US Patent & Trademark Office
Patent Public Search | Text View

United States Patent Application Publication 20250261479
Kind Code A1
Publication Date August 14, 2025
Inventor(s) Cheng; Kai et al.

METHOD FOR MANUFACTURING LIGHT EMITTING DEVICE

Abstract

A method for manufacturing an electronic device is provided. The method for manufacturing the electronic device includes: providing a substrate with elements disposed thereon and transferring at least one of the elements from the substrate to a driving substrate, which includes illuminating a region of the substrate overlapped with the at least one of the elements by an energy beam, wherein the driving substrate includes a circuit board and a pixel defining layer disposed on the circuit board, and the pixel defining layer includes a hole for accommodating the at least one of the elements. A bottom surface of the at least one of the elements is higher than a top surface of the pixel definition layer when the region of the substrate is illuminated by the energy beam.

Inventors: **Cheng; Kai (Miaoli County, TW), Hsieh; Tsau-Hua (Miaoli County, TW), Shih; Jian-Jung (Miaoli County, TW), Lin; Fang-Ying (Miaoli County, TW), Wang; Hui-Chieh (Miaoli County, TW), Huang; Wan-Ling (Miaoli County, TW)**

Applicant: **Innolux Corporation** (Miaoli County, TW)

Family ID: **1000008560713**

Assignee: **Innolux Corporation (Miaoli County, TW)**

Appl. No.: **19/096741**

Filed: **April 01, 2025**

Related U.S. Application Data

parent US continuation 18298343 20230410 parent-grant-document US 12294038 child US 19096741
parent US continuation 16853723 20200420 parent-grant-document US 11658262 child US 18298343
us-provisional-application US 62873191 20190712

Publication Classification

Int. Cl.: **H10H20/01** (20250101); **H01L25/075** (20060101)

U.S. Cl.:

CPC **H10H20/01** (20250101); **H01L25/0753** (20130101); H10H20/0364 (20250101)

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION [0001] This application is a continuation application of and claims the priority benefit of a prior U.S. application Ser. No. 18/298,343, filed on Apr. 10, 2023. The prior U.S. application Ser. No. 18/298,343 is a continuation application of and claims the priority benefit of a prior U.S. application Ser. No. 16/853,723, filed on Apr. 20, 2020, which claims the priority benefit of U.S. provisional application Ser. No. 62/873,191, filed on Jul. 12, 2019. The entirety of each of the above-mentioned patent applications is hereby incorporated by reference herein and made a part of this specification.

BACKGROUND
Technical Field
[0002] The disclosure relates to a method for manufacturing an electronic device, and in particular, to a method for manufacturing a light emitting device.
Description of Related Art
[0003] Light emitting diode (LED) transfer is a key step in the method for manufacturing light emitting devices. Several methods have been proposed for transferring LEDs between different substrates. However, due to the limited information on LED transfer technology, knowledge of LED mass transfer, selective transfer or repair transfer is insufficient or incomplete.
SUMMARY
[0004] The disclosure provides a method for manufacturing a light emitting device, which is suitable for LED mass transfer, selective transfer, or repair transfer.
[0005] According to an embodiment of the disclosure, a method for manufacturing an electronic device is provided. The method for manufacturing the electronic device includes: providing a substrate with elements disposed thereon and transferring at least one of the elements from the substrate to a driving substrate, which includes illuminating a region of the substrate overlapped with the at least one of the elements by an energy beam, wherein the driving substrate includes a circuit board and a pixel defining layer disposed on the circuit board, and the pixel defining layer includes a hole for accommodating the at least one of the elements. A bottom surface of the at least one of the elements is higher than a top surface of the pixel definition layer when the region of the substrate is illuminated by the energy beam.
[0006] Based on the above, in one or more embodiments of the disclosure, the method for manufacturing the light emitting device describes LED transfer technology and is suitable for LED mass transfer, selective transfer, or repair transfer.
[0007] In order to make the above features or advantages of the disclosure more obvious, the following embodiment is described in detail with reference to the accompanying drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The accompanying drawings are included to provide a further understanding of the disclosure, and are incorporated in and constitute a part of this specification. The drawings illustrate exemplary embodiments of the disclosure and, together with the description, serve to explain the principles of the disclosure.

[0009] FIG. **1**A to FIG. **1**D are flowcharts of a method for manufacturing a light emitting device according to a first embodiment of the disclosure.

[0010] FIG. **1**E is a schematic diagram showing an alternative step that can replace the step shown in FIG. **1**A.

[0011] FIG. **2**A to FIG. **2**C are flowcharts of a method for manufacturing a light emitting device according to a second embodiment of the disclosure.

[0012] FIG. **3**A to FIG. **3**B are flowcharts of a method for manufacturing a light emitting device according to a third embodiment of the disclosure.

[0013] FIG. **4**A to FIG. **4**B are flowcharts of a method for manufacturing a light emitting device according to a fourth embodiment of the disclosure.

[0014] FIG. **5**A and FIG. **5**B are schematic top views of a light emitting device before and after repairing, respectively.

DESCRIPTION OF THE EMBODIMENTS

[0015] The disclosure may be understood by referring to the following detailed descriptions in conjunction with the accompanying drawings. It should be noted that in order for the reader to understand easily and for the simplicity of the drawings, multiple drawings in the disclosure only illustrate a portion of the light emitting device, and specific elements in the drawings are not drawn to scale. In addition, the number and size of each element in the drawings are only for illustration and are not intended to limit the scope of the disclosure.

[0016] Certain terms are used throughout the disclosure and the appended claims to refer to specific elements. Persons skilled in the art should understand that electronic equipment manufacturers may refer to the same elements using different names. The disclosure is not intended to distinguish between the elements with the same function but different names. In the following specification and claims, words such as “having” and “including” are open-ended words, which should be interpreted as the meaning of “including but not limited to . . . ”.

[0017] Directional terms such as “up”, “down”, “front”, “rear”, “left”, “right”, etc., as mentioned in the disclosure only refer to directions with reference to the drawings. Therefore, the directional terms are only for illustration and are not intended to limit the disclosure. In the drawings, the drawings illustrate general characteristics of methods, structures, and/or materials used in specific embodiments. However, the drawings should not be construed to define or limit the scope or nature covered by the embodiments. For example, for clarity, the relative size, thickness, and location of each film layer, region, and/or structure may be reduced or enlarged.

[0018] It should be understood that when an element or film layer is referred to as being disposed “on” or “connected” to another element or film layer, the former may be directly on or directly connected to the other element or film layer or there may be an intervening element or film layer between the two (indirect case). In contrast, when an element is referred to as being “directly on” or “directly connected” to another element or film layer, there is no intervening element or film layer between the two.

[0019] The term “approximately”, “around”, “equal to”, “equal”, or “same” typically represents falling within a 20% range of a given value or range, or represents falling within a 10%, 5%, 3%, 2%, 1%, or 0.5% range of a given value or range.

[0020] In the disclosure, the same or similar elements will be given the same or similar reference numerals, and detailed descriptions thereof will be omitted. In addition, as long as the features in different embodiments do not violate the spirit of the disclosure and are not mutually conflicting, they may be mixed and used arbitrarily. Also, all simple equivalent changes and modifications made according to the specification or claims fall within the scope of the disclosure. In addition, terms such as “first”, “second”, etc. mentioned in the specification or claims are only used to name discrete elements or to distinguish different embodiments or ranges, but not to limit the upper limit or lower limit of the number of elements and the manufacturing sequence or configurational sequence of the elements.

[0021] The light emitting device of the disclosure may include a display device, an antenna device, a sensing device, or a splicing device, but is not limited thereto. In one example, the light emitting device may be a backlight module of a display device, but not limited thereto. The light emitting device may be a bendable or flexible device. The light emitting device may include, for example, at least one light emitting unit. The light emitting unit may include a light emitting diode (LED). The LED may include, for example, an organic LED (OLED), a mini LED, a micro LED, or a quantum dot LED (abbreviated as QLED or QDLED), fluorescence, phosphor, other suitable materials, or a combination thereof, but is not limited thereto.

[0022] FIG. **1**A to FIG. **1**D are flowcharts of a method for manufacturing a light emitting device according to a first embodiment of the disclosure. Referring to FIG. **1**A, a substrate **10** with light emitting units **12** disposed thereon is provided. In some embodiments, the substrate **10** is a growth substrate, and the light emitting units **12** may be formed on the substrate **10** through an epitaxy process, but not limited thereto. The growth substrate may include a sapphire wafer or other substrate suitable for fabricating the light emitting units **12**. In other embodiments, the substrate **10** is a carrier substrate, and the light emitting units **12** may be formed on or disposed on the substrate **10** through a transfer process, but not limited thereto. The carrier substrate (also referred to as “a carrier”) may include a rigid substrate for carrying the light emitting units **12**, but not limited thereto. In some embodiments, the carrier substrate may further include an adhesive layer (not shown) to allow the light emitting units **12** to be attached to the rigid substrate. The adhesive layer may include one or more organic material layers. A material of the one or more organic material layers may include acrylic, silicone, photo resin, resin, or petroleum series material, but not limited thereto.

[0023] At least one of the light emitting units **12** may include a light emitting diode (LED) **120**. The at least one of the light emitting units **12** may further include a plurality of pads **122** (e.g., a pair of pads **122**) disposed on the LED **120**, wherein the LED **120** is located between the plurality of pads **122** and the substrate **10**, and the LED **120** can be lit by receiving external signals via the plurality of pads **122**.

[0024] Then, the light emitting units **12** are attached to a carrier **20**. In some embodiments, the light emitting units **12** are attached to the carrier **20** through a lamination process, wherein a lamination pressure thereof is in a range from 0.1M Pa to **3**M Pa (i.e., 0.1×106 Pa≤lamination pressure≤3×106 Pa), and a lamination temperature thereof is in a range from room temperature to 300° C. (i.e., room temperature≤lamination temperature≤300° C.). The room temperature may be around 25° C.

[0025] In some embodiments, the carrier **20** may include a rigid substrate **200** and an adhesive layer **202** disposed on the rigid substrate **200**. The rigid substrate **200** has stiffness to maintain a flat surface for carrying the light emitting units **12** during the transfer of the light emitting units **12**. For example, the rigid substrate **200** includes a glass substrate, but not limited thereto. The adhesive layer **202** is adapted to allow the light emitting units **12** to be attached to the rigid substrate **200**, and when the adhesive layer **202** is exposed to light, heat, or mechanical force, the adhesive ability or sticky force of the adhesive layer **202** may be reduced or the adhesive layer **202** may be evaporated. For example, the adhesive layer **202** may include one or more organic material layers. A material of the one or more organic material layers may include acrylic, silicone, photo resin, resin, petroleum series material, other suitable materials, and a combination thereof, but not limited thereto. The adhesive layer **202** may be a single layer or multiple layers. A thickness T**202** of the adhesive layer **202** may be in a range from 0.1 μm to 100 μm (i.e., 0.1 μm ≤T**202**≤100 μm), but not limited thereto. The thickness T**202** of the adhesive layer **202** may refer to the maximum thickness of the cross-sectional area of the adhesive layer **202**. In some alternative embodiments, the adhesive layer **202** may include a UV tape or a thermal tape, but not limited thereto.

[0026] The light emitting units **12** may be attached to the adhesive layer **202** after the light emitting units **12** are attached to the carrier **20**. In some embodiments, the light emitting units **12** may contact the adhesive layer **202** and may not be immersed in the adhesive layer **202**, as shown in FIG. **1**A. However, whether the light emitting units **12** are immersed in the adhesive layer **202** or not is not limited in the disclosure, and the depths to which the light emitting units **12** are immersed in the adhesive layer **202** may depend on factors such as process conditions (e.g., lamination force) and the material property. FIG. **1**E is a schematic diagram showing an alternative step that can replace the step shown in FIG. **1**A. As shown in FIG. **1**E, in some alternative embodiments, the light emitting units **12** may be immersed in the adhesive layer **202**, and the light emitting units **12** may or may not contact the rigid substrate **200**.

[0027] After the light emitting units **12** are attached to the carrier **20**, the substrate **10** may be removed. The upper half of FIG. **1**B illustrates the situation where the substrate **10** is removed and the carrier **20** attached with the light emitting units **12** is turned over.

[0028] In some embodiments, the substrate **10** is removed from the light emitting units **12** through a light illumination process, an etching process, a heating process, a mechanical force application process, or a combination thereof. Take the light illumination process for example, the substrate **10** may be illuminated by an energy beam (not shown). The energy beam may be a laser beam, but not limited thereto. In some embodiments, a wavelength of the energy beam may be in a range from 200 nm to 1064 nm (i.e., 200 nm≤wavelength≤1064 nm), but not limited thereto. For example, the wavelength of the energy beam may be 266 nm, 308 nm, 355 nm, 532 nm, or 1064 nm, but not limited thereto.

[0029] In the case where the substrate **10** is a growth substrate (such as a sapphire substrate) and the light emitting units **12** are grown on the growth substrate, a chemical reaction generated by the irradiation of the energy beam causes nitrogen gas to be generated at an interface between the substrate **10** and the light emitting units **12**, thereby separating the substrate **10** from the light emitting units **12**. In the case where the substrate **10** is a carrier substrate and the light emitting units **12** are attached to an adhesive layer (not shown) of the carrier substrate, a chemical reaction generated by the irradiation of the energy beam causes the adhesive layer of the carrier substrate to reduce its adhesive ability or causes the adhesive layer of the carrier substrate to evaporate, thereby separating the substrate **10** from the light emitting units **12**. Under both circumstances, the energy beam illuminates the substrate **10** from a side of the substrate **10** opposite to the carrier **20** to minimize the effect of the energy beam on the adhesive layer **202** of the carrier **20**, and the light emitting units **12** are still attached to the carrier **20** after the irradiation of the energy beam. Moreover, the substrate **10** may be separated from the light emitting units **12** by illuminating the entire substrate **10** with the energy beam or by illuminating partial regions (e.g., regions of the substrate **10** that are overlapped with the light emitting units **12** in a normal direction D of the substrate **10**) of the substrate **10** with the energy beam.

[0030] After the substrate **10** is removed, a portion of the light emitting units **12** (e.g., the light emitting units **12**P among the light emitting units **12**) are transferred from the carrier **20** to a driving substrate **40**, as shown in FIG. **1**B to FIG. **1**D.

[0031] FIG. **1**B illustrates a step of a selective transfer. The selective transfer refers to a case where a portion of the light emitting units **12** (e.g., the light emitting units **12**P among the light emitting units **12**) are transferred, and the other portion of the light emitting units **12** (e.g., the light emitting units **12**P′ among the light emitting units **12**) are not transferred.

[0032] Referring to FIG. **1**B, the portion of the light emitting units **12** (e.g., the light emitting units **12**P among the light emitting units **12**) are transferred from the carrier **20** to another carrier (e.g., a carrier **30**). In some embodiments, the portion of the light emitting units **12** (e.g., the light emitting units **12**P among the light emitting units **12**) are transferred from the carrier **20** to the carrier **30** through steps of: turning over the carrier **20** attached with the light emitting units **12** and the light emitting units **12** faces the carrier **30**; and illuminating regions R of the carrier **20** overlapped with the light emitting units **12**P by an energy beam EB. For the related description of the energy beam EB and the chemical reaction generated at the adhesive layer **202** of the carrier **20** due to the irradiation of the energy beam EB, please refer to the above, and it will not be repeated here.

[0033] After the irradiation of the energy beam EB, the adhesive ability or sticky of the adhesive layer **202** is reduced or the adhesive layer **202** is evaporated in regions R subjected to the energy beam EB, and the light emitting units **12**P falls on the carrier **30** by gravity. In some embodiments, a gap G between the carrier **20** and the carrier **30** when the carrier **20** is illuminated by the energy beam EB may be in a range from 1 μm to 300 μm (i.e., 1 μm≤G≤300 μm) to improve the accuracy or success rate of LED transfer, such as 50 μm, 100 μm or 200 μm. The gap G between the carrier **20** and the carrier **30** refers to the distance between the outermost surface of the carrier **20** facing the carrier **30** and the outermost surface of the carrier **30** facing the carrier **20** along a stacking direction of the carrier **20** and the carrier **30**.

[0034] In some embodiments, the carrier **30** may include a rigid substrate **300** and an adhesive layer **302** disposed on the rigid substrate **300**, but not limited thereto. For the related description of the rigid substrate **300** and the adhesive layer **302**, please refer to the rigid substrate **200** and the adhesive layer **202** above, and it will not be repeated here. In some embodiments, the rigid substrate **300** and the rigid substrate **200** may have the same or different properties, such as material, thickness, light transmittance, hardness, or the like. In some embodiments, the adhesive layer **302** and the adhesive layer **202** may have the same or different properties, such as material, thickness, viscosity, number of film layers, or the like. In some embodiments, a thickness T**302** of the adhesive layer **302** may be in a range from 0.1 μm to 100 μm (i.e., 0.1 μm≤T**302**≤100 μm, such as 1 μm, 5 μm, 10 μm, or 50 μm), and the thickness T**302** of the adhesive layer **302** may be the same as or different from the thickness T**202** of the adhesive layer **202**. The thickness T**302** of the adhesive layer **302** refers to the maximum thickness of the cross-sectional area of the adhesive layer **302**.

[0035] After the portion of the light emitting units **12** (e.g., the light emitting units **12**P among the light emitting units **12**) are transferred from the carrier **20** to the carrier **30**, the light emitting units **12**P are disposed on the adhesive layer **302**, and the LEDs **120** of the light emitting units **12**P are located between the plurality of pads **122** and the adhesive layer **302**.

[0036] The adhesive layer **302** may help the light emitting units **12**P attach to the rigid substrate **300** with acceptable shift or twist. Therefore, in the step of FIG. **1**B, the selective transfer can also be changed to a mass transfer or a repair transfer as needed.

[0037] Referring to FIG. **1**C, after the light emitting units **12**P are transferred to the carrier **30**, the light emitting units **12**P are transferred from the carrier **30** to the driving substrate **40**. In some embodiments, the light emitting units **12**P are transferred from the carrier **30** to the driving substrate **40** through steps of: bonding the pads **122** of the light emitting units **12**P to pads **402** of the driving substrate **40**; and removing the carrier **30**. In some embodiments, the carrier **30** attached with the light emitting units **12**P is turned over and the pads **122** of the light emitting units **12**P faces the pads **402** of the driving substrate **40**, and the light emitting units **12**P and the pads **402** are located between the carrier **30** and the circuit board **400** of the driving substrate **40**. The circuit board **400** may be a printed circuit board (PCB), but not limited thereto. Then, the pads **122** of the light emitting units **12**P are aligned and in contacted with the pads **402** of the driving substrate **40**. After the pads **122** of the light emitting units **12**P are in contacted with the pads **402** of the driving substrate **40**, a eutectic bonding or a reflow process may be performed and the pads **122** of the light emitting units **12**P are connected to the pads **402** of the driving substrate **40**.

[0038] After the pads **122** of the light emitting units **12**P are connected to the pads **402** of the driving substrate **40**, the carrier **30** may be removed by illuminating the carrier **30** by an energy

beam (not shown). For the related description of the energy beam and the chemical reaction generated at the adhesive layer **302** of the carrier **30** due to the irradiation of the energy beam, please refer to the above, and it will not be repeated here.
[0039] After the carrier **30** is removed from the light emitting units **12**P, a light emitting device **1** is manufactured, as shown in FIG. **1**D.
[0040] In the embodiment shown in FIGS. **1**A to **1**D, the light emitting units **12**P are bonded to the driving substrate **40** through the transfer processes (e.g., one mass transfer process shown in FIG. **1**A, one selective transfer process shown in FIG. **1**B and one mass transfer process shown in FIG. **1**C). With the three transfer processes, the light emitting units **12**P to be transferred to the driving substrate **40** can be picked up from the substrate **10** and the pads **122** of the light emitting units **12**P can be turned to the direction where the pads **402** of the driving substrate **40** can be joined, which facilitates the bonding of the pads **122** of the light emitting units **12**P and the pads **402** of the driving substrate **40**. Moreover, because the accuracy or success rate of LED transfer is/are improved in the three transfer processes, the yield of the method for manufacturing the light emitting device **1** and the reliability of the light emitting device **1** can be improved.
[0041] In some embodiments, the light emitting units **12** (including the light emitting units **12**P and the light emitting units **12**P′) may emit light with the same color. For example, the light emitting units **12** are red light emitting units, green light emitting units, or blue light emitting units. After the light emitting units of a first color are transferred to the driving substrate **40** through the steps shown in FIGS. **1**A to **1**D, the light emitting units of a second color or multiple colors may be transferred to the driving substrate **40** by performing the steps shown in FIGS. **1**A to **1**D once or multiple times.
[0042] According to different requirements, in addition to the steps shown in FIGS. **1**A to **1**D, the manufacturing of the light emitting device **1** may also include other additional steps. For example, a step of attaching the circuit board **400** of the driving substrate **40** to other circuits (not shown) after the required transfer processes are completed, but not limited thereto.
[0043] FIG. **2**A to FIG. **2**C are flowcharts of a method for manufacturing a light emitting device according to a second embodiment of the disclosure, wherein FIG. **2**A is a schematic top view, and FIGS. **2**B and **2**C are schematic cross-sectional views.
[0044] Referring to FIG. **2**A, a driving substrate **40**A is provided. The driving substrate **40**A may further include a pixel defining layer **404** in addition to the circuit board **400** and the pads **402**. The pixel defining layer **404** is disposed on the circuit board **400**, and the pixel defining layer **404** includes holes H for accommodating the light emitting units to be transferred to the driving substrate **40**A. In some embodiments, as shown in FIG. **2**A, the hole H may be disposed with a pair of pads **402** to be bonded with the pads **122** of one light emitting unit. The design parameters (e.g., the pitch/shape/size/arrangement of the holes H) of the holes H may be changed as required and therefore are not limited to those shown in FIG. **2**A. For example, in some embodiments, the shape of the holes H may be circular, triangular, other polygon, or other suitable shape.
[0045] In some embodiments, a material of the pixel defining layer **404** may include an opaque insulating material to properly shield the elements located underneath from being seen by the user or reduce reflections. A material of the opaque insulating material may include acrylic, silicone, resin, or photo resin, and the material may be mixed with dyes to reduce light transmittance, but not limited thereto. In some embodiments, the pixel defining layer **404** may be formed on the circuit board **400** through a pattern process. The pattern process may include a spin coating process, a slit coating process, a printing process, or any other lithography processes.
[0046] Referring to FIG. **2**B, the substrate **10** provided with the light emitting units **12** is located on the driving substrate **40**A, and the light emitting units **12** face the driving substrate **40**A. The pads **122** of the light emitting units **12** are aligned with the pads **402** of the driving substrate **40**A. Then the light emitting units **12**P are transferred to the driving substrate **40**A through a selective transfer process. For example, regions RA of the substrate **10** overlapped with the light emitting units **12**P

in the normal direction D of the substrate **10** are illuminated by the energy beam EB, and the light emitting units **12**P are separated from the substrate **10** and fall on the driving substrate **40**A. For the related description of the energy beam EB and the chemical reaction generated at the substrate **10** due to the irradiation of the energy beam EB, please refer to the above, and it will not be repeated here.

[0047] Referring to FIG. **2**C, after the light emitting units **12**P are transferred from the substrate **10** to the driving substrate **40**A, a eutectic bonding or a reflow process may be performed and the pads **122** of the light emitting units **12**P are connected to the pads **402** of the driving substrate **40**A. In some embodiments, a substrate (not shown) may press down the light emitting units **12**P during the eutectic bonding, but not limited thereto.

[0048] After the pads **122** of the light emitting units **12**P are connected to the pads **402** of the driving substrate **40**A, a light emitting device **1**A is manufactured, as shown in FIG. **2**C.

[0049] In the embodiment shown in FIGS. **2**A to **2**C, the holes H of the pixel defining layer **404** can limit the regions where the light emitting units **12**P fall and thus improves the accuracy of the LED transfer. Moreover, side walls of the holes H can support the light emitting units **12**P, and thus reduce the poor contact due to LED tilting or improve success rate of the LED transfer. Therefore, the light emitting units **12**P may be bonded to the driving substrate **40**A through the transfer processes (e.g., one selective transfer process shown in FIG. **2**B), and the yield of the method for manufacturing the light emitting device **1**A and the reliability of the light emitting device **1**A can be improved.

[0050] In some embodiments, the light emitting units with different colors may sequentially be transferred to the driving substrate **40**A by performing the steps shown in FIGS. **2**A to **2**C multiple times. That is, the light emitting units with the same color may be transferred at the same time, but not limited thereto. According to different requirements, in addition to the steps shown in FIGS. **2**A to **2**C, the manufacturing of the light emitting device **1**A may also include other additional steps. For example, a step of attaching the circuit board **400** of the driving substrate **40**A to other circuits (not shown) after the required transfer processes are completed, but not limited thereto.

[0051] FIG. **3**A to FIG. **3**B are flowcharts of a method for manufacturing a light emitting device according to a third embodiment of the disclosure. Referring to FIG. **3**A, the substrate **10** provided with the light emitting units **12** is located on the carrier **20**, and the light emitting units **12** face the carrier **20**. Then the light emitting units **12**P are transferred to the carrier **20** through a selective transfer process. For example, regions RA of the substrate **10** overlapped with the light emitting units **12**P in the normal direction D of the substrate **10** are illuminated by the energy beam EB, and the light emitting units **12**P are separated from the substrate **10** and fall on the carrier **20**. A gap GB between the substrate **10** and the carrier **20** when the substrate **10** is illuminated by the energy beam EB may be greater than 0 μm and less than or equal to 1000 μm (i.e., 0 μm<GB≤ 1000 μm, such as 100 μm, 200 μm, 400 μm, or 800 μm) to improve the accuracy or success rate of LED transfer. The gap GB between the substrate **10** and the carrier **20** refers to the distance between the outermost surface of the carrier **20** facing the substrate **10** and the outermost surface of the substrate **10** facing the carrier **20** along a stacking direction of the carrier **20** and the substrate **10**. For the related description of the energy beam EB and the chemical reaction generated at the substrate **10** due to the irradiation of the energy beam EB, please refer to the above, and it will not be repeated here.

[0052] Referring to FIG. **3**B, after the selective transfer shown in FIG. **3**A, the light emitting units **12**P are transferred from the carrier **20** to the carrier **30**. For example, the light emitting units **12**P are attached to the carrier **30**, and then the carrier **20** is removed. When the light emitting units **12**P are attached to the carrier **30**, the light emitting units **12**P may contact the adhesive layer **302** of the carrier **30**.

[0053] After the light emitting units **12**P are attached to the carrier **30**, the carrier **20** is removed. The adhesion of the adhesive layer **302** to the light emitting units **12**P shall be greater than the adhesion of the adhesive layer **202** to the light emitting units **12**P, and when the carrier **20** is removed, the light emitting units **12**P are still attached to the carrier **30**. Accordingly, the adhesive layer **302** of the carrier **30** has a adhesive ability or sticky higher than that of the adhesive layer **202** of the carrier **20**.

[0054] After the light emitting units **12**P are transferred from the carrier **20** to the carrier **30**, steps shown in FIGS. **1**C and **1**D may be sequentially proceeded, and the light emitting device **1** in FIG. **1**D is manufactured.

[0055] In the embodiment shown in FIGS. **3**A and **3**B, the light emitting units **12**P are bonded to the driving substrate **40** through the transfer processes (e.g., one selective transfer process shown in FIG. **3**A and two mass transfer process shown in FIG. **3**B and FIG. **1**C).

[0056] In some embodiments, the light emitting units with different colors may sequentially be transferred to the driving substrate **40** by performing the steps shown in FIGS. **3**A, **3**B, **1**C and **1**D multiple times. According to different requirements, in addition to the steps shown in FIGS. **3**A, **3**B, **1**C and **1**D, the manufacturing of the light emitting device **1** may also include other additional steps. For example, a step of attaching the circuit board **400** of the driving substrate **40** to other circuits (not shown) after the required transfer processes are completed, but not limited thereto.

[0057] FIG. **4**A to FIG. **4**B are flowcharts of a method for manufacturing a light emitting device according to a fourth embodiment of the disclosure. Referring to FIG. **4**A, after the light emitting units **12** are transferred from the substrate **10** to the carrier **20** as shown in FIG. **1**A, the light emitting units **12** are transferred from the carrier **20** to the carrier **30**. For example, the light emitting units **12** are attached to the carrier **30**, and then the carrier **20** is removed. When the light emitting units **12** are attached to the carrier **30**, the light emitting units **12** are attached to the adhesive layer **302** of the carrier **30**.

[0058] Referring to FIG. **4**B, after the light emitting units **12** are transferred from the carrier **20** to the carrier **30**, the light emitting units **12**P may be transferred from the carrier **30** to the driving substrate **40**A by illuminating regions RB of the carrier **30** overlapped with the light emitting units **12**P by the energy beam EB. For the related description of the energy beam EB and the chemical reaction generated at the adhesive layer **302** of the carrier **30** due to the irradiation of the energy beam EB, please refer to the above, and it will not be repeated here.

[0059] After the light emitting units **12** are transferred from the carrier **20** to the carrier **30**, the step shown in FIG. **2**C may be proceeded, and the light emitting device **1**A in FIG. **2**C is manufactured.

[0060] In some embodiments, the light emitting units with different colors may sequentially be transferred to the driving substrate **40**A by performing the steps shown in FIGS. **1**A, **4**A, **4**B and **2**C multiple times. According to different requirements, in addition to the steps shown in FIGS. **1**A, **4**A, **4**B and **2**C, the manufacturing of the light emitting device **1**A may also include other additional steps. For example, a step of attaching the circuit board **400** of the driving substrate **40**A to other circuits (not shown) after the required transfer processes are completed, but not limited thereto.

[0061] FIG. **5**A and FIG. **5**B are schematic top views of a light emitting device before and after repairing, respectively. FIG. **5**A illustrates a driving substrate **40**B of a light emitting device **1**B before repairing. The light emitting device **1**B includes red light emitting units R, green light emitting units G and blue light emitting units B disposed on the driving substrate **40**B and arranged in an array. For repair needs, the driving substrate **40**B further includes redundant regions RR disposed adjacent to the red light emitting units R, the green light emitting units G and the blue light emitting units B. When at least one of the light emitting units on the driving substrate **40**B is found to be inoperable, a light emitting unit having the same color as that of the inoperable light emitting unit (the light emitting unit with x mark) may be disposed in the redundant region RR adjacent to the inoperable light emitting unit through a repair transfer process. For example, red light emitting units R may be transferred to redundant regions RR adjacent to the inoperable red light emitting units R through one of the transfer processes described above. Then, green light emitting units G may be transferred to redundant regions RR adjacent to the inoperable green light emitting units G through one of the transfer processes described above. Then, blue light emitting

units B may be transferred to redundant regions RR adjacent to the inoperable blue light emitting units B through one of the transfer processes described above.
[0062] In summary, in one or more embodiments of the disclosure, the method for manufacturing the light emitting device describes light emitting unit transfer technology and is suitable for the mass transfer, the selective transfer, or the repair transfer. In some embodiments, the light emitting units may be detached from a substrate or a carrier through a light illumination process (e.g., a laser lift off process). In some embodiments, the selective transfer may be performed by illuminating the regions of the substrate or the carrier that are overlapped with the light emitting units to be detached from the substrate or the carrier by the energy beam of the light illumination process.
[0063] It will be apparent to those skilled in the art that various modifications and variations can be made to the disclosed embodiments without departing from the scope or spirit of the disclosure. In view of the foregoing, it is intended that the disclosure covers modifications and variations provided that they fall within the scope of the following claims and their equivalents. Moreover, each of the claims constitutes an individual embodiment, and the scope of the disclosure also includes the scope of the various claims and combinations of the embodiments.

Claims

1. A method for manufacturing an electronic device, comprising: providing a substrate with elements disposed thereon; and transferring at least one of the elements from the substrate to a driving substrate, which comprises illuminating a region of the substrate overlapped with the at least one of the elements by an energy beam, wherein the driving substrate comprises a circuit board and a pixel defining layer disposed on the circuit board, and the pixel defining layer comprises a hole for accommodating the at least one of the elements; and wherein a bottom surface of the at least one of the elements is higher than a top surface of the pixel definition layer when the region of the substrate is illuminated by the energy beam.
2. The method for manufacturing the electronic device according to claim 1, wherein the driving substrate further comprises pads disposed on the circuit board and in the hole.
3. The method for manufacturing the electronic device according to claim 2, wherein the at least one of the elements is aligned with the pads.
4. The method for manufacturing the electronic device according to claim 3, further comprising performing a eutectic bonding process or a reflow process such that pads of the at least one of the elements are bonded to the pads of the driving substrate after transferring the at least one of the elements from the substrate to the driving substrate.
5. The method for manufacturing the electronic device according to claim 1, wherein the elements comprise light emitting units.
6. The method for manufacturing the electronic device according to claim 1, wherein a wavelength of the energy beam is in a range from 266 nm to 1064 nm.
7. The method for manufacturing the electronic device according to claim 1, wherein a material of the pixel defining layer comprises an opaque insulating material.
8. The method for manufacturing the electronic device according to claim 1, wherein a shape of the hole is circular, triangular, or polygonal.
9. The method for manufacturing the electronic device according to claim 1, wherein the substrate is a carrier substrate and the elements are attached to the substrate through an adhesive layer.
10. A method for manufacturing an electronic device, comprising: providing a substrate with elements disposed thereon; transferring a portion of the elements from the substrate to a carrier, which comprises illuminating regions of the substrate overlapped with the portion of the elements by an energy beam, transferring the portion of the elements from the carrier to another carrier; and transferring the portion of the elements from the another carrier to a driving substrate, wherein a gap between the substrate and the carrier when the regions of the substrate are illuminated by the

energy beam is in a range from 1 μm to 300 μm.
11. The method for manufacturing the electronic device according to claim 10, wherein a wavelength of the energy beam is in a range from 266 nm to 1064 nm.
12. The method for manufacturing the electronic device according to claim 10, wherein the elements comprise light emitting units.
13. The method for manufacturing the electronic device according to claim 10, wherein the carrier comprises: a rigid substrate; and an adhesive layer disposed on the rigid substrate, wherein the portion of the elements are attached to the adhesive layer after transferring from the substrate to the carrier.
14. The method for manufacturing the electronic device according to claim 13, wherein a thickness of the adhesive layer is in a range from 0.1 μm to 100 μm.
15. The method for manufacturing the electronic device according to claim 10, wherein the another carrier comprises: a rigid substrate; and an adhesive layer disposed on the rigid substrate, wherein the portion of the elements are disposed on the adhesive layer after the portion of the elements are transferred from the carrier to the another carrier.
16. The method for manufacturing the electronic device according to claim 10, wherein after transferring the portion of the elements from the another carrier to the driving substrate, the method for manufacturing the electronic device further comprises: bonding pads of the portion of the elements to pads of the driving substrate; and removing the another carrier.
17. The method for manufacturing the electronic device according to claim 16, wherein removing the another carrier comprises illuminating the another carrier by another energy beam.
18. The method for manufacturing the electronic device according to claim 10, wherein each of the carrier and the another carrier comprises: a rigid substrate; and an adhesive layer disposed on the rigid substrate, wherein the adhesive layer of the another carrier has a viscosity higher than that of the adhesive layer of the carrier, the portion of the elements are attached to the adhesive layer of the another carrier when transferring the portion of the elements from the carrier to the another carrier, and the portion of the elements are disposed on the adhesive layer of the another carrier after the elements are transferred from the carrier to the another carrier.
19. The method for manufacturing the electronic device according to claim 10, wherein after transferring the portion of the elements from the another carrier to the driving substrate, the method for manufacturing the electronic device further comprises: bonding the portion of the elements to the driving substrate by a eutectic bonding or a reflow process.