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(54) **MASS TRANSFER METHOD FOR MICRO LIGHT EMITTING DIODE AND LIGHT EMITTING PANEL MODULE USING THEREOF**

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(52) **U.S. Cl.**

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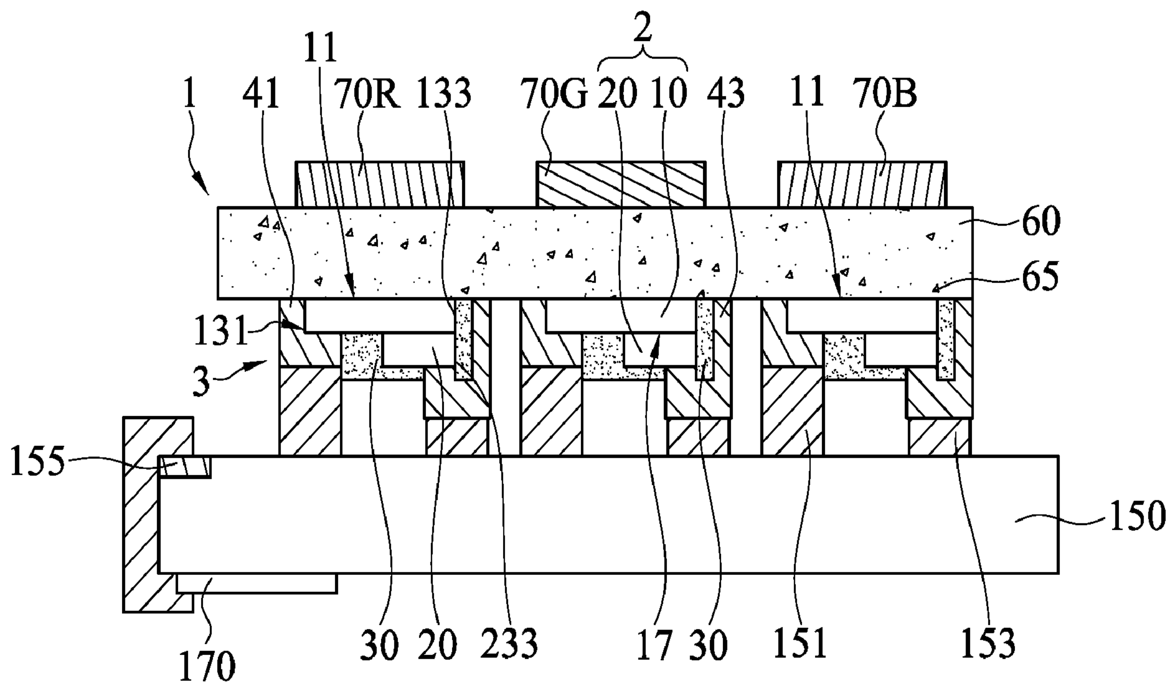
(57) **ABSTRACT**

A mass transfer method for micro light emitting diode (LED) includes a micro-LED manufacturing step, a connecting step, a removing step, a fluorescent-powder layer forming step, and a filtering-sheet forming step. In the micro-LED manufacturing step, micro-LEDs are formed on a wafer substrate. Each micro-LED includes first and second electrodes. In the connecting step, the wafer substrate including the micro-LEDs is connected with a circuit substrate including first electrical-connection portions and second electrical-connection portions. Each first electrical-connection portion is connected to the first electrode of the corresponding micro-LED, and each second electrical-connection portion is connected to the second electrode of the corresponding micro-LED. In the removing step, the wafer substrate is removed. In the fluorescent-powder layer forming step, a fluorescent-powder layer is formed on the light-emitting surface of each of the micro-LEDs. In the filtering-sheet forming step, filtering-sheets are attached on the fluorescent-powder layer.



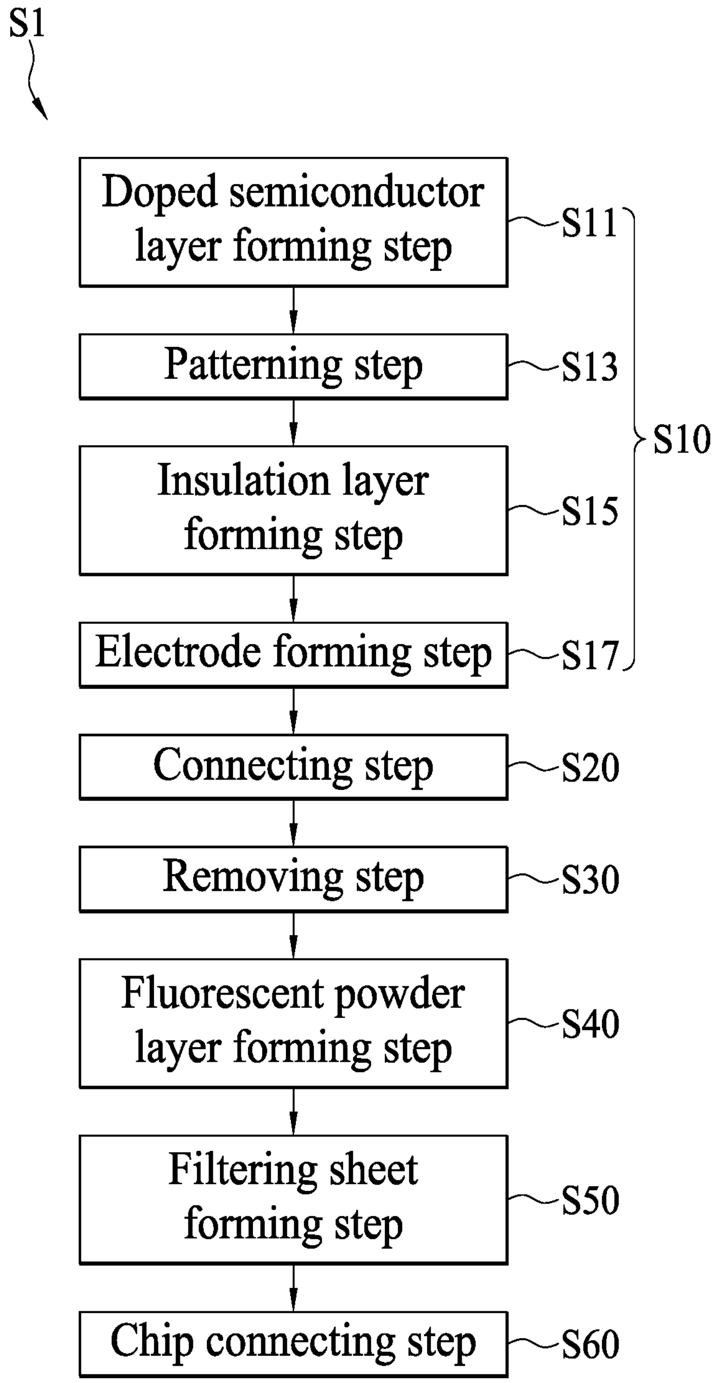

S1
Doped semiconductor layer forming step
S11
Patterning step
S13
Insulation layer forming step
S15
Electrode forming step
S17
S10
Connecting step
S20
Removing step
S30
Fluorescent powder layer forming step
S40
Filtering sheet forming step
S50
Chip connecting step
S60

FIG.1

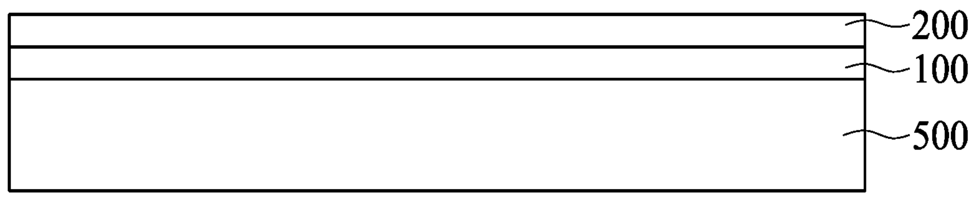


FIG.2

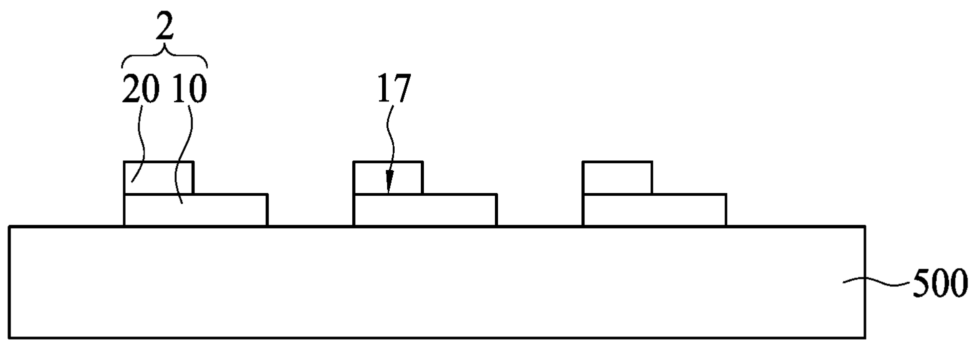


FIG.3

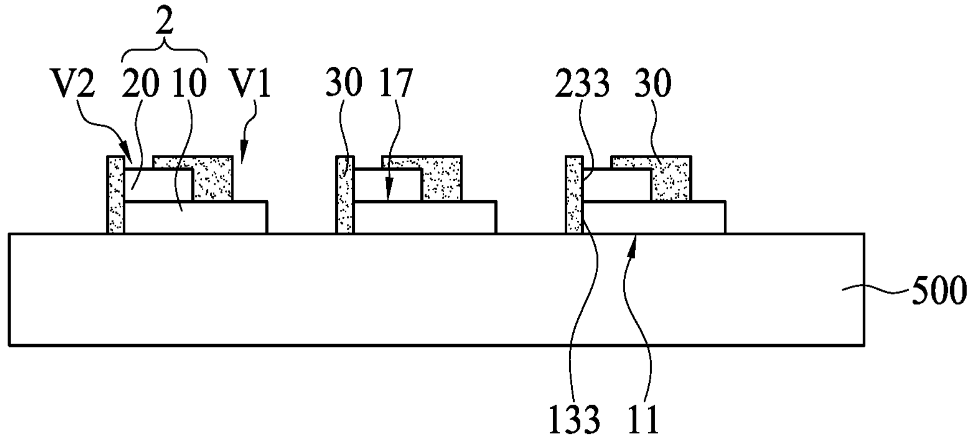

2
V2
20
10
V1
30
17
233
30
500
133
11

FIG.4

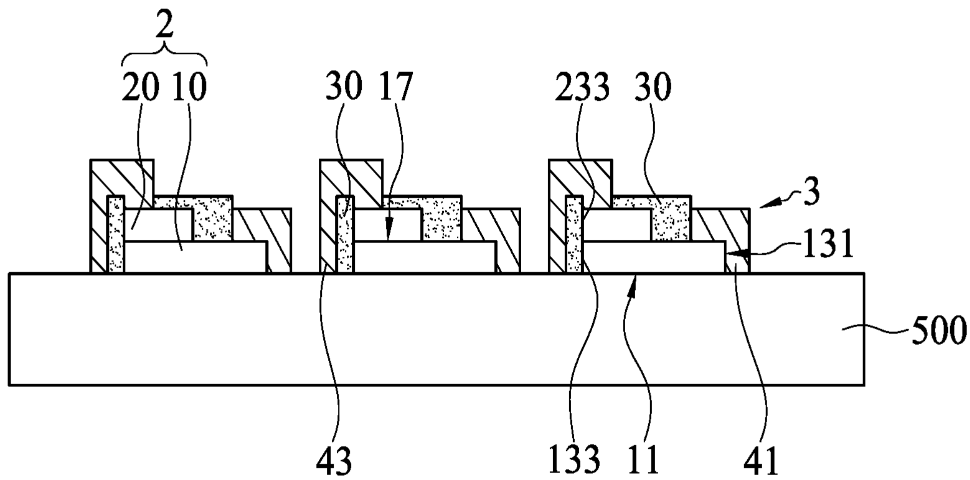

2
20
10
30
17
233
30
3
131
500
43
133
11
41

FIG.5

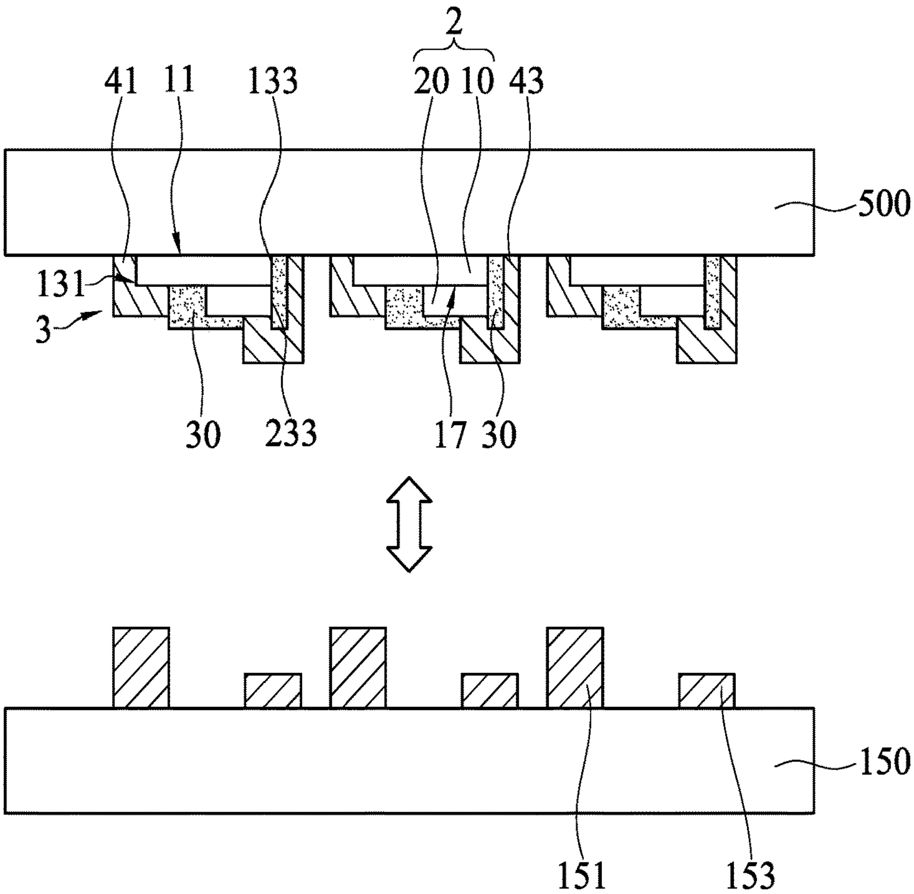

2
41 11 133 20 10 43
500
131
3
30 233 17 30
150
151 153

FIG.6

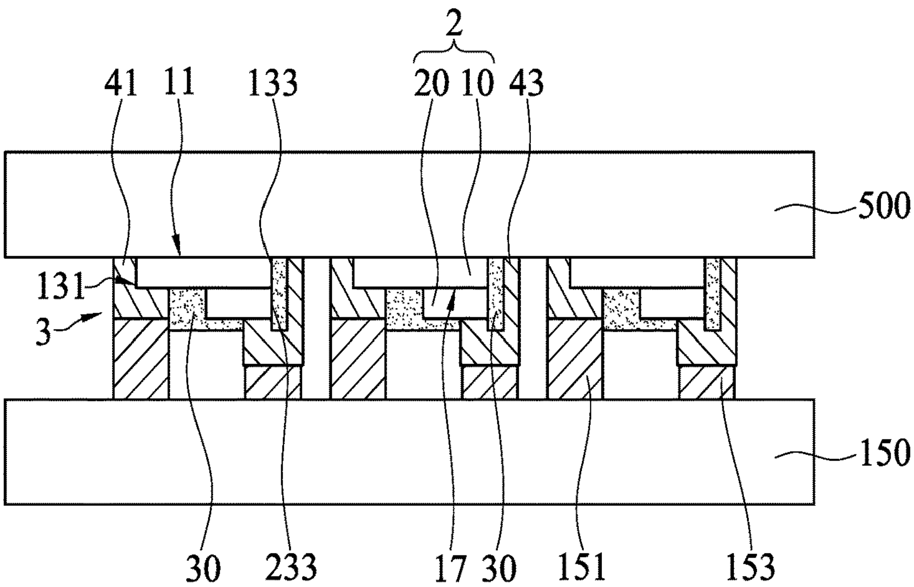

2
41 11 133 20 10 43
500
131
3
150
30 233 17 30 151 153

FIG.7

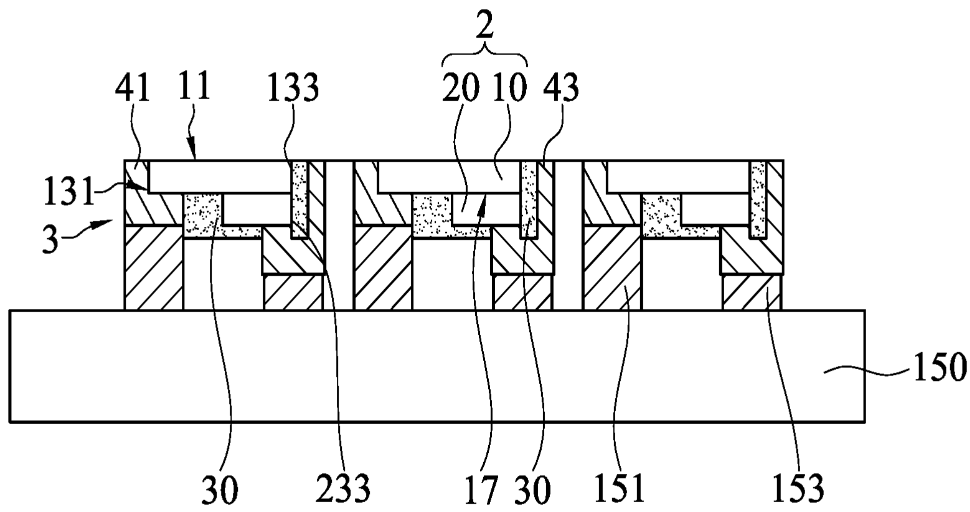

2
41
11
133
20
10
43
131
3
150
30
233
17
30
151
153

FIG.8

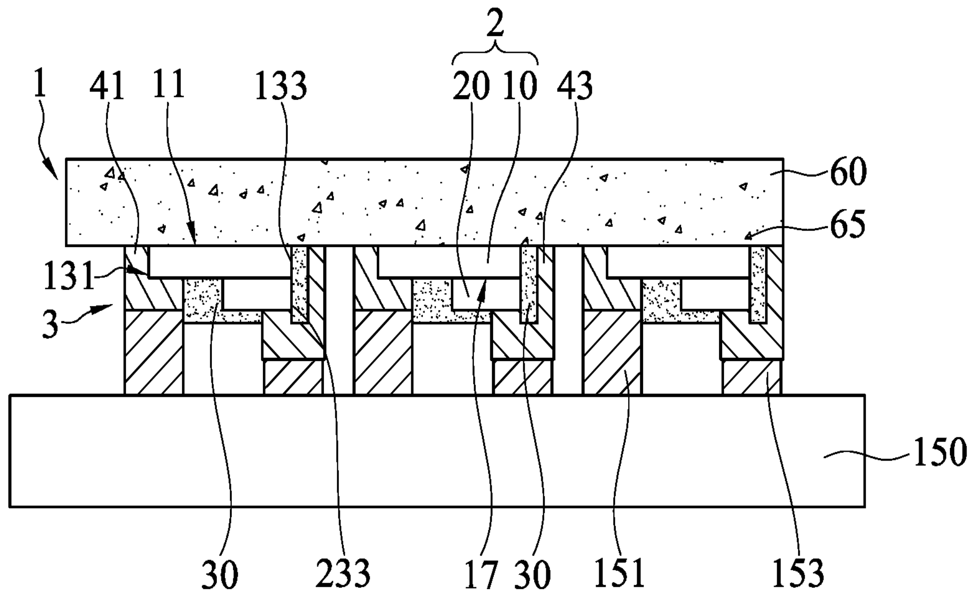

2
1
41
11
133
20
10
43
60
65
131
3
150
30
233
17
30
151
153

FIG.9

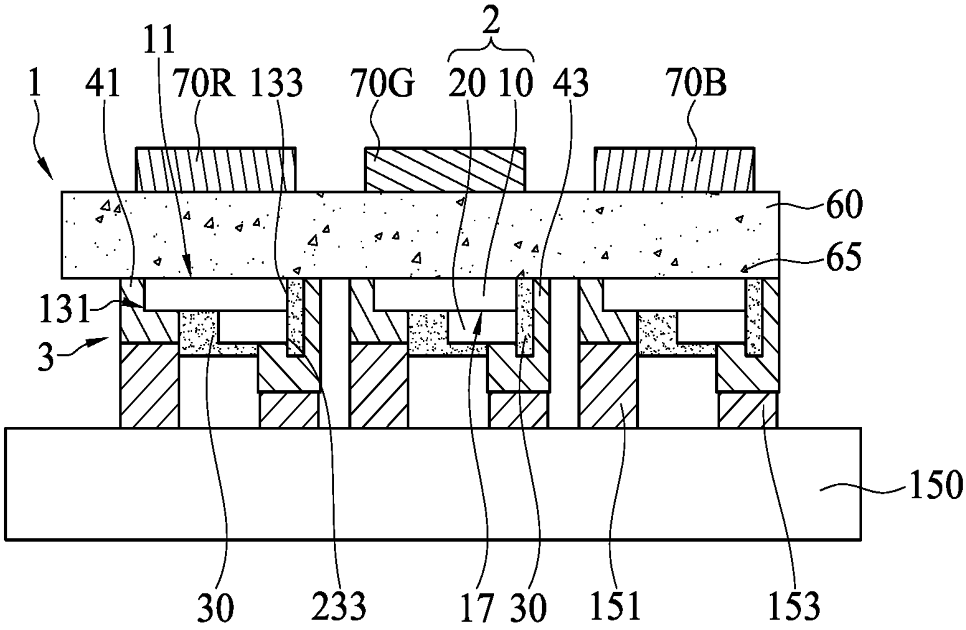

2
11
1
41
70R
133
70G
20
10
43
70B
60
65
131
3
150
30
233
17
30
151
153

FIG.10

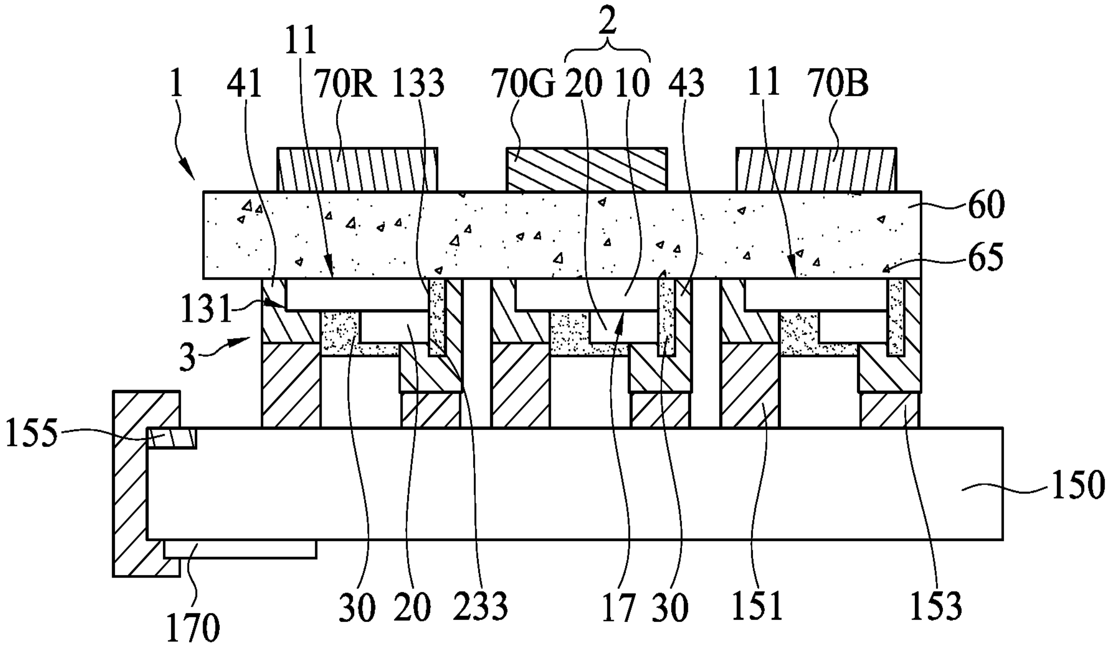

2
11
1
41
70R
133
70G
20
10
43
11
70B
60
65
131
3
155
150
170
30
20
233
17
30
151
153

FIG.11

MASS TRANSFER METHOD FOR MICRO LIGHT EMITTING DIODE AND LIGHT EMITTING PANEL MODULE USING THEREOF

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This non-provisional application claims priority under 35 U.S.C. § 119(a) to Patent Application No. 107146260 in Taiwan, R.O.C. on Dec. 20, 2018, the entire contents of which are hereby incorporated by reference.

BACKGROUND

Technical Field

[0002] The instant disclosure relates to display technologies, in particular, to a mass transfer method for micro LED and a light emitting panel module using thereof.

Related Art

[0003] Digital displays are utilized to different applications. In particular, liquid crystal displays (LCD) are the most popular displays. Regarding users demands, displays with are expected. However, though organic light-emitting diode (OLED) displays have advantages of high brightness and chromaticity, the lifetime for the OLED displays is limited. For example, after displays, mobile phones, or watches using OLED are used for a period (e.g., after 2000 hours), a screen burn-in phenomenon occurs frequently due to the intrinsic character of the OLED material.

[0004] LED may also have a higher brightness and chromaticity performance. However, problems of the size of the light source and the arrangements of the color blocks are to be solved firstly. Currently, the red light LEDs, the green light LEDs, and the blue light LEDs are manufactured individually and then transferred on the circuit board, for example, in a way of adhering. Nevertheless, in order to improve the resolution, the sizes of the LEDs are to be reduced. In the LED transfer method known to the inventor, the main drawback is that the arrangement precision for the LEDs cannot be improved. Moreover, in the case where the size of the LEDs are reduced, during cutting the LEDs from the wafer, the LEDs may be damaged or the electrical property of the LEDs may be affected, thereby decreasing the defect-free rate of the LED products.

SUMMARY

[0005] In view of this, in one embodiment, a mass transfer method for micro light emitting diode (LED) is provided. The mass transfer method comprises a micro LED manufacturing step, a connecting step, a removing step, a fluorescent powder layer forming step, and a filtering sheet forming step. In the micro LED manufacturing step, a plurality of micro LEDs is formed on a wafer substrate. Each of the micro LEDs comprises a first electrode and a second electrode. In the connecting step, the wafer substrate comprising the micro LEDs is connected with a circuit substrate. The circuit substrate comprises a plurality of first electrical connection portions and a plurality of second electrical connection portions. Each of the first electrical connection portions is connected to the first electrode of the corresponding micro LED, and each of the second electrical connection portions is connected to the second electrode of the corresponding micro LED. In the removing step, the wafer substrate is removed. In the fluorescent powder layer forming step, a fluorescent powder layer is formed on the surface of each of the micro LEDs. In the filtering sheet forming step, a plurality of filtering sheets is attached on the fluorescent powder layer. Each of the filtering sheets corresponds to a light emitting surface.

[0006] In one or some embodiments, the micro LED manufacturing step comprises a doped semiconductor layer forming step, a patterning step, an insulation layer forming step, and an electrode forming step. In the doped semiconductor layer forming step, a first-type doped semiconductor material and a second-type doped semiconductor material layer are sequentially formed on the wafer substrate. In the patterning step, the first-type doped semiconductor material layer and the second-type doped semiconductor material layer are patterned to form a plurality of semiconductor patterns. Each of the semiconductor patterns has a first doped layer and a second doped layer, and a length of the second doped layer is less than a length of the first doped layer. In the insulation layer forming step, an insulation layer is formed on the first doped layer and the second doped layer. The insulation layer comprises a first via and a second via. The first via exposed a portion of the first doped layer, and the second via exposed a portion of the second doped layer. In the electrode forming step, the first electrode and the second electrode are formed on the insulation layer. A portion of the first electrode is filled in the first via and connected to the first doped layer. A portion of the second electrode is filled in the second via and connected to the second doped layer. The first electrode and the second electrode are separated from each other by the insulation layer.

[0007] Moreover, in one or some embodiments, the first electrode further shields a first side surface of the first doped layer, and the second electrode further shields the first doped layer and second side surfaces of the second doped layer. The second side surfaces are opposite to the first side surface.

[0008] In one or some embodiments, the light emitting surface is a surface of the wafer substrate disposing the first doped layer, and the light emitting surfaces of the micro LEDs are substantially at a same plane.

[0009] In one or some embodiments, the circuit substrate is an ASIC.

[0010] In one or some embodiments, the mass transfer method further comprises a chip connecting step. In the chip connecting step, a wired region of the circuit substrate is connected with an ASIC.

[0011] A light emitting panel module is also provided. The light emitting panel module comprises a circuit substrate, a plurality of micro LEDs, a fluorescent powder layer, and a plurality of filtering sheets. The circuit substrate comprises a plurality of first electrical connection portions and a plurality of second electrical connection portions. Each of the micro LEDs comprises a first doped layer, a second doped layer, a first electrode, and a second electrode. The first doped layer is stacked with the second doped layer. A first surface of the first doped layer is a light emitting surface, and a length of the first doped layer is greater than a length of the second doped layer. The first electrode is separated from the second electrode. Each of the first electrodes is connected to a connection surface of the first doped layer and a corresponding first electrical connection portion of the first electrical connection portions. Each of the second electrodes is connected to the second doped layer and a corresponding second electrical connection portion of the second electrical connection portions. The connection surface is opposite to the light emitting surface, and the light emitting surfaces of the micro LEDs are substantially at a same plane. The fluorescent powder layer is on the light emitting surface of each of the micro LEDs. The filtering sheets are on the fluorescent powder layer. Each of the filtering sheets corresponds to the light emitting surface of the corresponding micro LED.

[0012] In one or some embodiments, the first electrode and the second electrode are separated from each other by an insulation layer. Moreover, the first electrode further shields a first side surface of the first doped layer, the second electrode further shields the first doped layer and second side surfaces of the second doped layer, and the first side surface is opposite to the second side surfaces.

[0013] In one or some embodiments, the circuit substrate is an ASIC.

[0014] In one or some embodiments, the light emitting panel module further comprises an ASIC connected to a wired region of the circuit substrate.

[0015] In one or some embodiments, a length of each of the filtering sheets is greater than a length of the light emitting surface of the corresponding micro LED.

[0016] In the mass transfer method according to one or some embodiments of the instant disclosure, the micro LEDs on the wafer substrate are connected to the electrical connection portions of the circuit substrate to achieve the electrical connection between the micro LEDs and the circuit substrate. Then, the wafer substrate is removed. Under such arrangement, the transfer precision and the product defect-free rate can be improved greatly as well as having the advantages of fast product manufacture.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The disclosure will become more fully understood from the detailed description given herein below for illustration only, and thus not limitative of the disclosure, wherein:

[0018] FIG. **1** illustrates a flowchart of a mass transfer method for micro light emitting diode (LED) according to an exemplary embodiment of the instant disclosure;

[0019] FIGS. **2** to **10** illustrate sectional views showing steps corresponding to the mass transfer method for micro LED; and

[0020] FIG. **11** illustrates a sectional view of a light emitting panel module according to another embodiment of the instant disclosure.

DETAILED DESCRIPTION

[0021] FIG. **1** illustrates a sectional view of a mass transfer method for micro light emitting diode (LED) according to an exemplary embodiment of the instant disclosure. FIGS. **2** to **10** illustrate sectional views showing steps corresponding to the mass transfer method for micro LED. As shown in FIG. **1**, the mass transfer method S**1** comprises a micro LED manufacturing step S**10**, a connecting step S**20**, a removing step S**30**, a fluorescent powder layer forming step S**40**, and a filtering sheet forming step S**50**.

[0022] In one or some embodiments, the micro LED manufacturing step S**10** comprises a doped semiconductor layer forming step S**11**, a patterning step S**13**, an insulation layer forming step S**15**, and an electrode forming step S**17**. As shown in FIG. **2**, in the doped semiconductor layer forming step S**11**, a first-type doped semiconductor material layer **100** and a second-type doped semiconductor material layer **200** are sequentially formed on the wafer substrate **500**. For example, the wafer substrate **500** may be a sapphire wafer substrate, the first-type doped semiconductor material layer **100** may be an n-type doped semiconductor layer, and the second-type doped semiconductor material layer **200** may be a p-type doped semiconductor layer, embodiments are not limited thereto.

[0023] As shown in FIG. **3**, in the patterning step S**13**, the first-type doped semiconductor material layer **100** and the second-type doped semiconductor material layer **200** are patterned to form a plurality of semiconductor patterns **2**. Each of the semiconductor patterns **2** has a first doped layer **10** and a second doped layer **20**. A length of the second doped layer **20** is less than a length of the first doped layer **10**. In other words, by lithography, etching, or other ways, the first-type doped semiconductor material layer **100** may be patterned to form a plurality of first doped layers **10**, and the second-type doped semiconductor material layer **200** may be patterned to form a plurality of second doped layers **20**. In this embodiment, for each of the semiconductor patterns **2**, a connection surface **17** between the first doped layer **10** and the second doped layer **20** forms a p-n junction.

[0024] As shown in FIG. **4**, in the insulation layer forming step S**15**, an insulation layer **30** is formed on the first doped layer **10** and on the second doped layer **20**. The insulation layer **30** comprises a first via V**1** and a second via V**2**. The first via V**1** exposes a portion of the first doped layer **10**, and the second via V**2** exposes a portion of the second doped layer **20**. In this embodiment, firstly an insulation material layer may be formed by roller-coating, and then the first via V**1** and the second via V**2** are formed on the insulation material layer using lithography or plasma etching techniques, so that the insulation layer **30** can be formed.

[0025] As shown in FIG. **5**, in the electrode forming step S**17**, a first electrode **41** and a second electrode **43** are formed on the insulation layer **30**. A portion of the first electrode **41** is filled in the first via V**1** and connected to the first doped layer **10**. A portion of the second electrode **43** is filled in the second via V**2** and connected to the second doped layer **20**. The first electrode **41** and the second electrode **43** are separated from each other by the insulation layer **30**. Accordingly, a plurality of micro LEDs **3** can be formed on the wafer substrate **500**. It is understood that, the foregoing steps are provided for illustrative purposes, and are not limitations for the embodiments of the instant disclosure. Methods for forming micro LED **3** on the wafer substrate **500** through the wafer manufacturing processes are applicable to be used in the micro LED manufacturing step S**10**.

[0026] As shown in FIGS. **6** and **7**, in the connecting step S**20**, the wafer substrate **500** comprising the micro LEDs **3** is connected with a circuit substrate **150**. The circuit substrate **150** comprises a plurality of first electrical connection portions **151** and a plurality of second electrical connection portions **153**. Each of the first electrical connection portions **151** is connected to the first electrode **41** of the corresponding micro LED **3**, and each of the second electrical connection portions **153** is connected to the second electrode **43** of the corresponding micro LED **3**. In this embodiment, the first electrical connection portions **151** and the second electrical connection portions **153** may be solder balls or bumps. The first electrical connection portions **151** and the second electrical connection portions **153** may have different heights, so that the first electrodes **41** and the second electrodes **43** can be respectively connected to the first electrical connection portions **141** and the second electrical connection portions **143** in a convenient manner, but embodiments are not limited thereto.

[0027] As shown in FIG. **8**, in the removing step S**30**, the wafer substrate **500** is removed, so that a surface between the first doped layer **10** and the wafer substrate **500** becomes a light emitting surface **11** of the micro LED **3**. In this embodiment, the light emitting surface **11** and the connection surface **17** are at opposite sides of the first doped layer **10**. Moreover, since the first doped layer **10** is formed on the flat wafer substrate **500**, the light emitting surfaces **11** of the micro LEDs **3** are substantially at a same plane after the wafer substrate **500** is removed. In this embodiment, the term substantially indicates that the light emitting surfaces **11** of the micro LEDs **3** are at the same plane in a macroscopic perspective, while tolerances generated during manufacturing processes in a microscopic perspective are allowed.

[0028] As shown in FIG. **9**, in the fluorescent powder forming step S**40**, a fluorescent powder layer **60** is formed on the surface of each of the micro LEDs **3**. In this embodiment, the micro LEDs **3** may be white light micro LEDs or blue light micro LEDs.

[0029] A plurality of fluorescent powders **65** in the fluorescent powder layer **60** can be excited by the light emitted from the light emitting surfaces **11** of the micro LEDs **3** to provide different light colors, so that the color gamut can be further expanded. In this embodiment, the fluorescent powder **65** may be quantum dots, but embodiments are not limited thereto.

[0030] As shown in FIG. **10**, in the filtering sheet forming step S**50**, a plurality of filtering sheets **70**R, **70**G, **70**B is attached on the fluorescent powder layer **60**. Each of the filtering sheets **70**R, **70**G, **70**B corresponds to the light emitting surface **11** of each of the micro LEDs **3**. As shown in the figure, the filtering sheet **70**R is a red color filter, the filtering sheet **70**G is a green color filter, and the filtering sheet **70**B is a blue color filter, so that the micro LEDs **3** and the filtering sheets **70**R, **70**G, **70**B can form pixels. In this embodiment, the order for the arrangement of the filtering sheets **70**R, **70**G, **70**B is provided as an illustrative purpose, but not a limitation. According to the arrangement for the pixel, the filtering sheets **70**R, **70**G, **70**B can be attached on certain locations of the micro LEDs **3** by different ways. In this embodiment, in the case where the micro LED **3** is a white light micro LED, the filtering sheet may not be required to be attached on the certain position of the white light micro LED **3**, so that the brightness of the pixel can be improved. Accordingly, a light emitting panel module **1** can be manufactured. Moreover, the length of each of the filtering sheets **70**R, **70**G, **70**B may be greater than the length of the light emitting surface **11** of the corresponding micro LED **3**, so that light leakage can be prevented.

[0031] In this embodiment, the circuit substrate **150** may be an application specific integrated circuit (ASIC). Moreover, as shown in FIG. **10**, the first electrode **41** further shields a first side surface **131** of the first doped layer **10**, and the second electrode **43** further shields the first doped layer **10** and second side surfaces **133**, **233** of the second doped layer **20**. The first side surface **131** is opposite to the second side surfaces **133**, **233**. Because the first electrode **41** and the second electrode **43** are made of metal materials, the first electrode **41** and the second electrode **43** can be used for shielding lights and reflecting lights. Hence, the lights emitted from the first side surface **131** can be reflected by the first electrode **41** and directed toward the light emitting surface **11** and the lights emitted from the second side surfaces **133**, **233** can be reflected by the second electrode **43** and directed toward the light emitting surface **11**.

[0032] FIG. **11** illustrates a sectional view of a light emitting panel module according to another embodiment of the instant disclosure. Pease refer to FIGS. **1** and **11**. The mass transfer method S**1** may further comprise a chip connecting step S**60**. In the chip connecting step S**60**, a wired region **155** of the circuit substrate **150** is connected with an ASIC **170**. Hence, the size of the ASIC **170** can be further reduced. In this embodiment, the positions of the wired region **155** and the ASIC **170** are provided for illustrative purposes, but not a limitation. Moreover, the chip connecting step S**60** may be performed prior to the connecting step S**20**, and the chip connecting step S**60** is not required to be performed as the last step of the mass transfer method S**1**.

[0033] As above, in the mass transfer method S**1** according to one or some embodiments of the instant disclosure, the micro LEDs **3** on the wafer substrate **500** are connected to the electrical connection portions **151**, **153** of the circuit substrate **150** to achieve the electrical connection between the micro LEDs **3** and the circuit substrate **150**. Then, the wafer substrate **500** is removed. Under such arrangement, the method can be performed in a wafer scale perspective, and die cutting and glue transfer steps may not be required, thereby benefiting the advantages of high precision, high defect-free rate, and fast product manufacture.

[0034] While the instant disclosure has been described by the way of example and in terms of the preferred embodiments, it is to be understood that the invention need not be limited to the disclosed embodiments. On the contrary, it is intended to cover various modifications and similar arrangements included within the spirit and scope of the appended claims, the scope of which should be accorded the broadest interpretation so as to encompass all such modifications and similar structures.

What is claimed is:

1. A mass transfer method for micro light emitting diode (LED) comprising:

a micro LED manufacturing step: forming a plurality of micro LEDs on a wafer substrate, wherein each of the micro LEDs comprises a first electrode and a second electrode;

a connecting step: connecting the wafer substrate comprising the micro LEDs with a circuit substrate, wherein the circuit substrate comprises a plurality of first electrical connection portions and a plurality of second electrical connection portions; each of the first electrical connection portions is connected to the first electrode of the corresponding micro LED, and each of the second electrical connection portions is connected to the second electrode of the corresponding micro LED;

a removing step: removing the wafer substrate;

a fluorescent powder layer forming step: forming a fluorescent powder layer on a surface of each of the micro LEDs; and

a filtering sheet forming step: attaching a plurality of filtering sheets on the fluorescent powder layer, wherein each of the filtering sheets corresponds to a light emitting surface of the corresponding micro LED.

2. The mass transfer method for micro LED according to claim **1**, wherein the micro LED manufacturing step comprises:

a doped semiconductor layer forming step: sequentially forming a first-type doped semiconductor material layer and a second-type doped semiconductor material layer on the wafer substrate;

a patterning step: patterning the first-type doped semiconductor material layer and the second-type doped semiconductor material layer to form a plurality of semiconductor patterns, wherein each of the semiconductor patterns has a first doped layer and a second doped layer, and a length of the second doped layer is less than a length of the first doped layer;

an insulation layer forming step: forming an insulation layer on the first doped layer and on the second doped layer, wherein the insulation layer comprises a first via and a second via, the first via exposes a portion of the first doped layer, and the second via exposes a portion of the second doped layer; and

an electrode forming step: forming the first electrode and the second electrode on the insulation layer, wherein a portion of the first electrode is filled in the first via and connected to the first doped layer, a portion of the second electrode is filled in the second via and connected to the second doped layer; the first electrode and the second electrode are separated from each other by the insulation layer.

3. The mass transfer method for micro LED according to claim **2**, wherein the first electrode further shields a first side surface of the first doped layer, the second electrode further shields the first doped layer and second side surfaces of the second doped layer, and the second side surfaces are opposite to the first side surface.

4. The mass transfer method according to claim **2**, wherein the light emitting surface is a surface of the wafer substrate disposing the first doped layer, and the light emitting surfaces of the micro LEDs are substantially at a same plane.

5. The mass transfer method according to claim **1**, wherein the circuit substrate is an ASIC.

6. The mass transfer method according to claim **1**, further comprising a chip connecting step: connecting a wired region of the circuit substrate with an ASIC.

7. A light emitting panel module, comprising:

a circuit substrate comprising a plurality of first electrical connection portions and a plurality of second electrical connection portions;

a plurality of micro LEDs each comprises a first doped layer, a second doped layer, a first electrode, and a second electrode, wherein the first doped layer is stacked with the second doped layer; a first surface of the first doped layer is a light emitting surface; a length of the first doped layer is greater than a length of the second doped layer; the first electrode is separated from the second electrode; each of the first electrodes is connected to a connection surface of the first doped layer and a corresponding first electrical connection portion of the first electrical connection portions, and each of the second electrodes is connected to the second doped layer and a corresponding second electrical connection portion of the second electrical connection portions; the connection surface is opposite to the light emitting surface, and the light emitting surfaces of the micro LEDs are substantially at a same plane;

a fluorescent powder layer on the light emitting surface of each of the micro LEDs; and

a plurality of filtering sheets on the fluorescent powder layer, wherein each of the filtering sheets corresponds to the light emitting surface of the corresponding micro LED.

8. The light emitting panel module according to claim **7**, wherein the first electrode and the second electrode are separated from each other by an insulation layer.

9. The light emitting panel module according to claim **8**, wherein the first electrode further shields a first side surface of the first doped layer, the second electrode further shields the first doped layer and second side surfaces of the second doped layer, and the first side surface is opposite to the second side surfaces.

10. The light emitting panel module according to claim **7**, wherein the circuit substrate is an ASIC.

11. The light emitting panel module according to claim **7**, further comprising an ASIC connected to a wired region of the circuit substrate.

12. The light emitting panel module according to claim **7**, wherein a length of each of the filtering sheets is greater than a length of the light emitting surface of the corresponding micro LED.

* * * * *

patsnap

专利名称(译)	微型发光二极管的传质方法及其使用的发光面板模块		
公开(公告)号	[US20200203319A1](US20200203319A1)	公开(公告)日	2020-06-25
申请号	US16/460782	申请日	2019-07-02
[标]申请(专利权)人(译)	茂丞科技股份有限公司		
申请(专利权)人(译)	J-度量TECHNOLOGY CO.，LTD.		
当前申请(专利权)人(译)	J-度量TECHNOLOGY CO.，LTD.		
[标]发明人	LEE HUNG PING CHIU YI HSIANG		
发明人	LEE, HUNG-PING CHIU, YI-HSIANG		
IPC分类号	H01L25/075 H01L33/50 H01L33/62		
CPC分类号	H01L33/62 H01L33/502 H01L25/0753 H01L2933/0066 H01L2933/0041		
优先权	107146260 2018-12-20 TW		
外部链接	Espacenet USPTO		

摘要(译)

用于微发光二极管（LED）的传质方法包括微LED制造步骤，连接步骤，去除步骤，荧光粉层形成步骤和滤片形成步骤。 在微LED制造步骤中，微LED形成在晶片基板上。 每个微型LED包括第一电极和第二电极。 在连接步骤中，将包括微型LED的晶片基板与包括第一电连接部和第二电连接部的电路基板连接。 每个第一电连接部分连接到相应的微型LED的第一电极，并且每个第二电连接部分连接到相应的微型LED的第二电极。 在去除步骤中，去除晶片衬底。 在荧光粉层形成步骤中，在每个微型LED的发光表面上形成荧光粉层。 在过滤片形成步骤中，将过滤片附着在荧光粉层上。