

20 11. The method according to claim 1, wherein the bumps are solder bumps, and the method further comprises:

reflowing the solder bumps to bond the flip-die with the receiving substrate; and
underfilling the bottom of the flip-die.

25 12. The method according to claim 1, wherein the step of attaching the flip-die on the receiving substrate further comprises: attaching the flip-die on the receiving substrate through an anisotropic conductive layer;

Wherein the method further comprises: processing the anisotropic conductive layer to bond the flip-die with the receiving substrate.

13. The method according to claim 12, wherein the anisotropic conductive layer is at least one of an anisotropic conductive film, an anisotropic conductive paste and an anisotropic conductive tape.

5

14. The method according to claim 1, wherein the flip-die is temporarily bonded on the first substrate through a temporary bonding layer, and the method further comprising: removing the temporary bonding layer.

10

15. A method for manufacturing a flip-die device, comprising assembling a flip-die to a receiving substrate by using the method according to claim 1.

16. A flip-die device, which is manufactured by using the method according to claim 15.

15

17. An electronic apparatus, containing a flip-die device according to claim 16.

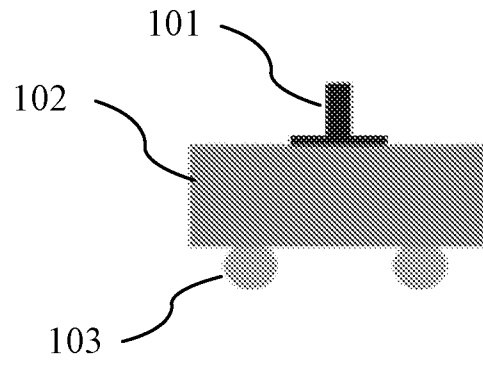


FIG. 1A

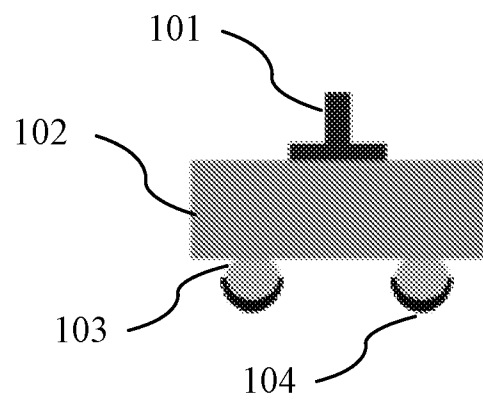


FIG. 1B

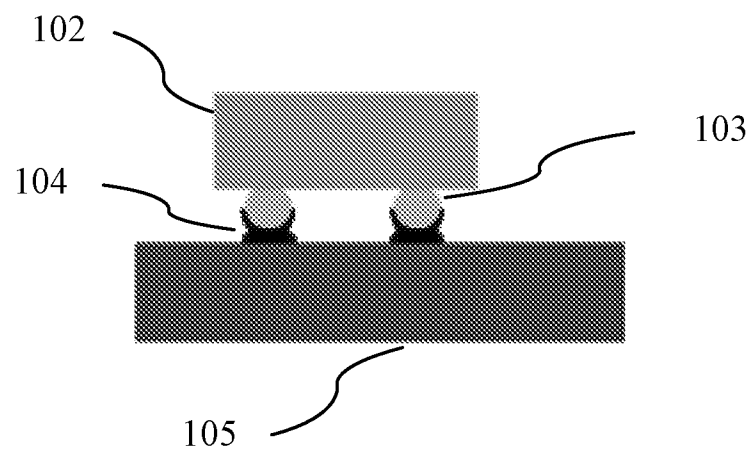
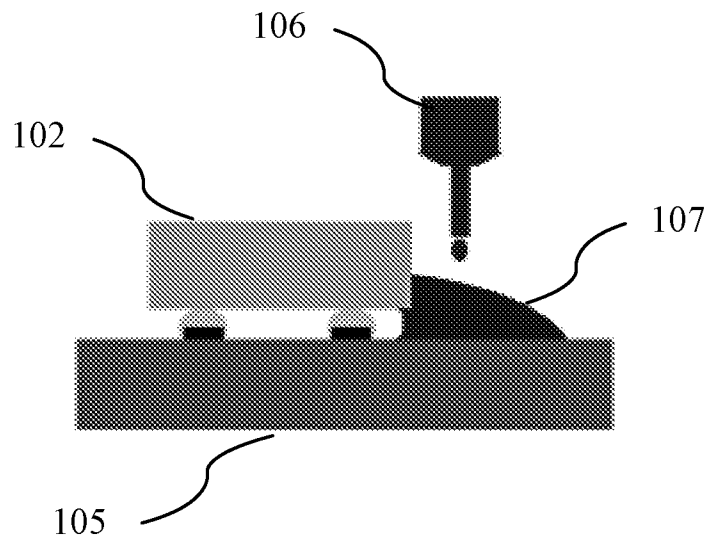
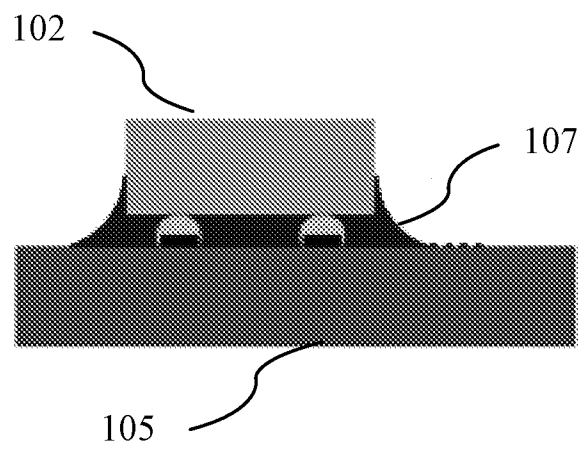
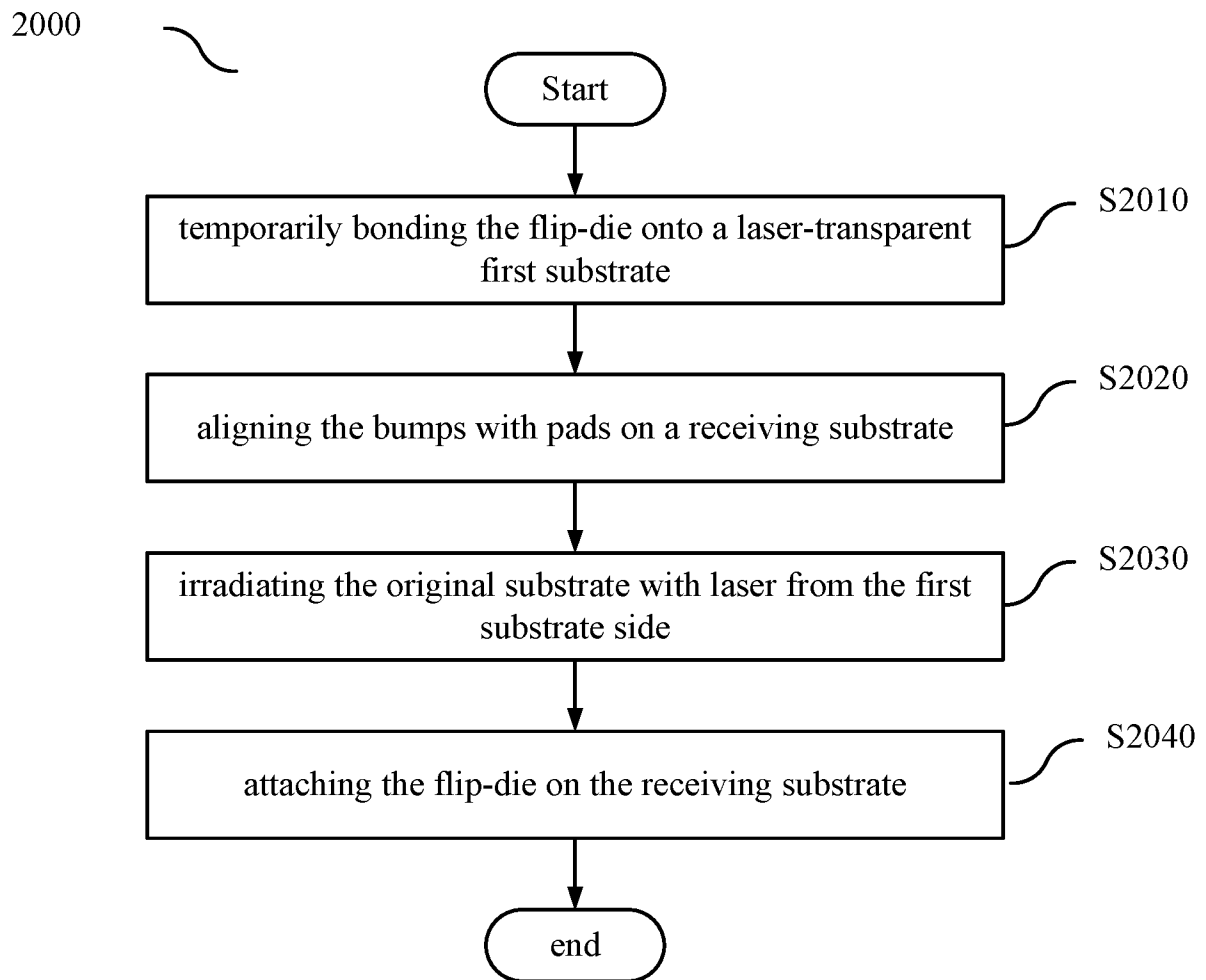
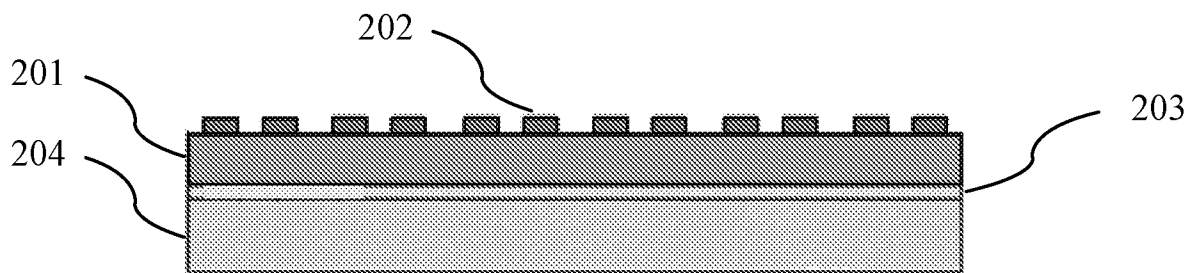


FIG. 1C

**FIG. 1D****FIG. 1E**

**FIG. 2****FIG. 3A**

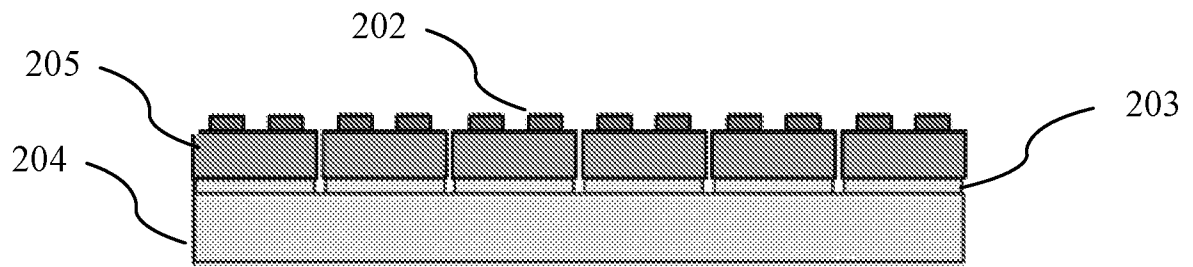


FIG. 3B

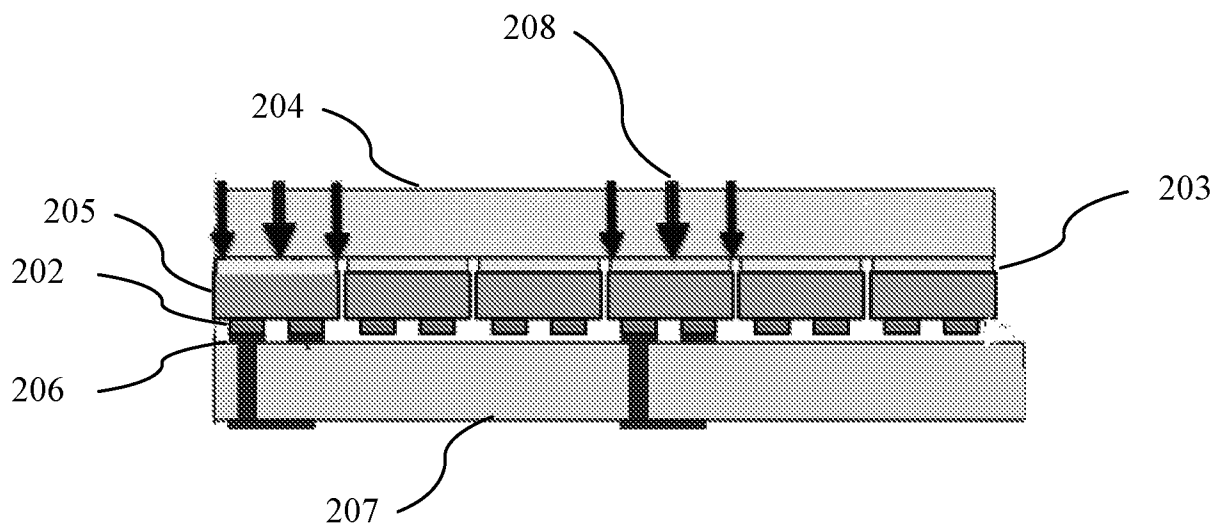


FIG. 3C

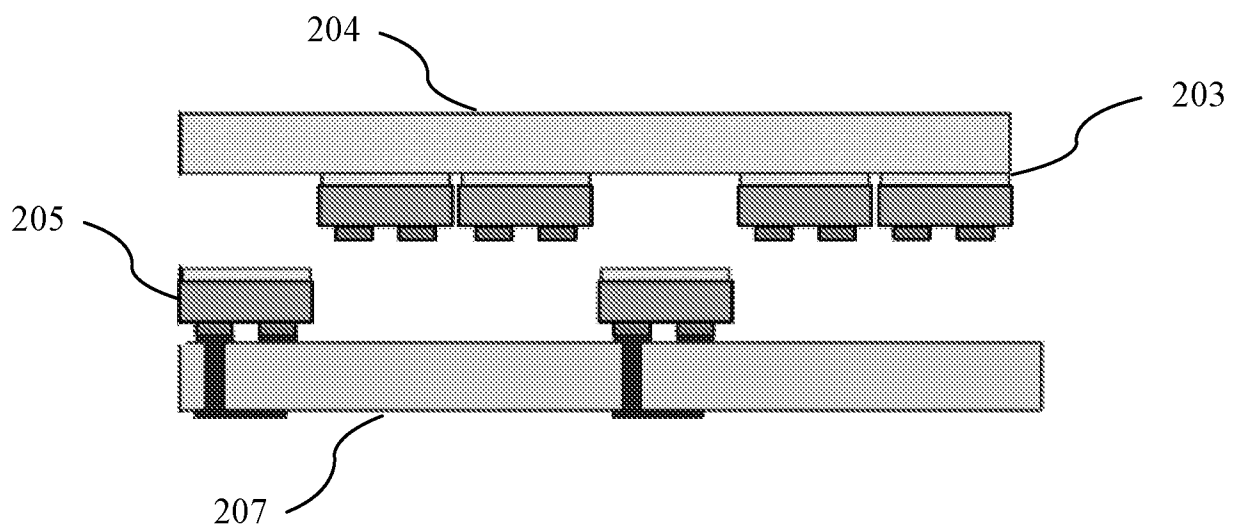


FIG. 3D

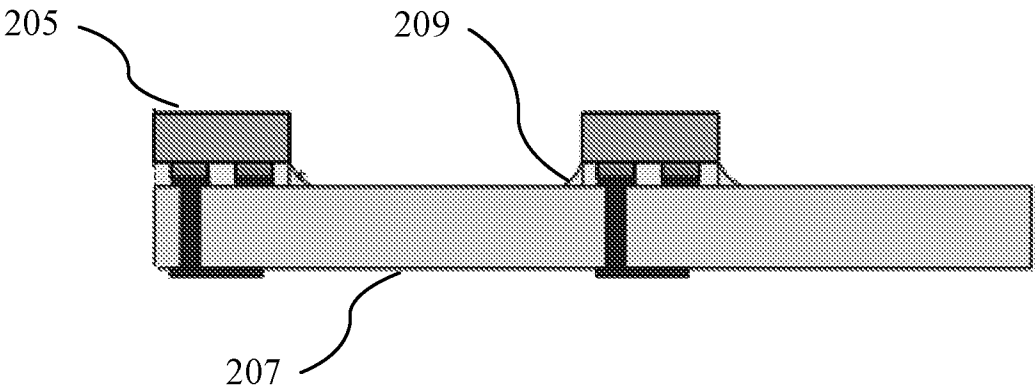


FIG. 3E

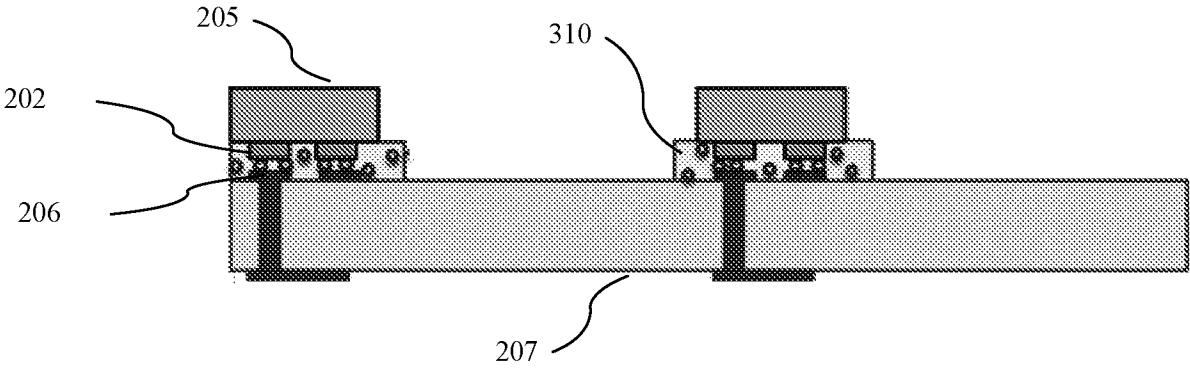


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2015/083983

A. CLASSIFICATION OF SUBJECT MATTER

H01L 21/50(2006.01)i

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)

H01L

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)

CNPAT,WPI,EPODOC,CNKI,GOOGLE:flip,temporary,laser,peel,remove,lift-off

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 101996892 A (EPISTAR CORP.) 30 March 2011 (2011-03-30) description, paragraphs [0048]-[0056] and [0079]-[0084], figures 23A-23E	1-17
A	CN 1564331 A (UNIV. TSINGHUA) 12 January 2005 (2005-01-12) the whole document	1-17
A	CN 101114683 A (EVERLIGHT ELECTRONICS CO., LTD.) 30 January 2008 (2008-01-30) the whole document	1-17
A	CN 103647012 A (INST. SEMICONDUCTORS CHINESE ACAD. SCI.) 19 March 2014 (2014-03-19) the whole document	1-17
A	US 2002173077 A1 (HO, TZONG DA ET AL.) 21 November 2002 (2002-11-21) the whole document	1-17

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

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“P” document published prior to the international filing date but later than the priority date claimed

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Date of the actual completion of the international search

17 September 2015

Date of mailing of the international search report

24 September 2015

Name and mailing address of the ISA/CN

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2015/083983

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
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				CN	103199023	A	10 July 2013
CN	1564331	A	12 January 2005	CN	100386890	C	07 May 2008
CN	101114683	A	30 January 2008	CN	100530720	C	19 August 2009
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