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- (54) TRANSFERRING METHOD OF MICRO-LED, AND MANUFACTURING METHOD OF MICRO-LED DEVICE

TRANSFERRINGVERFAHREN VON MIKRO-LED UND HERSTELLUNGSVERFAHREN EINER MIKRO-LED-VORRICHTUNG

PROCÉDÉ DE TRANSFERT DE MICRO-DEL, ET PROCÉDÉ DE FABRICATION D'UN DISPOSITIF À MICRO-DEL

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#### Description

#### FIELD OF THE INVENTION

**[0001]** The present disclosure relates to Micro-Light Emitting Diode (micro LED) array for display, and in particular, the present invention relates to to a method for transferring micro-LED, and a method for manufacturing a micro-LED device.

#### **BACKGROUND OF THE INVENTION**

**[0002]** The micro-LED technology refers to the LED array of small size integrated on a substrate with high density. Currently, the micro-LED technology is starting development, and it is expected in the industry that a high-quality micro-LED product comes into the market. High-quality micro-LED will have a deep affection on the conventional display products such as LCD/OLED that have already been put into the market.

[0003] In the process of manufacturing micro-LEDs, micro-LEDs are first formed on a donor wafer, and then the micro-LEDs are transferred to a receiving substrate. The receiving substrate is a display screen, for example. [0004] One difficulty during manufacturing a micro-LED lies in how to transfer a micro-LED from a donor wafer to a receiving substrate. In the prior art, the transfer is generally performed by means of electrostatic pick-up. A transfer head array will be needed during the electrostatic pick-up. The structure of the transfer head array is relatively complicated, and the stability thereof shall be considered. An extra cost shall be paid for manufacturing a transfer head array. A phase change shall be made before pick-up with the transfer head array. In addition, during manufacturing with a transfer head array, limitations apply to the thermo budget of a micro-LED for phase change, which is generally lower than 350°C, or more specifically, lower than 200°C; otherwise, the performance of the micro-LED will be degraded. It generally requires two transfers during the manufacturing with transfer head array, i.e., the transfer from a donor wafer to a carrier wafer and the transfer from the carrier wafer to a receiving substrate.

**[0005]** US patent No. 8,333,860B1 discloses an array of transfer heads for transferring micro devices, in which a voltage is applied to the electrode in the transfer head to pick-up a micro device.

**[0006]** US patent No. 8,426,227B1 discloses a method of forming a micro light emitting diode array, in which a micro-LED array is transferred to a receiving substrate by using a transfer head array.

**[0007]** US application No. 20080023435A1 discloses a method for self-assembling a plurality of microstructures onto a substrate, The microstructures are selfaligned with the substrate, and further permanently fixed on and electrical connection with the substrate by the solder bumps between the microstructures and the substrate, which is formed by the solder bumps via reflow process. There is no need for the using of the conventional pick-and-place device in the present method. A laser beam is directly projected through a transparent substrate so that the material in the contact region inbetween the transparent substrate and the microstructures is cleaved into gas and metal.

**[0008]** US application No. 20110151602A1 discloses a method of manufacturing a transferable element, the method comprising the steps of: providing a host sub-

- <sup>10</sup> strate of a material exhibiting optical transparency; forming an epitaxial layer on said host substrate including a layer allowing for radiation lift off; defining one or more semiconductor die in said epitaxial layer; adhering a transfer device to one or more of said semiconductor die;
- <sup>15</sup> irradiating said radiation lift off layer to weaken the layer; and moving said transfer device and said substrate apart; thereby transferring said one or more semiconductor die from said host substrate to said transfer device.

#### 20 SUMMARY OF THE INVENTION

**[0009]** One object of this invention is to provide a new technical solution for transferring a micro-LED.

- [0010] According to an embodiment of the present in vention, there is provided a method for transferring micro LEDs according to claim 1, comprising: forming micro LEDs on a laser-transparent original substrate, wherein the micro-LEDs are lateral micro-LEDs whose P electrodes and N electrodes are located on one side; bringing
   the P electrodes and N electrodes of the lateral micro LEDs into contact with pads preset on a receiving sub
  - strate; and irradiating the original substrate with laser from the original substrate side to lift-off the lateral micro-LEDs from the original substrate, wherein the lateral mi-
- <sup>35</sup> cro-LEDs contain magnetic substance, and the P electrodes and N electrodes of the lateral micro-LEDs are brought into contact with pads preset on a receiving substrate by means of an action of electromagnetic force simultaneously with the step of irradiating the original
   <sup>40</sup> substrate with laser.

**[0011]** The method further comprises: providing an anisotropic conductive layer on a receiving substrate. Preferably, the P electrodes and N electrodes of the lateral micro-LEDs are brought into contact with pads preset on

<sup>45</sup> a receiving substrate via the anisotropic conductive layer. Preferably, the method further comprises: processing the anisotropic conductive layer, to electrically connect the P electrodes and N electrodes of the lateral micro-LEDs with the pads on the receiving substrate.

<sup>50</sup> **[0012]** Preferably, the anisotropic conductive layer is at least one of an anisotropic conductive film, an anisotropic conductive paste and an anisotropic conductive tape.

[0013] Preferably, the P electrodes and N electrodes of the lateral micro-LEDs are brought into contact with pads preset on a receiving substrate by means of an action of electromagnetic force is assisted by gravity.

[0014] Preferably, the P electrodes and N electrodes

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of the lateral micro-LEDs are brought into contact with pads preset on a receiving substrate by means of an action of electromagnetic force is assisted by electrostatic force.

**[0015]** Preferably, the electrostatic force is applied by applying voltage to the pads.

**[0016]** According to another embodiment of the present invention, there is provided a method for manufacturing a micro-LED device, comprising transferring lateral micro-LEDs to a receiving substrate by using the method according to the present invention.

**[0017]** 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.

**[0018]** Further features of the present invention and advantages thereof will become 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**

**[0019]** The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments, some of which are embodiments of the invention and, together with the description thereof, serve to explain the principles of the invention.

Figure 1 shows a flow chart of an illustrative embodiment of the method according to the present disclosure.

Figure 2A to 2G shows an example for transferring a micro-LED according to the present disclosure.

Figure 3 shows a flow chart of another illustrative embodiment of the method according to the present disclosure.

Figures 4A to 4L show another example for transferring a micro-LED according to the present disclosure.

Figure 5 shows a flow chart of still another illustrative embodiment of the method according to the present disclosure.

Figures 6A to 6F show an example for transferring red micro-LEDs according to the present disclosure. Figures 7A to 7L show still another example for transferring a micro-LED according to the present disclosure.

Figure 8 shows still an example for transferring a lateral micro-LED according to the present disclosure.

Figure 9 shows still another example for transferring a lateral micro-LED according to the present disclo-

sure.

Figure 10 shows a flow chart of an embodiment of the method according to the present invention.

#### DETAILED DESCRIPTION OF THE EMBODIMENTS

**[0020]** Various exemplary embodiments of the present invention will now be described in detail with reference to the drawings. It should be noted that the relative ar-

10 rangement 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.

**[0021]** The following description of at least one exemplary embodiment is merely illustrative in nature and is in no way intended to limit the invention, its application, or uses.

[0022] Techniques, methods and apparatus as known by one of ordinary skill in the relevant art may not be <sup>20</sup> discussed in detail but are intended to be part of the spec-

ification where appropriate. [0023] 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

<sup>25</sup> of the exemplary embodiments could have different values.

**[0024]** 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.

**[0025]** Embodiments and examples of the present invention will be described below with reference to the drawings. Those embodiments described with reference to Figures 1 to 9 are presented here so as to facilitate understanding of the invention, and do not form part of the invention.

**[0026]** Fig. 1 shows a flow chart of an illustrative embodiment of the method for transfer micro-LED according to the present disclosure.

40 **[0027]** As shown in Fig. 1, at step S1100, a micro-LED is formed on a laser-transparent original substrate.

**[0028]** The laser-transparent original substrate can be a sapphire substrate, SiC substrate and so on, for example. The micro-LED can be used for being mounted on a display screen panel

<sup>45</sup> a display screen panel.

**[0029]** It should be understood by a person skilled in the art that one micro-LED could be formed on the original substrate, or a plurality of micro-LED could be formed on the original substrate. For example, a plurality of micro-

50 LEDs can be formed on the laser-transparent original substrate. The plurality of micro-LEDs can form an array.
 [0030] In an example, in a case where a plurality of micro-LEDs are formed on the laser-transparent original substrate, the original substrate can be singulated or di 55 vided into multiple pieces for more flexible transferring

vided into multiple pieces for more flexible transferring.
 [0031] At step S1200, the micro-LED is brought into contact with a pad preset on a receiving substrate.
 [0032] Encomplete the receiving substrate.

[0032] For example, the receiving substrate is a display

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screen panel.

**[0033]** For example, the pad can be set for red pixel array, yellow pixel array or blue pixel array.

**[0034]** In an example, in a case where a plurality of micro-LED are formed, at least one micro-LED of the plurality of micro-LEDs can be brought into contact with at least one pad preset on the receiving substrate. The at least one micro-LED could be one, several or all of the plurality of micro-LEDs. It should be understood by a person skilled in the art that, although it is just described here that at least one micro-LED, which is expected to be lifted-off, is in contact with a pad, a remaining micro-LED of the plurality of micro-LEDs can also be in contact with a pad.

**[0035]** For example, in the step of contact (S1200), the micro-LED can be brought into contact with the pad preset on the receiving substrate via a liquid thin film. For example, the liquid thin film can include flux. Herein, the lift-off of a micro-LED will be easy through the surface tension force of the liquid thin film (flux), and the successful rate is high.

**[0036]** At step S1300, the original substrate is irradiated with laser from the original substrate side to lift-off the micro-LED from the original substrate.

[0037] In an example, in a case where at least one micro-LED is in contact with pad, at least one area on the original substrate can be irradiated with laser from the original substrate side to lift-off the at least one micro-LED from the original substrate. For example, a technician can select the at least one area. For example, the at least one area corresponds to the at least micro-LED, respectively. The at least one area can be just partial area on the original substrate, or can be the whole area. [0038] In another example, the original substrate can be offset for transferring additional micro-LEDs.

**[0039]** In another example, after the transferring using the original substrate, an additional laser-transparent backup substrate can be used to cope with a situation in which micro-LEDs are missing at some points on the display screen panel. For example, a micro-LED can be formed on an additional laser-transparent backup substrate; the micro-LED on the backup substrate is brought into contact with a pad preset on a receiving substrate; and the backup substrate is irradiated with laser from the backup substrate. In such a way, the quality of a display screen can further be improved.

**[0040]** An array of micro-LEDs can be formed on the receiving substrate after the transferring of micro-LEDs to the receiving substrate.

**[0041]** After the transferring of micro-LEDs to the receiving substrate, the present disclosure can further include subsequent steps.

**[0042]** For example, the lifted-off micro-LEDs can be reflow-soldered on the receiving substrate. A negative electrode can be deposited on the micro-LEDs. The reflow-soldering can be performed after micro-LEDs of each color are transferred. Alternatively, the reflow-sol-

dering can be performed after micro-LEDs of all colors are transferred.

**[0043]** In addition, the soldered micro-LED can be filled with polymer. For example, a confocal dielectric deposition can be used instead of polymer filling.

**[0044]** In another embodiment, the present disclosure further includes a method for manufacturing a micro-LED device. The manufacturing method comprises transferring a micro-LED to a receiving substrate by using the

<sup>10</sup> method for transferring a micro-LED according to the present disclosure.

**[0045]** In another embodiment, the present disclosure further includes a micro-LED device, such as a display screen device. The micro-LED device can be manufac-

<sup>15</sup> tured by using the method for manufacturing a micro-LED device according to the present disclosure.

**[0046]** In comparison with the prior art, under the similar conditions, the micro-LED manufactured by using the solution of the present disclosure is relatively simple and reliable while maintaining a high quality, and the through

put thereof is relatively high with low cost. [0047] In another embodiment, the present disclosure further includes an electronic apparatus. The electronic apparatus contains a micro-LED device according to the

<sup>25</sup> present disclosure. For example, the electronic apparatus can be a mobile phone, a pad computer and so on.
[0048] In the solution of the present disclosure, a micro-LED is formed directly on the original substrate and it is transferred to a receiving substrate by means of laser
<sup>30</sup> lift-off. The solution of this disclosure has not been con-

lift-off. The solution of this disclosure has not been conceived by the prior art.

**[0049]** In addition, the micro-LED can be selectively transferred through the present disclosure.

[0050] In addition, in the solution of the present disclo <sup>35</sup> sure, the transfer can be performed only once while two transfers are needed in the prior art.

**[0051]** In addition, in comparison with the prior art, the solution of the present disclosure is relatively efficient, the cost is relatively low and product performance degrade due to an extra thermal budget will not occur.

**[0052]** In addition, in comparison with the prior art using a pick-up head, the present disclosure does not need a complicated pick-up system, and thus the cost of product manufactured using the present disclosure will relatively low and reliable.

**[0053]** In addition, since it does not need the temporary bonding in the prior art between the micro-LED and the intermediate carrier substrate, the cost can be further decreased by this disclosure.

50 [0054] Since it is not necessary to consider the phase change of bonding layer considered in the prior art using pick-up head, the manufacturing method of the present disclosure can have a relatively high through put and the extra thermal load limitation will be less. Consequently,
 <sup>55</sup> under the similar conditions, the manufactured micro-LED will have a higher performance.

**[0055]** An example for transferring a micro-LED according to the present disclosure will be described below

with reference to Figs. 2A to 2G.

**[0056]** As shown in Fig. 2A, micro-LEDs 2 are formed on a laser-transparent original substrate 1 such as sapphire substrate. The micro-LEDs 2 have a vertical micro-LED structure, for example. The micro-LEDs 2 contains, for example, a n-doped GaN layer, a multiple quantum well structure, a p-doped GaN layer, a p metal electrode, a bump, and so on.

**[0057]** As shown in Fig. 2A, the plurality of micro-LEDs 2 can be singulated.

**[0058]** As shown in Fig. 2B, the original substrate 1 is flipped over, and is aligned with a receiving substrate 4 with liquid thin film (for example, containing flux) 5. The micro bumps on the micro-LEDs are in contact with the flux. Pads 3 are preset on the receiving substrate 4. For example, the pads 3 include pad 3r for receiving red micro-LED, pad 3b for receiving blue micro-LED and pad 3g for receiving green micro-LED.

**[0059]** As shown in Fig. 2C, partial areas 7 on the original substrate are selectively irradiated with laser 7, to lift off the selected micro-LEDs 2a, 2b of the plurality of formed micro-LEDs from the original substrate.

**[0060]** As shown in Fig. 2D, the original substrate 1 is lifted up. Because of the function of the surface tension force of the liquid thin film, the selected micro-LEDs 2a, 2b are lifted-off easily, while the other micro-LEDs are remained on the original substrate 1.

**[0061]** Then, the original substrate is moved and the operations of Figs. 2C to 2D are repeated, so that a plurality of micro-LEDs are transferred to the receiving substrate.

**[0062]** As shown in Fig. 2E, the plurality of micro-LEDs are transferred to the receiving substrate 4.

**[0063]** As shown in Fig. 2F, for example, the plurality of micro-LEDs are soldered onto the receiving substrate through reflow soldering. Then, the flux is cleaned.

**[0064]** As shown in Fig. 2G, the receiving substrate is filled with polymer 8 and is sealed. Then, n-metal electrode 9 is deposited, for example, using ITO material.

**[0065]** Figure 3 shows a flow chart of another illustrative embodiment of the method for transferring a micro-LED according to the present disclosure.

**[0066]** As shown in Figure 3, at step S2100, micro-LEDs are formed on a laser-transparent original substrate.

**[0067]** At step S2200, an anisotropic conductive layer is provided on a receiving substrate.

**[0068]** For example, the anisotropic conductive layer is at least one of an anisotropic conductive film (ACF), an anisotropic conductive paste (ACP) and an anisotropic conductive tape (ACT).

**[0069]** At step S2300, the micro-LEDs are brought into contact with the anisotropic conductive layer on the receiving substrate. For example, the micro-LEDs are adhered to the anisotropic conductive layer on the receiving substrate. At this step, the micro-LEDs can be aligned with the receiving substrate in advance, for example.

**[0070]** At step S2400, the original substrate is irradiat-

ed with laser from the original substrate side to lift-off the micro-LEDs from the original substrate.

[0071] For example, the above steps can be performed with respect to red micro-LEDs, green micro-LEDs and
<sup>5</sup> blue micro-LEDs, respectively. Since the transfer with respect to the three micro-LEDs can be regarded as a simple repeat of the above steps, they are not repeated here. As long as each of the above steps is performed in a solution, the solution will be covered by this disclo<sup>10</sup> sure.

**[0072]** At step S2500, the anisotropic conductive layer is processed to electrically connect the micro-LEDs (its electrodes) with the pads on the receiving substrate.

[0073] In an example, pressure can be applied on the
anisotropic conductive layer from the micro-LED side by
using an auxiliary substrate. For example, the temperature of processing the anisotropic conductive layer can
be between 150°C and 200°C. For example, the applied
pressure is between 1 MPa and 4 MPa. For example,
the time period of applying pressure is between 10 second and 30 second.

**[0074]** In an example, the auxiliary substrate can be a flat rigid substrate. The inventors of the present application have found that the possible displacement of the

25 micro-LEDs can be reduced by using a rigid substrate. This point has not noticed by a person skilled in the art. [0075] For example, the surface of the auxiliary substrate can be coated with temporary bonding polymer. In this situation, the step S2500 can further comprises: 30 bonding the auxiliary substrate with the anisotropic conductive layer via the temporary bonding polymer; and after applying pressure, de-bonding the auxiliary substrate via the temporary bonding polymer, to remove the auxiliary substrate. The advantage of temporarily bond-35 ing the auxiliary substrate with the anisotropic conductive layer lies in that, the positions of the micro-LEDs can be relatively fixed, and the displacement of micro-LEDs during processing the anisotropic conductive layer is reduced.

40 [0076] After the above processes, normal subsequent processes can be done on the micro-LEDs. For example, the subsequent processes include: etching the temporary bonding polymer, to expose the epitaxial layers of the micro-LEDs; forming N-metal electrodes on the epi-

<sup>45</sup> taxial layers of the micro-LEDs; and performing encapsulation on the N-metal electrodes.

**[0077]** For example, the receiving substrate can be a display substrate. Leads and pads can be set on the receiving substrate in advance, to be electronically connected with the micro-LEDs.

**[0078]** In this embodiment, the micro-LEDs and the receiving substrate are connected through an anisotropic conductive layer. This approach of processing is relatively simple and is more suitable for production in large bulk.

<sup>55</sup> **[0079]** In another embodiment, the present disclosure further provides a method for manufacturing a micro-LED device. The manufacturing method comprises transferring micro-LEDs to a receiving substrate by using the

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method according to the present disclosure. For example, the receiving substrate is a display screen or display substrate. The micro-LED device is a display device, for example.

**[0080]** In another embodiment, the present disclosure further provides a micro-LED device, such as a display device. The micro-LED device can be manufactured by using the method for manufacturing a micro-LED device according to the present disclosure. In the micro-LED device according to the embodiment, the micro-LEDs come into electronic contact with the pads on the receiving substrate via the anisotropic conductive layer, which is different from the micro-LED device in the prior art.

**[0081]** In another embodiment, the present disclosure further provides an electronic apparatus. The electronic apparatus contains a micro-LED device according to the embodiment. For example, the electronic apparatus can be a mobile phone, a pad and so on.

**[0082]** Figure 4A to 4L shows another example for transferring a micro-LED according to the present disclosure.

**[0083]** As shown in Figure 4A, an original substrate 201 such as a sapphire substrate has red micro-LEDs 202 thereon. The receiving substrate 204 such as display substrate has an anisotropic conductive film (ACF) 203 thereon. The receiving substrate 204 has signal leads 205 and pads 205' for connecting micro-LEDs.

**[0084]** As shown in Figure 4B, the original substrate 201 (red micro-LED 202) is brought into contact with the anisotropic conductive film 203 with a light force. For example, the red micro-LEDs 202 to be transferred can be aligned with the pads on the receiving substrate 204. The original substrate 201 is irradiated with laser 206, to selectively lift-off red micro-LEDs.

[0085] Figure 4C shows lifted-off red micro-LEDs 202r. [0086] Figure 4D shows an original substrate 207 and the green micro-LEDs 208 thereof. The green micro-LEDs to be lifted-off are aligned with the pads on the receiving substrate 204.

**[0087]** Figure 4E shows the situation in which the green micro-LEDs 208 are in contact with the anisotropic conductive film 203 with a light force. At least one green micro-LED is selectively lifted-off by using laser 209.

**[0088]** Figure 4F shows lifted-off red micro-LEDs 202r and green micro-LEDs 208g.

**[0089]** Figure 4G shows an original substrate 210 and the blue micro-LEDs 211 thereof. The blue micro-LEDs to be lifted-off are aligned with the pads on the receiving substrate 204.

**[0090]** Figure 4H shows the situation in which the blue micro-LEDs 211 are in contact with the anisotropic conductive film 203 with a light force. At least one blue micro-LED is selectively lifted-off by using laser 212.

**[0091]** Figure 4F shows lifted-off red micro-LEDs 202r, green micro-LEDs 208g and blue micro-LEDs 211b.

**[0092]** After the transfer of micro-LEDs in the three colors, an inspection and repair can be performed with respect to any defect.

**[0093]** Figure 4J shows an auxiliary substrate 213. The auxiliary substrate 213 is a flat rigid substrate, such a glass substrate. Polymer 214 such as 3M LC5200/5320 is coated on the auxiliary substrate 213. The polymer can be cured through UV and can be de-bonded through red

laser. [0094] In Figure 4K, the ACF 203 is processed through

the auxiliary substrate 213. For example, the processing condition is that the temperature is between  $150^{\circ}$ C and  $200^{\circ}$ C, the applied pressure is between 1 MPa and 4

10 200°C, the applied pressure is between 1 MPa and 4 MPa, the time period of applying pressure is between 10 second and 30 second. Through these processes, the ACF 203 interconnects the micro-LEDs with corresponding pad in the vertical direction.

<sup>15</sup> **[0095]** Then, the auxiliary substrate 213 is de-bonded (through the polymer 214).

**[0096]** In Figure 4L, the normal subsequent processes are performed: etching the polymer 214, to expose the epitaxial layers of the micro-LEDs; forming N-metal elec-

20 trodes 215(for example, ITO electrodes) on the epitaxial layers of the micro-LEDs; and performing encapsulation 216 on the N-metal electrodes (for example, PET lamination).

 [0097] Figure 5 shows a flow chart of still another illus trative embodiment of the method for transferring a micro-LED according to the present disclosure.

**[0098]** As shown in Figure 5, at step S3100, at least one micro-LED is transferred from an original substrate to a support body. For example, the original substrate is laser-transparent.

**[0099]** In an example, this step can comprises: mounting the original substrate onto the support body, wherein the micro-LEDs are formed on the original substrate, the support body has light-release adhesive on its surface,

and the micro-LEDs are adhered to the support body via the light-release adhesive; irradiating the original substrate with laser from the original substrate side, for lifting-off the at least one micro-LED from the original substrate, and irradiating light from the support body side, to release
 un-lifted-off micro-LEDs. In this example, the support

body is transparent. [0100] For example, the light-release adhesive can be a UV tape. For example, the support body is stiff. The

displacement of micro-LEDs during transfer will have affect on the quality of the final product. The inventors of this application have found that this displacement can be reduced by using a stiff support body. This point has not been noticed by a person skilled in the art. For example,

the material of the support body can be PET.
[0101] Generally, it is difficult to form red micro-LEDs on a laser-transparent substrate such as a sapphire substrate. Accordingly, in an example, the red micro-LEDs are formed in advance and then are transferred to an original substrate, for being finally transferred to a receiving substrate. For example, in this embodiment, red micro-LEDs can be formed on a growth substrate. Then, the red micro-LEDs are transferred to an intermediate substrate. After that, the red micro-LEDs are transferred

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from the intermediate substrate to the original substrate. [0102] At step S3200, the at least one micro-LED are

transferred from the support body to a backup substrate. [0103] For example, the backup substrate has elastomer or polymer on its surface. For example, the at least one micro-LED are bonded to the backup substrate through the elastomer or polymer.

**[0104]** In an example, this step can further comprises: bonding the support body with the at least one micro-LED to the backup substrate, and irradiating light from the support body side, to release the at least one micro-LED.

**[0105]** At step S3300, the at least one micro-LED are transferred from the backup substrate to a receiving substrate.

**[0106]** In an example, the step can further comprise: aligning the at least one micro-LED with the pads on the receiving substrate; and lifting-off the at least one micro-LED via the elastomer or polymer.

**[0107]** For example, the above transfer steps can be performed with respect to red micro-LEDs, blue micro-LEDs and greed micro-LEDs, respectively. They will not be repeatedly described here.

**[0108]** After the above processes, normal subsequent processes can be done on the micro-LEDs. For example, the subsequent processes include: coating polymer on the receiving substrate with micro-LEDs; curing the polymer; etching the polymer, to expose the epitaxial layers of the micro-LEDs; forming N-metal electrodes on the epitaxial layers of the micro-LEDs; and performing encapsulation on the N-metal electrodes.

**[0109]** The inventors of this disclosure have found that during the transfer of micro-LEDs, usually, only part of the micro-LEDs on the original substrate are transferred. If the micro-LEDs are directly transferred to a receiving substrate, the remaining micro-LEDs on the original substrate are often contaminated. In this embodiment, this contamination can be reduced through the transfer via an intermediate support body.

**[0110]** In another embodiment, the present disclosure further provides a method for manufacturing a micro-LED device. The manufacturing method comprises transferring micro-LEDs to a receiving substrate by using the method for transferring micro-LEDs according to this embodiment. For example, the receiving substrate is a display screen or display substrate. The micro-LED device is a display device, for example.

**[0111]** In another embodiment, the present disclosure further provides a micro-LED device, such as a display device. The micro-LED device can be manufactured by using the method for manufacturing a micro-LED device according to said embodiment.

**[0112]** In another embodiment, the present disclosure further provides an electronic apparatus. The electronic apparatus contains a micro-LED device according to the embodiment. For example, the electronic apparatus can be a mobile phone, a pad and so on.

[0113] Generally, red micro-LEDs cannot be directly

formed on a laser-transparent original substrate such as sapphire substrate. Thus, it is required that red micro-LEDs are formed on an additional substrate in advance, and then are transferred to a sapphire substrate. Figure

<sup>5</sup> 6A to 6F shows an example for transferring red micro-LEDs according to the present disclosure.
[0114] As shown in Figure 6A, red micro-LEDs 302 are formed on a growth substrate 301 such as GaAs substrate.

10 [0115] As shown in Figure 6B, the red micro-LEDs 302 are bonded with intermediate substrate 304 such as silicon substrate, through temporary bonding polymer 303. The polymer 303 is a thermal release tape (TRT), for example.

<sup>15</sup> [0116] As shown in Figure 6C, the growth substrate 301 is removed by a wet etching method, for example.
 [0117] As shown in Figure 6D, a light resist 305 is coated on an original substrate 306 such as sapphire substrate. The original substrate 306 and the red micro-LEDs

<sup>20</sup> 302 are bonded through the resist 305. The resist 305 can endure the temperature above 200°C; generally above 250°C.

**[0118]** As shown in Figure 6E, the polymer 303 is processed under a temperature less than 200°C, to remove the intermediate substrate 304.

**[0119]** As shown in Figure 6F, an O2 plasma etching is performed on the resist 305, to isolate the respective red micro-LEDs302.

[0120] Figure 7A to 7L shows still another example for
 30 transferring a micro-LED according to the present disclosure.

**[0121]** As shown in Figure 7A, the original substrate 406 has resist 405 and red micro-LEDs 402 thereon. The red micro-LEDs 402 are mounted onto a UV tape 411.

<sup>35</sup> The UV tape 411 is located on a stiff PET support body 402. The red micro-LEDs are selectively lifted-off through laser 413.

**[0122]** As shown in Figure 7B, an ultraviolet is irradiated from the support body 412 side, to release un-lifted-off red micro-LEDs.

**[0123]** The lifted-off red micro-LEDs 402r are easily separated from the original substrate 406. As shown in Figure 7C, the lifted-off red micro-LEDs 402r are adhered on the UV tape 411, while other red micro-LEDs remain on the original substrate 406.

**[0124]** As shown in Figure 7D, the backup substrate 415 such as glass substrate has elastomer/polymer 416 thereon. For example, the elastomer/polymer 416 is coated on the backup substrate 415 through spin coating.

50 For example, the elastomer/polymer 416 is PDMS or 3M LC 5320, and can be cured through ultraviolet, for example.

**[0125]** As shown in Figure 7E, the support body is fully irradiated with ultraviolet, to release the red micro-LEDs and elastomer/polymer 416.

**[0126]** After that, for example, if the micro-LEDs do not have bumps thereon, the micro-LEDs on the backup substrate 415 can be screen-printed using silver paste.

**[0127]** As shown in 7F, the red micro-LEDs on the backup substrate 415 are aligned with the pads 419 on the receiving substrate 417. For example, the receiving substrate is a display substrate, and includes signal leads 418. For example, the red micro-LEDs are bonded to the pads 419 through reflow. The temperature of reflow can be more than 260°C. Then, the backup substrate 415 is separated from the receiving substrate 417 through laser lift-off.

**[0128]** Figure 7G shows separated receiving substrate 417. The receiving substrate 417 has pads 419 and red micro-LEDs 402r thereon.

**[0129]** Figure 7H shows a schematic diagram of transferring red micro-LEDs 422g from a backup substrate 420 to the receiving substrate 417. The backup substrate 420 has elastomer/polymer 421.

**[0130]** Figure 7I shows the separated receiving substrate 417. The receiving substrate 417 has pads 419, red micro-LEDs 402r and green micro-LEDs 402r thereon.

**[0131]** Figure 7J shows a schematic diagram of transferring blue micro-LEDs 425b from a backup substrate 423 to the receiving substrate 417. The backup substrate 423 has elastomer/polymer 424.

**[0132]** Figure 7K shows the separated receiving substrate 417. The receiving substrate 417 has pads 419, red micro-LEDs 402r, green micro-LEDs 402r and blue micro-LEDs 425b thereon

**[0133]** In Figure 7L, the normal subsequent processes are performed on the transferred micro-LEDs: coating polymer 426 on the receiving substrate with micro-LEDs; curing the polymer426; etching the polymer, to expose the epitaxial layers of the micro-LEDs; forming N-metal electrodes 427 on the epitaxial layers of the micro-LEDs; and performing encapsulation (not shown) on the N-metal electrodes.

**[0134]** The solution of the present disclosure can use both vertical micro-LEDs and lateral micro-LEDs (flipchip micro-LEDs). The micro-LEDs of vertical structure shown in the previous figures are illustrative and do not limit the scope of the present disclosure. Figure 8 shows an example of lateral micro-LEDs of the present disclosure.

**[0135]** In the example of Figure 8, the micro-LEDs are lateral micro-LEDs. In the lateral micro-LEDs, the P electrodes and the N electrodes thereof are located on the same side. Figure 8 shows a red lateral micro-LED 505, a green lateral micro-LED 506 and a blue lateral micro-LED 507. The red lateral micro-LED 505 contains a P electrode 505p (positive electrode) and an N electrode 505n (negative electrode). The green lateral micro-LED 506 contains a P electrode 506p and an N electrode 506n6. The blue lateral micro-LED 507 contains a P electrode 507p and an N electrode 507p.

**[0136]** Lead structures (including pads) 515p, 515n, 516p, 516n, 517p, 517n are provided in the substrate 504. The lead structures 515p, 516p, 517p are for connection with positive electrodes. The lead structures

515n, 516n, 517n are for connection with negative electrodes.

**[0137]** In the example of Figure 8, the electrodes 505p, 505n, 506p, 506n, 507p, 507n are connected to the lead

structures 515p, 515n, 516p, 516n, 517p, 517n via an anisotropic conductive layer 503.

**[0138]** Polymer 502 can be coated between the lateral micro-LEDs. A transparent cover 501 can be provided over the lateral micro-LEDs.

10 [0139] Figure 9 shows another example of lateral micro-LEDs of the present disclosure. The difference between the example of Figure 9 and that of Figure 8 lies in that in Figure 9, the lateral micro-LEDs are connected to the substrate via solder rather than an anisotropic con-15 ductive layer.

**[0140]** Figure 9 shows a red lateral micro-LED 605, a green lateral micro-LED 606 and a blue lateral micro-LED 607. The red lateral micro-LED 605 contains a P electrode 605p and an N electrode 605n. The green lat-

<sup>20</sup> eral micro-LED 606 contains a P electrode 606p and an N electrode 606n. The blue lateral micro-LED 607 contains a P electrode 607p and an N electrode 607n.

**[0141]** Lead structures (including pads) 615p, 615n, 616p, 616n, 617p, 617n are provided in the substrate

<sup>25</sup> 604. The lead structures 615p, 616p, 617p are for connection with positive electrodes. The lead structures 615n, 616n, 617n are for connection with negative electrodes.

[0142] In the example of Figure 9, the electrodes 605p,
605n, 606p, 606n, 607p, 607n include solder bumps 602,
for example. The solder bumps 602 are coated with flux,
for example. The electrodes 605p, 605n, 606p, 606n,
607p, 607n are bonded to the lead structures 615p, 615n,
616p, 616n, 617p, 617n, for example, through reflowsoldering, respectively.

**[0143]** For example, polymer 603 can filled between the lateral micro-LEDs and the substrate 604. A transparent cover 601 can be provided over the lateral micro-LEDs. These processes are well-known in the art and thus are not described in detail here.

**[0144]** The present invention relates to the specific application of lateral micro-LEDs. More specifically, the present invention provides a method for transferring micro-LED. The method comprises: forming micro-LEDs

on a laser-transparent original substrate, wherein the micro-LEDs are lateral micro-LEDs whose P electrodes and N electrodes are located on one side; bringing the P electrodes and N electrodes of the lateral micro-LEDs into contact with pads preset on a receiving substrate; and
 irradiating the original substrate with laser from the orig-

inal substrate side to lift-off the lateral micro-LEDs from the original substrate.

**[0145]** A technical effect of using lateral micro-LEDs lies in that the processing for N metal electrode after the micro-LED transfer can be omitted. Furthermore, the wa-fer-level color-binning/testing can be simplified because the P electrodes and N electrodes already exist when a test at wafer-level is performed.

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**[0146]** Furthermore, in this method, an anisotropic conductive layer is provided on a receiving substrate so as to bring the P electrodes and N electrodes of the lateral micro-LEDs into contact with the pads through the anisotropic conductive layer. Then, after lifting-off the lateral micro-LEDs from the original substrate, the anisotropic conductive layer is processed to electrically connect the P electrodes and N electrodes of the lateral micro-LEDs with the pads on the receiving substrate.

**[0147]** 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.

**[0148]** In addition to bringing the P electrodes and N electrodes of the lateral micro-LEDs into contact with pads preset on a receiving substrate by the stickiness of an anisotropic conductive layer, the present invention further realizes the contact by action of electromagnetic force, and can further realize the contact by actions of gravity and/or electrostatic force.

**[0149]** For example, when the original substrate is irradiated with laser from the original substrate side, the lateral micro-LEDs are separated from the original substrate and the lateral micro-LEDs are dropped off onto the receiving substrate because of gravity.

**[0150]** For example, electrostatic force can be applied by applying voltage to the pads, so that the lateral micro-LEDs are dropped off onto the receiving substrate after being lifted-off from the original substrate because of the electrostatic force.

**[0151]** According to the invention, the lateral micro-LEDs contains magnetic substance such as Ni, a magnetic field is provided, so that the lateral micro-LEDs are dropped off onto the receiving substrate after being liftedoff from the original substrate because of the electromagnetic force.

**[0152]** Similarly, the transfer method in the example of using lateral micro-LEDs can be applied to a method for manufacturing a micro-LED device for transferring the lateral micro-LEDs onto a receiving substrate. For example, the receiving substrate is a display screen or display substrate. The micro-LED device is a display device, for example.

**[0153]** For example, a micro-LED device, such as a display device, can be manufactured by using the manufacturing method. The micro-LED device adopts lateral micro-LEDs.

[0154] For example, the present disclosure further provides an electronic apparatus. The electronic apparatus contains the micro-LED device. For example, the electronic apparatus can be a mobile phone, a pad and so on. [0155] Figure 10 shows a flow chart of a method for transferring micro-LEDs by means of a contactless action according to the present invention.

**[0156]** As shown in Figure 10, in the method for transferring micro-LEDs, at step S4100, micro-LEDs are formed on a laser-transparent original substrate.

[0157] The micro-LEDs are lateral micro-LEDs. In a

lateral micro-LED, the P electrodes and N electrodes are located on one same side. In a micro-LED of vertical structure, which do not form part of the present invention, the P electrodes and N electrodes thereof are located on opposite sides.

**[0158]** At step S4200, the original substrate is irradiated with laser from the original substrate side to lift-off the micro-LEDs from the original substrate.

 [0159] At step S4300, the micro-LEDs are brought into
 contact with pads preset on a receiving substrate through an action of contactless action.

**[0160]** The contactless action means that the action per se can be applied without the direct contact of objects. For example, the contactless action can be applied by

<sup>15</sup> means of a field. This is different from the action applied through the stickiness of an anisotropic conductive layer or by the surface tension of liquid (such as flux). It should be understood that although the contactless action per se can be applied without the direct contact of objects,

20 the direct contact of objects can be kept through the contactless action. For example, several example of the contactless action are given as below.

**[0161]** For example, the contactless action is gravity. The micro-LEDs are placed over the receiving substrate.

<sup>25</sup> When the lift-off is performed, the micro-LEDs are dropped off on the receiving substrate and is left on the receiving substrate.

**[0162]** For example, the contactless action is electrostatic force. The electrostatic force can be applied by applying voltage to the pads.

**[0163]** According to the invention, the contactless action is electromagnetic force. According to the invention, the micro-LEDs contain a magnetic substance, a magnetic field can be provided by means of a magnet such

- <sup>35</sup> as permanent magnet, so that the micro-LEDs are dropped off and are left onto the receiving substrate after being lifted-off from the original substrate because of the electromagnetic force, thereby contacting with the pads directly or indirectly.
- <sup>40</sup> **[0164]** In this embodiment, the micro-LEDs are attached onto the receiving substrate via a contactless manner.

**[0165]** The order of steps in Figure 10 are not according to the present invention. Indeed, although the step S4200

<sup>45</sup> are shown in front of the step S4030, the action of electromagnetic force is applied at the time when performing the step S4200. In other words, the step S4300 is performed simultaneously with the step S4200.

**[0166]** Similarly, the transfer method can be applied to a method for manufacturing a micro-LED device for transferring the micro-LEDs onto a receiving substrate. For example, the receiving substrate is a display screen or display substrate. The micro-LED device is a display device, for example.

<sup>55</sup> **[0167]** For example, a micro-LED device, such as a display device, can be manufactured by using the manufacturing method.

[0168] For example, the present disclosure further pro-

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vides an electronic apparatus. The electronic apparatus contains the micro-LED device. For example, the electronic apparatus can be a mobile phone, a pad and so on. **[0169]** 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 embodiments can be modified without departing from the scope of the present invention. The scope of the present invention is defined by the attached claims.

#### Claims

1. A method for transferring micro-LEDs comprising:

forming micro-LEDs (505, 506, 507; 605, 606, 607) on a laser-transparent original substrate (501; 601), wherein the micro-LEDs (505, 506, 507; 605, 606, 607) are lateral micro-LEDs whose P electrodes (505p, 506p, 507p; 605p, 606p, 607p) and N electrodes (505n, 506n, 507n; 605n, 606n, 607n) are located on one side;

bringing the P electrodes (505p, 506p, 507p; 605p, 606p, 607p) and N electrodes (505n, 506n, 507n; 605n, 606n, 607n) of the lateral micro-LEDs (505, 506, 507; 605, 606, 607) into contact with pads (515p, 515n, 516p, 516n, 517p, 517n; 615p, 615n, 616p, 616n, 617p, 617n) preset on a receiving substrate (504; 604); and

irradiating the original substrate (501; 601) with laser from the original substrate side to lift-off the lateral micro-LEDs from the original substrate,

wherein the lateral micro-LEDs (505, 506, 507; 605, 606, 607) contain a magnetic substance, and the P electrodes (505p, 506p, 507p; 605p, 606p, 607p) and N electrodes (505n, 506n, 507n; 605n, 606n, 607n) of the lateral micro-LEDs (505, 506, 507; 605, 606, 607) are brought into contact with pads preset on a receiving substrate by means of an action of electromagnetic force simultaneously with the step of irradiating the original substrate with laser;

wherein the method is **characterized by** further 50 comprising:

providing an anisotropic conductive layer (503) on a receiving substrate;

wherein the P electrodes and N electrodes <sup>55</sup> of the lateral micro-LEDs are brought into contact with pads preset on the receiving substrate via the anisotropic conductive layer; and

wherein the method further comprises: processing the anisotropic conductive layer (503), to electrically connect the P electrodes and N electrodes of the lateral micro-LEDs with the pads on the receiving substrate.

- 2. The method according to claim 1, **characterized in that** the anisotropic conductive layer (503) is at least one of an anisotropic conductive film, an anisotropic conductive paste and an anisotropic conductive tape.
- 15 3. The method according to claim 1, characterized in that the P electrodes and N electrodes of the lateral micro-LEDs are brought into contact with pads preset on a receiving substrate by means of an action of electromagnetic force assisted by gravity.
  - 4. The method according to claim 1, **characterized in that** the P electrodes and N electrodes of the lateral micro-LEDs are brought into contact with pads preset on a receiving substrate by means of an action of electromagnetic force assisted by electrostatic force.
  - 5. The method according to claim 4, **characterized in that** the electrostatic force is applied by applying voltage to the pads.
  - 6. The method according to claim 1, characterized in that the P electrodes and N electrodes of the lateral micro-LEDs include solder bumps, and the method further comprises: bonding the solder bumps with the pads.
  - 7. A method for manufacturing a micro-LED device, characterized by comprising transferring lateral micro-LEDs to a receiving substrate by using the method according to claim 1.

#### Patentansprüche

1. Verfahren zum Übertragen von Mikro-LEDs, umfassend:

Bilden der Mikro-LEDs (505, 506, 507; 605, 606, 607) auf einem lasertransparenten Originalsubstrat (501; 601), wobei die Mikro-LEDs (505, 506, 507; 605, 606, 607) laterale Mikro-LEDs sind, deren P-Elektroden (505p, 506p, 507p; 605p, 606p, 607p) und N-Elektroden (505n, 506n, 507n; 605n, 606n, 607n) auf einer gleichen Seite angeordnet sind; Bringen der P-Elektroden (505p, 506p, 507p; 605p, 606p, 607p) und N-Elektroden (505n, 506n, 507n; 605n,

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606n, 607n) der lateralen Mikro-LEDs (505, 506, 507; 605, 606, 607) in Kontakt mit Unterlagen (515p, 515n, 516p, 516n, 517p, 517n; 615p, 615n, 616p, 616n, 617p, 617n), die auf einem Empfangssubstrat (504; 604) voreingestellt sind; und

Bestrahlen des Originalsubstrats (501; 601) mit einem Laser aus der Originalsubstratseite, um die lateralen Mikro-LEDs vom Originalsubstrat abzuheben,

wobei die lateralen Mikro-LEDs (505, 506, 507; 605, 606, 607) eine magnetische Substanz enthalten, und gleichzeitig mit dem Schritt des Bestrahlens des Originalsubstrats mit einem Laser werden die P-Elektroden (505p, 506p, 507p; 605p, 606p, 607p) und N-Elektroden (505n, 506n, 507n; 605n, 606n, 607n) der lateralen Mikro-LEDs mit den auf dem Empfangssubstrat voreingestellten Unterlagen mittels der Wirkung einer elektromagnetischen Kraft in Kontakt gebracht,

**dadurch gekennzeichnet**, **dass** das Verfahren weiterhin umfasst:

Bereitstellen einer anisotropen leitfähigen <sup>25</sup> Schicht (503) auf dem Empfangssubstrat; wobei die P-Elektroden und N-Elektroden der lateralen Mikro-LEDs über die anisotrope leitfähige Schicht mit den auf dem Empfangssubstrat voreingestellten Unterlagen <sup>30</sup> in Kontakt gebracht werden;

wobei das Verfahren weiterhin umfasst: Bearbeiten der anisotropen leitfähigen Schicht (503), um die P-Elektroden und N-Elektroden der lateralen Mikro-LEDs mit den Unterlagen auf dem Empfangssubstrat elektrisch zu verbinden.

- Verfahren nach Anspruch 1, dadurch gekennzeichnet, dass die anisotrope leitfähige Schicht 40 (503) mindestens eine von der Gruppe einer anisotropen leitfähigen Film, einer anisotropen leitfähigen Paste und eines anisotropen leitfähigen Bands ist.
- Verfahren nach Anspruch 1, dadurch gekennzeichnet, dass die P-Elektroden und N-Elektroden der lateralen Mikro-LEDs mit den auf dem Empfangssubstrat voreingestellten Unterlagen mittels einer durch die Schwerkraft unterstützten Wirkung einer elektromagnetischen Kraft in Kontakt gebracht 50 werden.
- Verfahren nach Anspruch 1, dadurch gekennzeichnet, dass die P-Elektroden und N-Elektroden der lateralen Mikro-LEDs mit den auf dem Empfangssubstrat voreingestellten Unterlagen mittels einer durch eine elektrostatische Kraft unterstützten Wirkung einer elektromagnetischen Kraft in Kontakt

gebracht werden.

- Verfahren nach Anspruch 4, dadurch gekennzeichnet, dass die elektrostatische Kraft durch Ausüben einer Spannung auf die Unterlagen ausgeübt wird.
- Verfahren nach Anspruch 1, dadurch gekennzeichnet, dass die P-Elektroden und N-Elektroden der lateralen Mikro-LEDs Lötperlen umfassen, und dass das Verfahren weiterhin umfasst: Verbinden der Lötperlen mit den Unterlagen.
- Verfahren zum Herstellen einer Mikro-LED-Vorrichtung, gekennzeichnet durch das Übertragen der lateralen Mikro-LEDs auf ein Empfangssubstrat unter Verwendung des Verfahrens nach Anspruch 1.

#### 20 Revendications

- 1. Procédé pour transférer des micro-LEDs, comprenant:
  - formation des micro-LEDs (505, 506, 507; 605, 606, 607) sur un substrat d'origine transparent au laser (501; 601), dans lequel les micro-LEDs (505, 506, 507; 605, 606, 607) sont micro-LEDs latérales dont des électrodes P (505p, 506p, 507p; 605p, 606p, 607p) et des électrodes N (505n, 506n, 507n; 605n, 606n, 607n) sont situées sur un côté;

mise en contact des électrodes P (505p, 506p, 507p; 605p, 606p, 607p) et électrodes N (505n, 506n, 507n; 605n, 606n, 607n) des micro-LEDs latérales (505, 506, 507; 605, 606, 607) avec les plots (515p, 515n, 516p, 516n, 517p, 517n; 615p, 615n, 616p, 616n, 617p, 617n) préréglés sur un substrat de réception (504; 604) ; et

irradiation du substrat d'origine (501; 601) avec laser issu du côté du substrat d'origine pour décoller les micro-LEDs latérales du substrat d'origine,

dans lequel les micro-LEDs latérales (505, 506, 507; 605, 606, 607) contiennent une substance magnétique, et les électrodes P (505p, 506p, 507p; 605p, 606p, 607p) et les électrodes N (505n, 506n, 507n; 605n, 606n, 607n) des micro-LEDs latérales (505, 506, 507; 605, 606, 607) sont mises en contact avec les plots préréglés sur un substrat de réception par l'intermédiare d'un action de une force électromagnétique simultanément avec l'étape d'irradiation du substrat d'origine avec le laser;

dans lequel le procédé est **caractérisé en ce qu**'il comprend en outre:

disposition d'une couche conductrice ani-

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sotrope (503) sur un substrat de réception; dans lequel les électrodes P et électrodes N des micro-LEDs latérales sont mises en contact avec les plots préréglés sur le substrat de réception via la couche conductrice anisotrope; dans lequel le procédé comprend en outre:

traitement de la couche conductrice anisotrope (503), pour connecter électriquement les électrodes P et électrodes N des micro-LEDs latérales avec les plots sur le substrat de réception.

- Procédé selon la revendication 1, caractérisé en ce que la couche conductrice anisotrope (503) est au moins l'un d'un film conducteur anisotrope, d'une pâte conductrice anisotrope et d'un ruban conducteur anisotrope.
- Procédé selon la revendication 1, caractérisé en ce que les électrodes P et électrodes N des micro-LEDs latérales sont mises en contact avec les plots préréglés sur un substrat de réception par l'intermédiare d'un action d'une force électromagnétique assistée par la gravité.
- Procédé selon la revendication 1, caractérisé en ce que les électrodes P et électrodes N des micro-LEDs latérales sont mises en contact avec les plots préréglés sur un substrat de réception par l'intermédiare d'un action d'une force électromagnétique assistée par une force électrostatique.
- Procédé selon la revendication 4, caractérisé en ce que la force électrostatique est appliquée en appliquant une tension aux plots.
- Procédé selon la revendication 1, caractérisé en ce que les électrodes P et électrodes N des micro-LEDs latérales comprennent des bosses de soudure, et le 40 procédé comprend en outre: liaison des bosses de soudure avec les plots.
- Procédé de fabrication d'un dispositif à micro-LED, caractérisé en ce qu'il comprend transfert des micro-LEDs latérales sur un substrat de réception en utilisant le procédé selon la revendication 1.

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**FIG.** 1



**FIG. 2A** 



FIG. 2B



FIG. 2C



FIG. 2D



FIG. 2E



FIG. 2F









FIG. 4A











FIG. 4D







FIG. 4F











**FIG. 4I** 











FIG. 4L













FIG. 7B



































FIG. 9



#### **REFERENCES CITED IN THE DESCRIPTION**

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# patsnap

专利名称(译)	微型led的转移方法和微型led器件的制造方法			
公开(公告)号	EP3221903B1	公开(公告)日	2019-06-19	
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[标]申请(专利权)人(译)	歌尔声学股份有限公司			
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发明人	ZOU, QUANBO WANG, ZHE			
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代理机构(译)	HÜBNER,胃食管反流病			
其他公开文献	EP3221903A1 EP3221903A4			
外部链接	<u>Espacenet</u>			

摘要(译)

本发明公开了一种微型LED的转移方法,制造方法,装置和电子设备。 转移微型LED的方法包括:在激光透明的原始基板上形成微型LED,其 中微型LED是横向微型LED,其P电极和N电极位于一侧;使横向微型LED 的P电极和N电极与预设在接收基板上的焊盘接触;用来自原始基板侧的激 光照射原始基板,以从原始基板上剥离横向微型LED。使用横向微型 LED的技术效果在于,可以省略微型LED转移后的N金属电极的处理。



FIG. 2A