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(54) **MICRO LED DISPLAY AND METHOD OF MANUFACTURING THE SAME**

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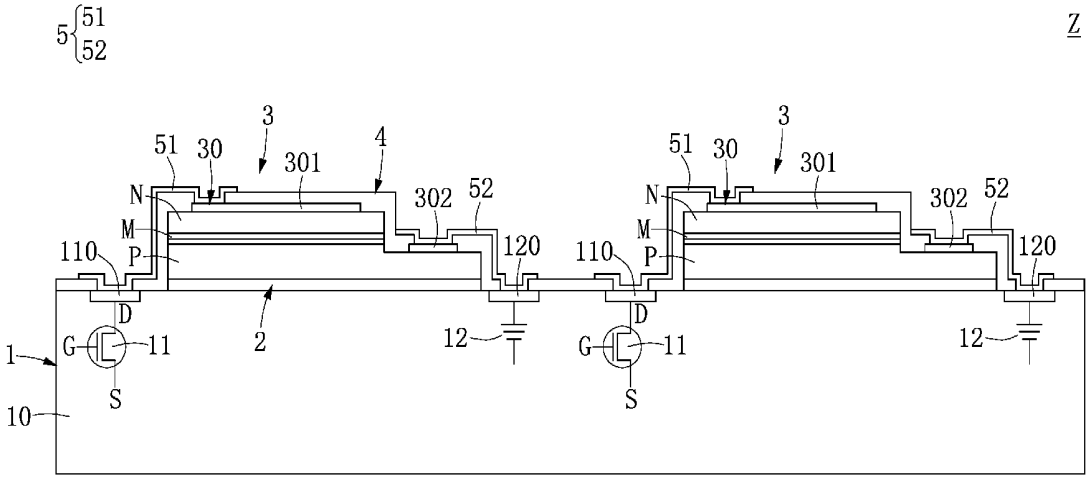
CPC ***H01L 27/156*** (2013.01); *H01L 2933/0066* (2013.01); ***H01L 33/62*** (2013.01); ***H01L 25/0753*** (2013.01)

(57) **ABSTRACT**

A micro LED display and method of manufacturing the same are provided. The micro LED display includes a wafer level substrate, an adhesive layer, a plurality of light emitting assemblies and a conductive structure. The wafer level substrate includes a plurality of control circuits, wherein each of the control circuits has a conductive contact. The adhesive layer is disposed on the wafer level substrate. Each of the light emitting assemblies includes a plurality of light emitting diode structures disposed on the adhesive layer. The conductive structure is electrically connected between the light emitting diode structure and the control circuit, which are corresponding to each other.



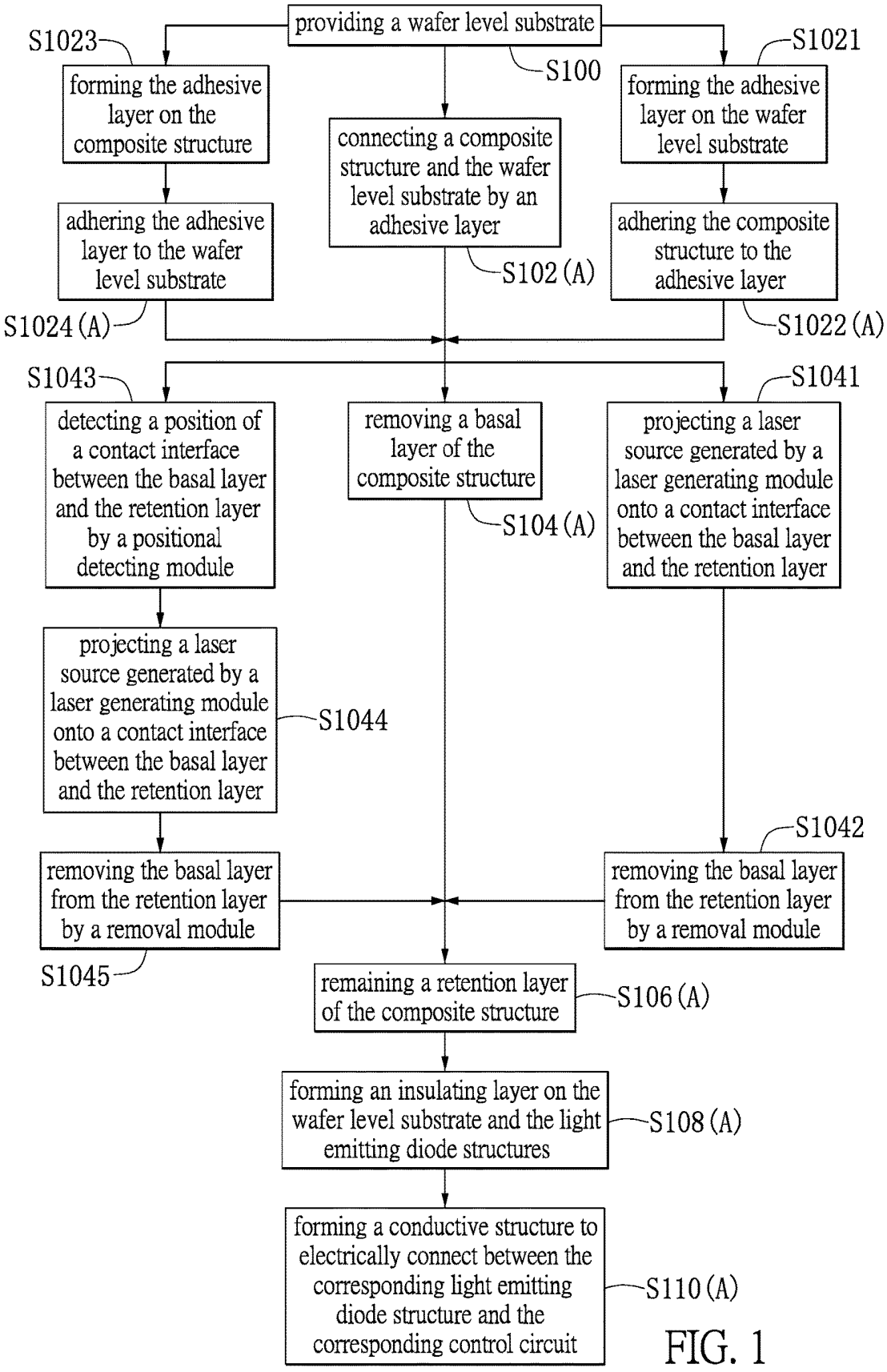

providing a wafer level substrate
S100
S1023
forming the adhesive layer on the composite structure
adhering the adhesive layer to the wafer level substrate
S1024 (A)
connecting a composite structure and the wafer level substrate by an adhesive layer
S102 (A)
S1021
forming the adhesive layer on the wafer level substrate
adhering the composite structure to the adhesive layer
S1022 (A)
S1043
detecting a position of a contact interface between the basal layer and the retention layer by a positional detecting module
projecting a laser source generated by a laser generating module onto a contact interface between the basal layer and the retention layer
S1044
removing the basal layer from the retention layer by a removal module
S1045
removing a basal layer of the composite structure
S104 (A)
S1041
projecting a laser source generated by a laser generating module onto a contact interface between the basal layer and the retention layer
S1042
removing the basal layer from the retention layer by a removal module
remaining a retention layer of the composite structure
S106 (A)
forming an insulating layer on the wafer level substrate and the light emitting diode structures
S108 (A)
forming a conductive structure to electrically connect between the corresponding light emitting diode structure and the corresponding control circuit
S110 (A)

FIG. 1

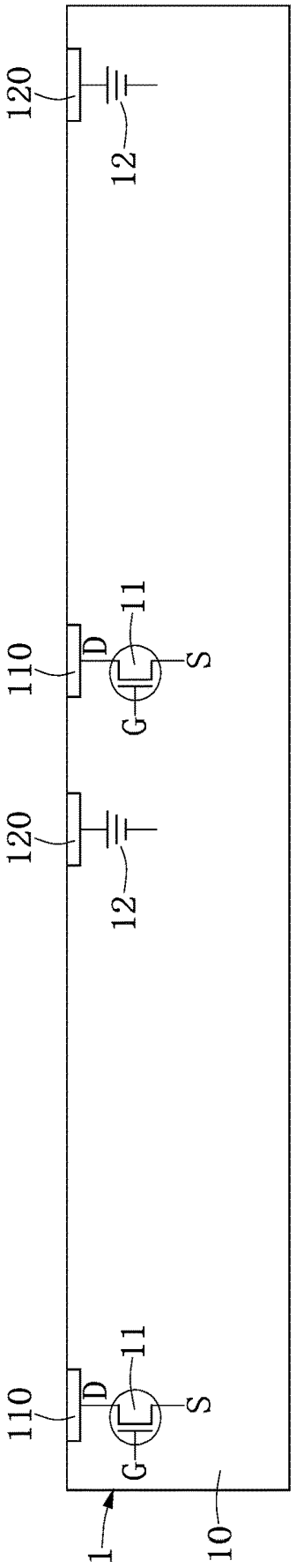


FIG. 2

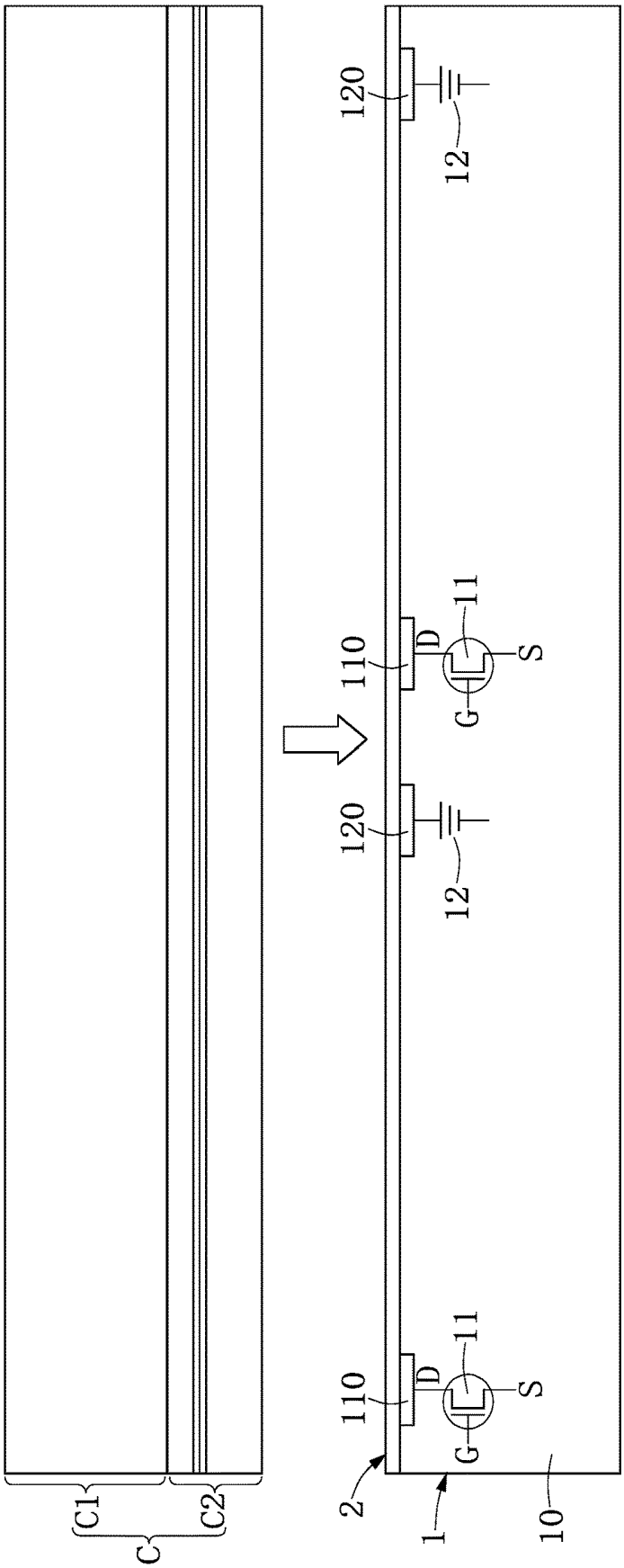


FIG. 3

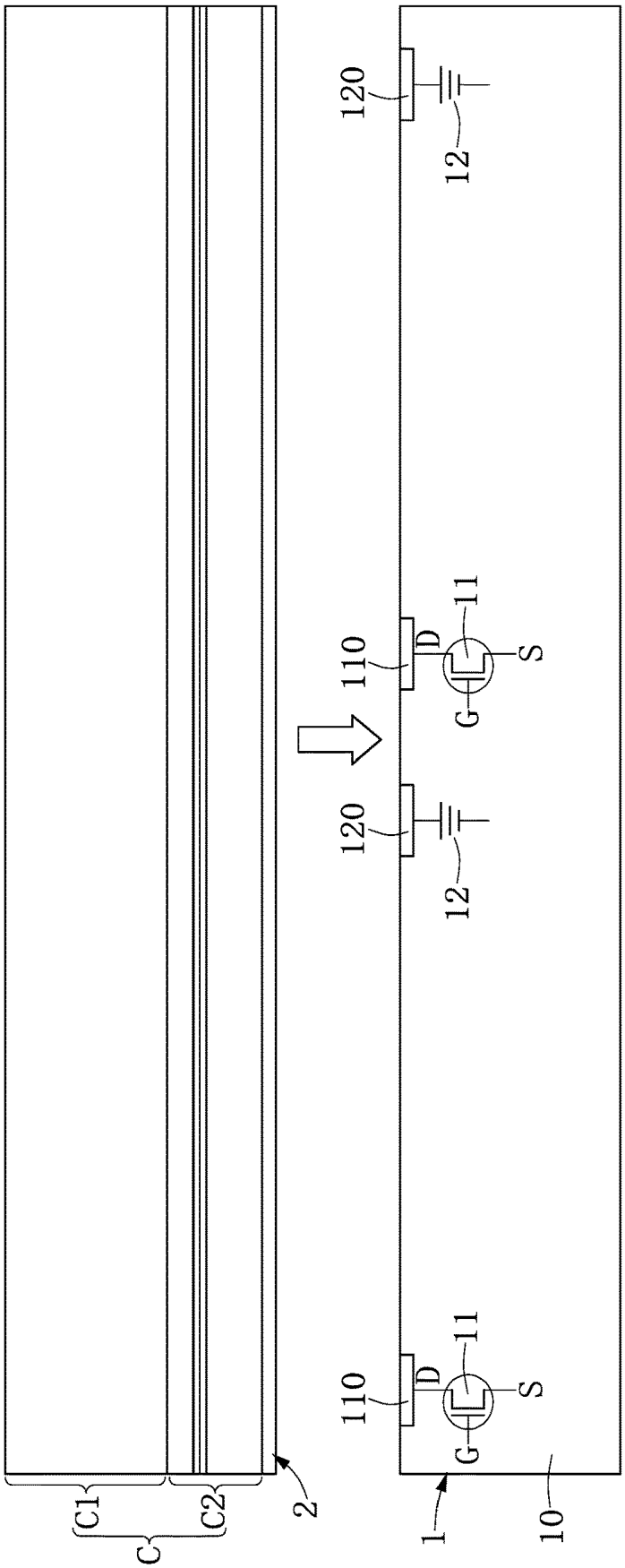


FIG. 4

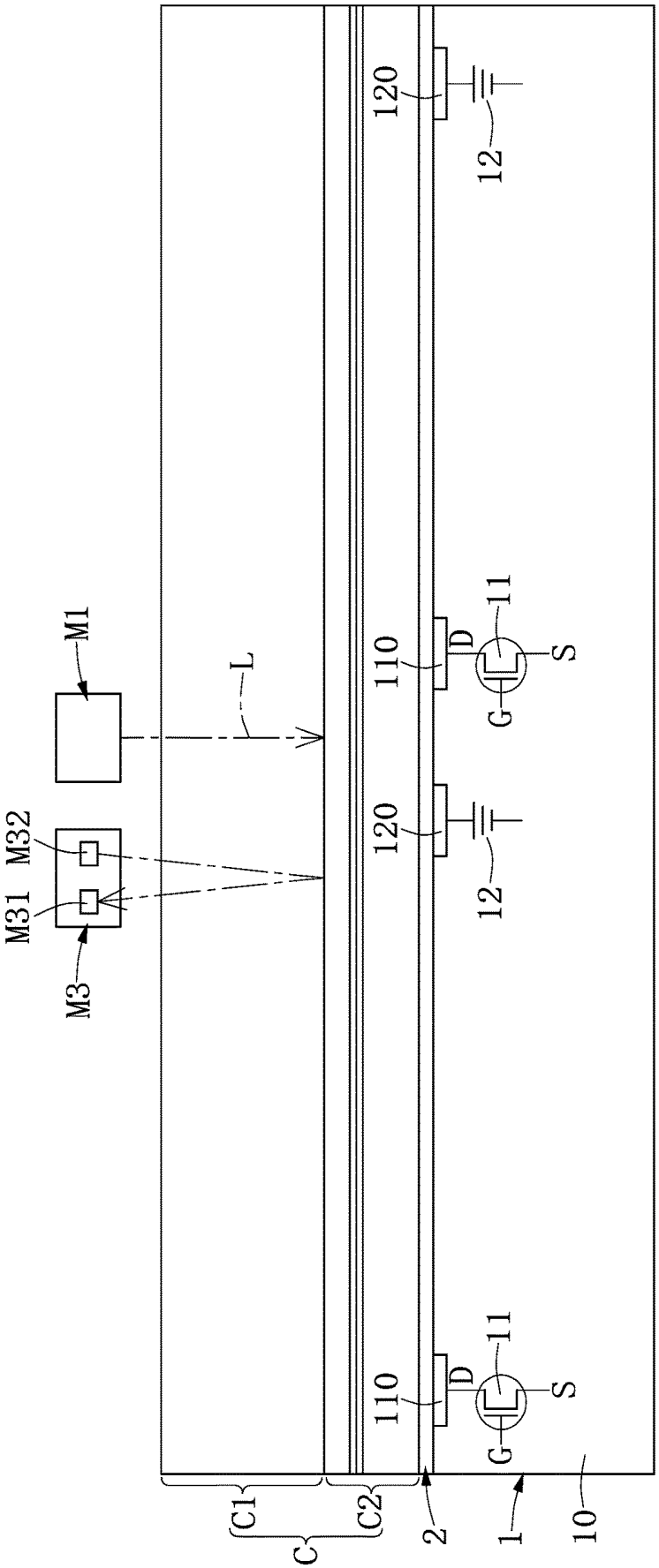


FIG. 5

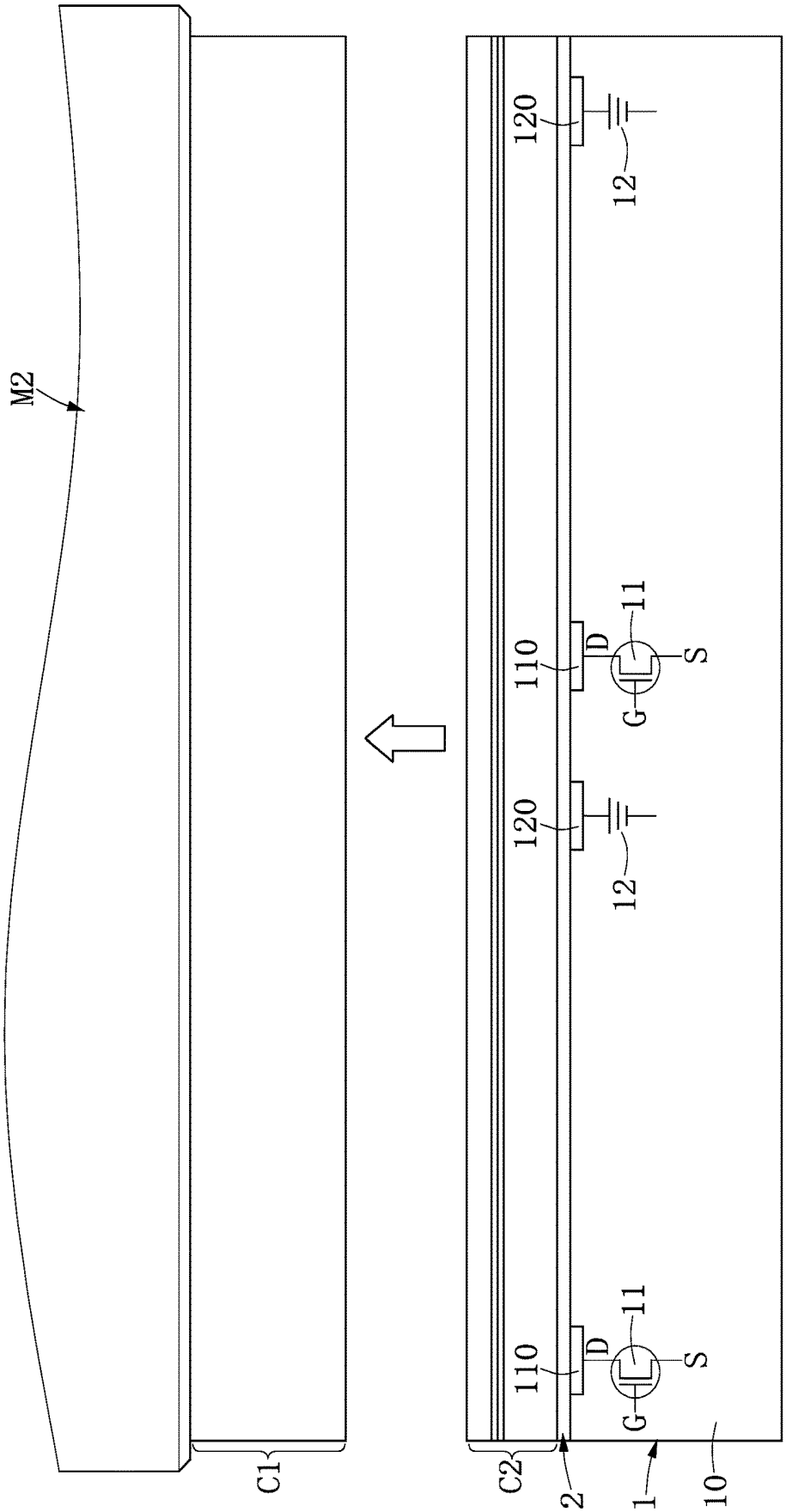


FIG. 6

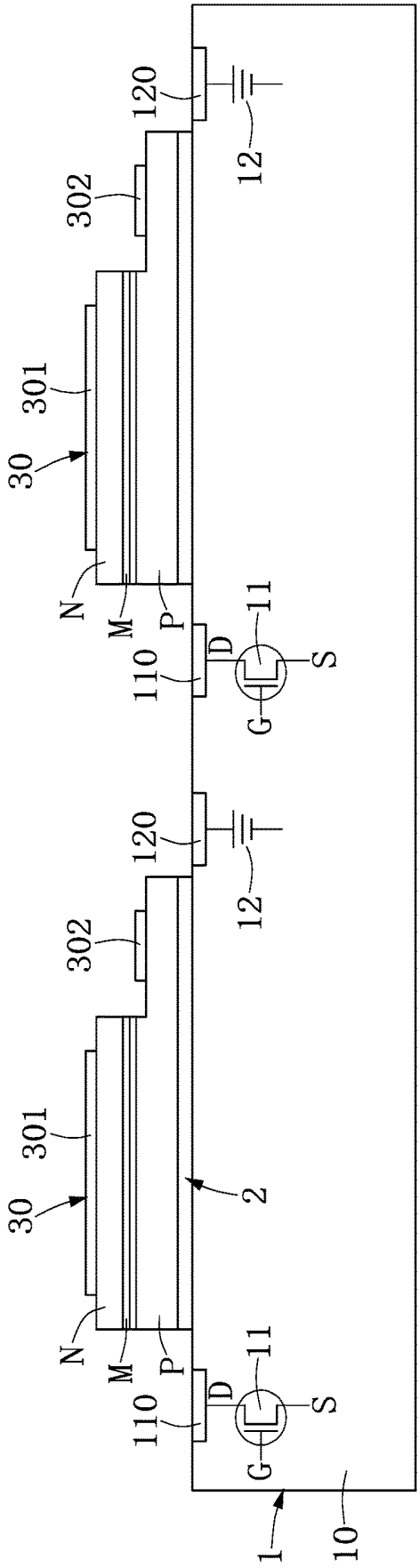
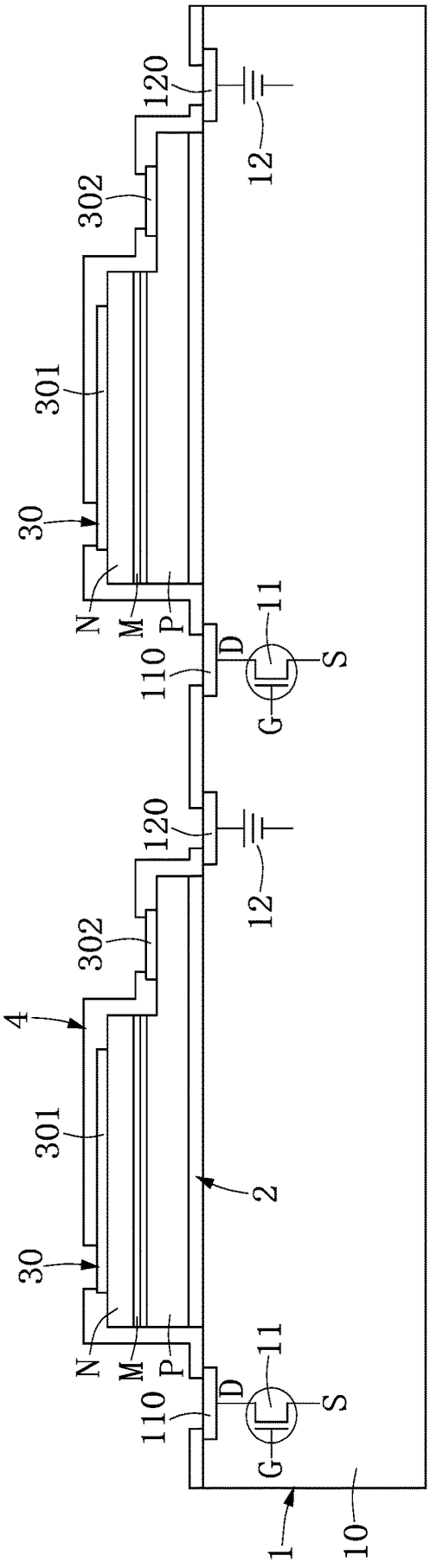


FIG. 7


120
12
302
301
30
N
M
P
110
D
11
S
G
120
12
302
4
301
2
30
N
M
P
110
D
11
S
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1
10

FIG. 8

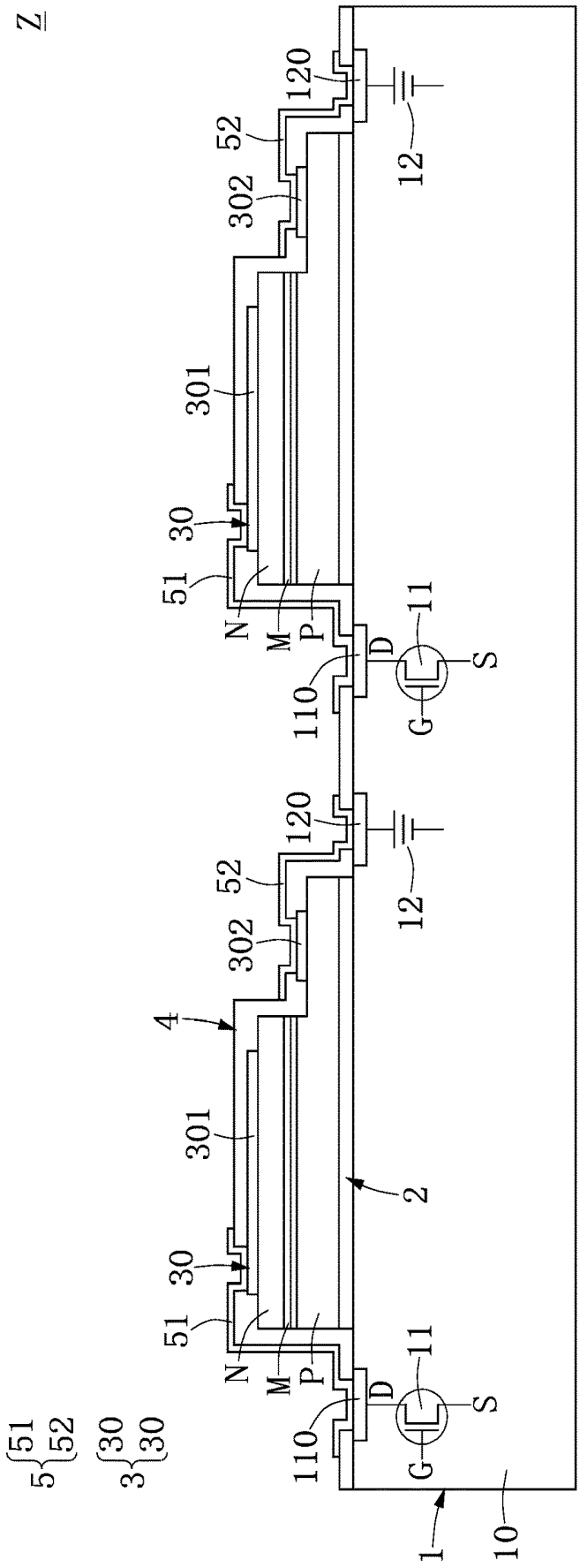
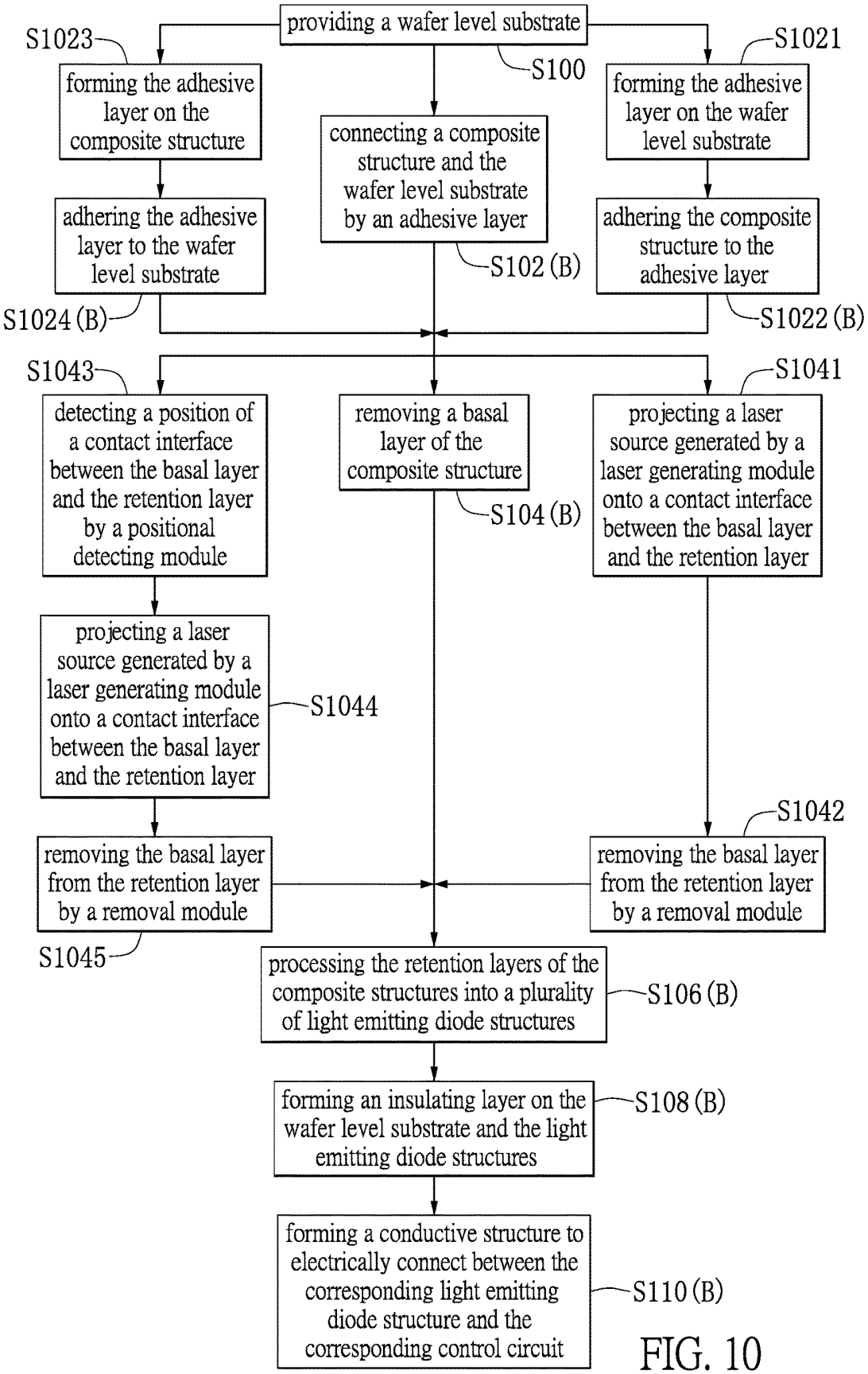


FIG. 9


providing a wafer level substrate
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adhering the adhesive layer to the wafer level substrate
S1024 (B)
connecting a composite structure and the wafer level substrate by an adhesive layer
S102 (B)
S1021
forming the adhesive layer on the wafer level substrate
adhering the composite structure to the adhesive layer
S1022 (B)
S1043
detecting a position of a contact interface between the basal layer and the retention layer by a positional detecting module
projecting a laser source generated by a laser generating module onto a contact interface between the basal layer and the retention layer
S1044
removing the basal layer from the retention layer by a removal module
S1045
removing a basal layer of the composite structure
S104 (B)
S1041
projecting a laser source generated by a laser generating module onto a contact interface between the basal layer and the retention layer
S1042
removing the basal layer from the retention layer by a removal module
processing the retention layers of the composite structures into a plurality of light emitting diode structures
S106 (B)
forming an insulating layer on the wafer level substrate and the light emitting diode structures
S108 (B)
forming a conductive structure to electrically connect between the corresponding light emitting diode structure and the corresponding control circuit
S110 (B)

FIG. 10

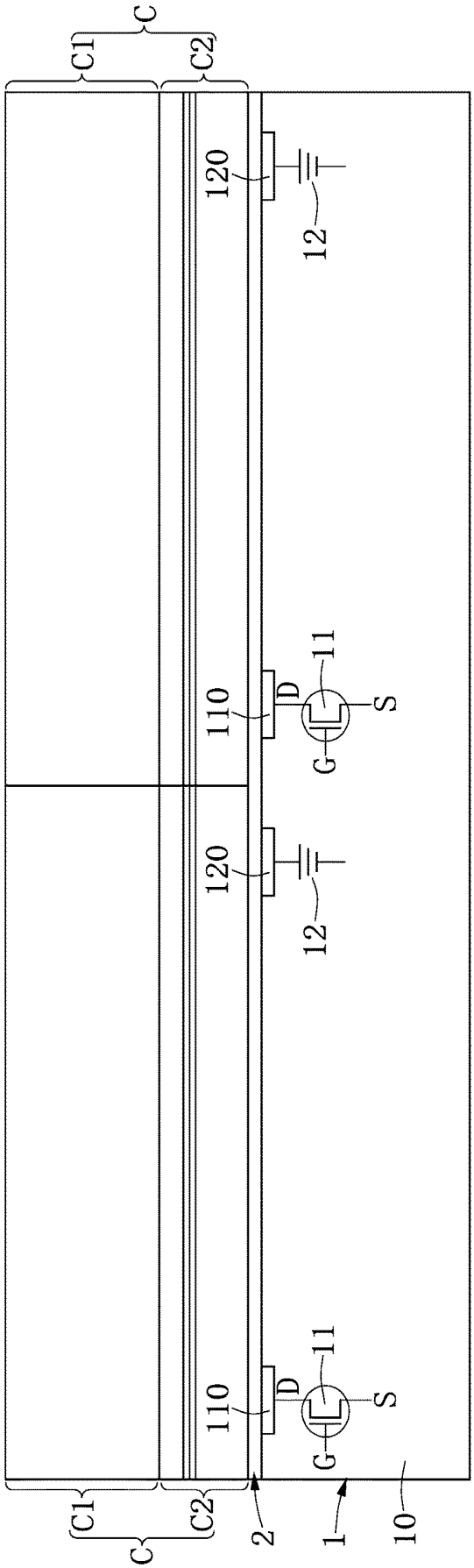

FIG. 11

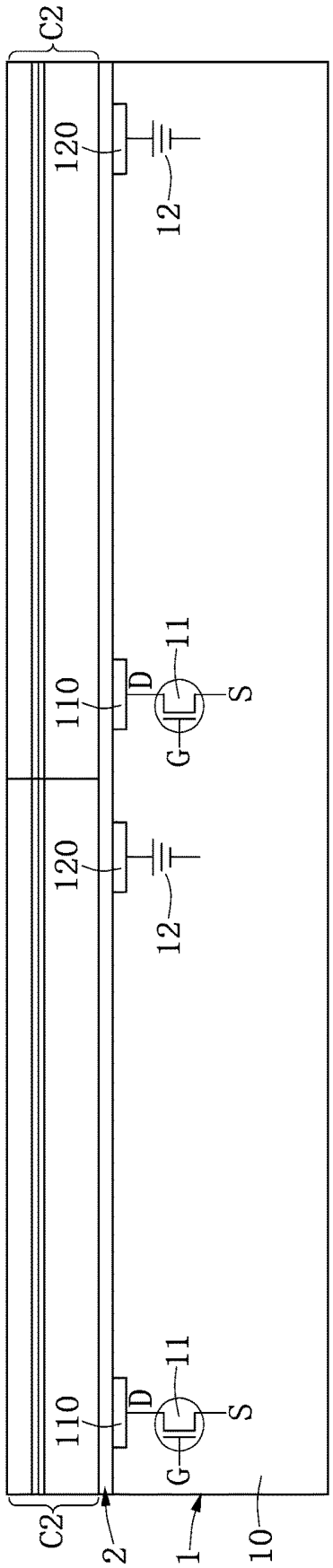

FIG. 12

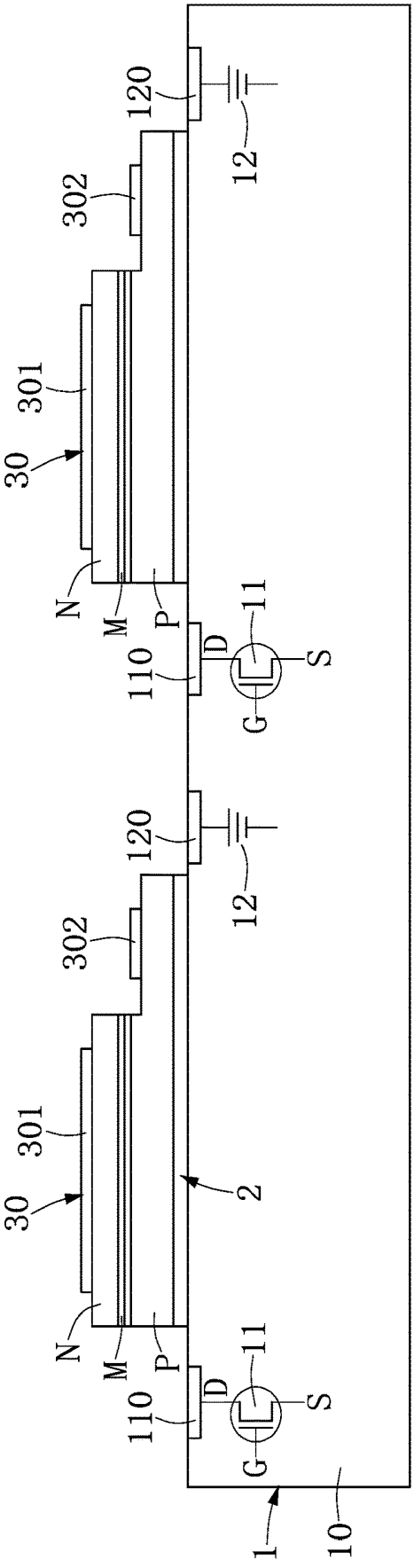

FIG. 13

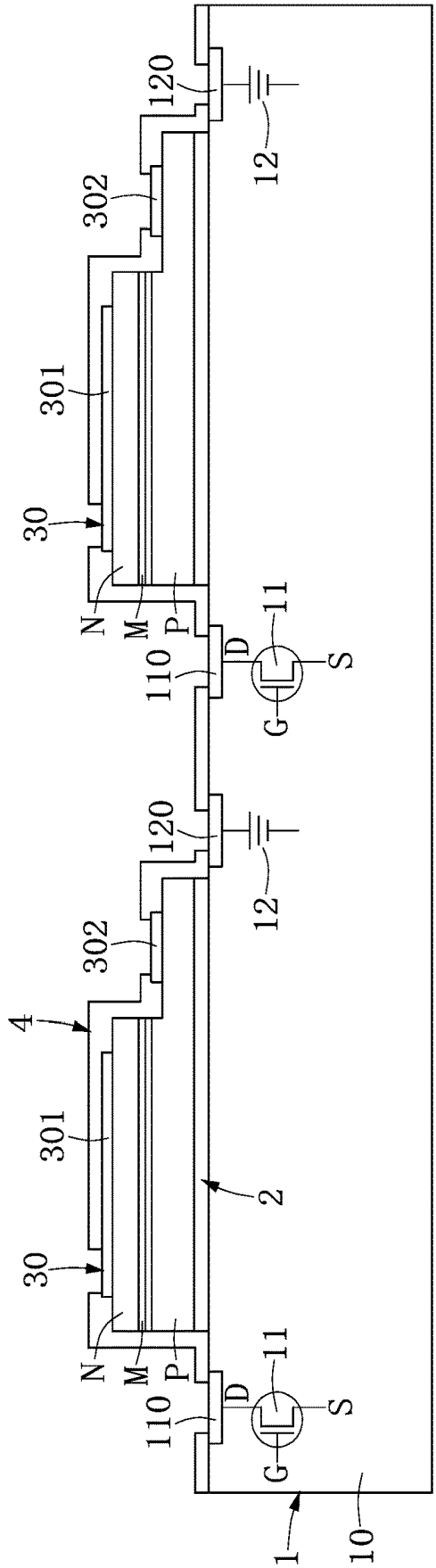

FIG. 14

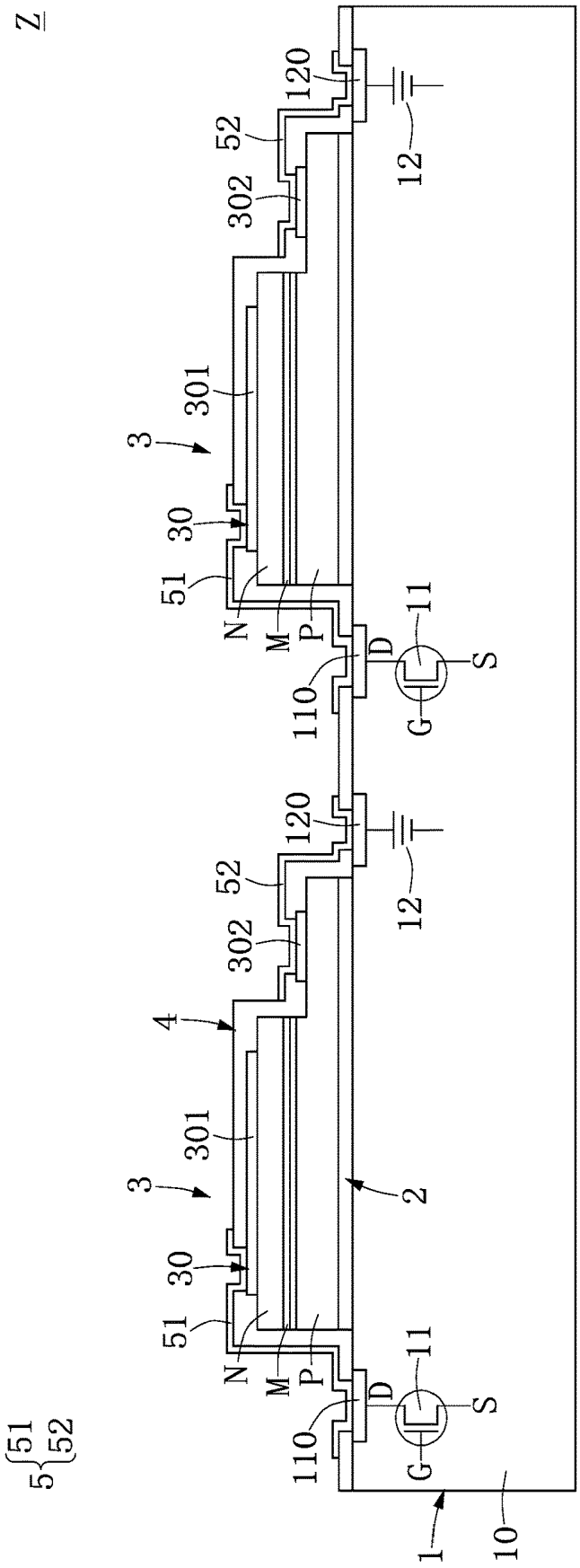

FIG. 15

MICRO LED DISPLAY AND METHOD OF MANUFACTURING THE SAME

CROSS-REFERENCE TO RELATED PATENT APPLICATION

[0001] This application claims the benefit of priority to Taiwan Patent Application No. 107112397, filed on Apr. 11, 2018. The entire content of the above identified application is incorporated herein by reference.

[0002] Some references, which may include patents, patent applications and various publications, may be cited and discussed in the description of this disclosure. The citation and/or discussion of such references is provided merely to clarify the description of the present disclosure and is not an admission that any such reference is "prior art" to the disclosure described herein. All references cited and discussed in this specification are incorporated herein by reference in their entireties and to the same extent as if each reference was individually incorporated by reference.

FIELD OF THE DISCLOSURE

[0003] The present disclosure relates to a display and a method of manufacturing the same, and more particularly to a micro LED display and a method of manufacturing the same.

BACKGROUND OF THE DISCLOSURE

[0004] A light emitting diode (LED) is now widely used because of its excellent light quality and high luminous efficiency. Generally, in order to enhance color performance of the display device which uses an LED as a light emitting assembly, in the prior art a combination of red, green, and blue LED chips is used to form a full-color LED display device. The full-color LED display device can emit red, green and blue colors respectively through the red, green and blue LED chips, and then form a full-color light by mixing lights to display related information. However, the conventional LED display and the manufacturing method thereof still need to be improved.

SUMMARY OF THE DISCLOSURE

[0005] In response to the above-referenced technical inadequacies, the present disclosure provides a micro LED display and method of manufacturing the same.

[0006] In one aspect, the present disclosure provides a micro LED display including a wafer level substrate, an adhesive layer, a plurality of light emitting assemblies, an insulating layer, and a conductive structure. The wafer level substrate includes a wafer body, a plurality of control circuits built in the wafer body, and a plurality of ground circuits built in the wafer body. Each of the control circuits has a conductive contact exposed outside of the wafer body and each of the ground circuits has a ground contact exposed outside of the wafer body. The adhesive layer is disposed on the wafer body. Each of the light emitting assemblies includes a plurality of light emitting diode structures, which are disposed on the adhesive layer without contacting the wafer level substrate, and each of the light emitting diode structures has a first electrode end and a second electrode end. The insulating layer is formed on the wafer level substrate and the light emitting assemblies, and the conductive contact of each of the control circuits, the ground contact of each of the control circuits, and the first electrode end and the second electrode end of each of the light emitting diode structures are exposed from the insulating layer. The conductive structure includes a plurality of first conductive layers and a plurality of second conducive layers, each of the first conductive layers is electrically connected between the corresponding first electrode end and the corresponding conductive contact, and each of the second conductive layers is electrically connected between the corresponding second electrode end and the corresponding ground contact. In addition, the light emitting assemblies are disposed adjacent to each other, such that the light emitting diode structures of the light emitting assemblies are arranged into a pixel array.

[0007] In one aspect, the present disclosure provides a micro LED display including a wafer level substrate, which includes a wafer level substrate, an adhesive layer, a plurality of light emitting assemblies, and a conductive structure. The wafer level substrate includes a plurality of control circuits, and each of the control circuits has a conductive contact. The adhesive layer is disposed on the wafer level substrate. Each of the light emitting assemblies has a plurality of light emitting diode structures, which are disposed on the adhesive layer. The conductive structure is electrically connected between the corresponding light emitting diode structure and the corresponding control circuit. In addition, the light emitting assemblies are disposed adjacent to each other, such that the light emitting diode structures of the light emitting assemblies are arranged into a pixel array.

[0008] In one another aspect, the present disclosure further provides a method of manufacturing a micro LED display including the following steps: providing a wafer level substrate which includes a plurality of control circuits, wherein each of the control circuits has a conductive contact; connecting a plurality of composite structures and the wafer level substrate by an adhesive layer; removing a basal layer of each of the composite structures and remaining a retention layer of each of the composite structures; processing the retention layers of the composite structures into a plurality of light emitting diode structures which are disposed on the adhesive layer; and forming a conductive structure to electrically connected between the corresponding light emitting diode structure and the corresponding control circuit.

[0009] Therefore, each of the light emitting assemblies which includes the light emitting diode structures and the wafer level substrate which includes the control contacts are connected with each other by the adhesive layer with the features of "the adhesive layer is disposed on the wafer level substrate and each of the light emitting assemblies includes the light emitting diode structures disposed on the adhesive layer" or "connecting a plurality of composite structures and the wafer level substrate by an adhesive layer, removing a basal layer of each of the composite structures and remaining a retention layer of each of the composite structures, and processing the retention layers of the composite structures into a plurality of light emitting diode structures which are disposed on the adhesive layer".

[0010] These and other aspects of the present disclosure will become apparent from the following description of the embodiment taken in conjunction with the following drawings and their captions, although variations and modifications therein may be affected without departing from the spirit and scope of the novel concepts of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The present disclosure will become more fully understood from the detailed description and the accompanying drawings, in which:

[0012] FIG. **1** is a flowchart of a method of manufacturing a micro LED display according to a first embodiment of the present disclosure.

[0013] FIG. **2** is a schematic view showing step S**100** of the method of manufacturing a micro LED display according to the first embodiment of the present disclosure.

[0014] FIG. **3** is a schematic view showing step S**1021** of the method of manufacturing a micro LED display according to the first embodiment of the present disclosure.

[0015] FIG. **4** is a schematic view showing step S**1023** of the method of manufacturing a micro LED display according to the first embodiment of the present disclosure.

[0016] FIG. **5** is a schematic view showing step S**102**(A) of the method of manufacturing a micro LED display according to the first embodiment of the present disclosure.

[0017] FIG. **6** is a schematic view showing step S**104**(A) of the method of manufacturing a micro LED display according to the first embodiment of the present disclosure.

[0018] FIG. **7** is a schematic view showing step S**106**(A) of the method of manufacturing a micro LED display according to the first embodiment of the present disclosure.

[0019] FIG. **8** is a schematic view showing step S**108**(A) of the method of manufacturing a micro LED display according to the first embodiment of the present disclosure.

[0020] FIG. **9** is a schematic view showing step S**110**(A) of the method of manufacturing a micro LED display according to the first embodiment of the present disclosure.

[0021] FIG. **10** is a flowchart of a method of manufacturing a micro LED display according to a second embodiment of the present disclosure.

[0022] FIG. **11** is a schematic view showing step S**102**(B) of the method of manufacturing a micro LED display according to the second embodiment of the present disclosure.

[0023] FIG. **12** is a schematic view showing step S**104**(B) of the method of manufacturing a micro LED display according to the second embodiment of the present disclosure.

[0024] FIG. **13** is a schematic view showing step S**106**(B) of the method of manufacturing a micro LED display according to the second embodiment of the present disclosure.

[0025] FIG. **14** is a schematic view showing step S**108**(B) of the method of manufacturing a micro LED display according to the second embodiment of the present disclosure.

[0026] FIG. **15** is a schematic view showing step S**110**(B) of the method of manufacturing a micro LED display according to the second embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

[0027] The present disclosure is more particularly described in the following examples that are intended as illustrative only since numerous modifications and variations therein will be apparent to those skilled in the art. Like numbers in the drawings indicate like components throughout the views. As used in the description herein and throughout the claims that follow, unless the context clearly dictates otherwise, the meaning of "a", "an", and "the" includes plural reference, and the meaning of "in" includes "in" and "on". Titles or subtitles can be used herein for the convenience of a reader, which shall have no influence on the scope of the present disclosure.

[0028] The terms used herein generally have their ordinary meanings in the art. In the case of conflict, the present document, including any definitions given herein, will prevail. The same thing can be expressed in more than one way. Alternative language and synonyms can be used for any term(s) discussed herein, and no special significance is to be placed upon whether a term is elaborated or discussed herein. A recital of one or more synonyms does not exclude the use of other synonyms. The use of examples anywhere in this specification including examples of any terms is illustrative only, and in no way limits the scope and meaning of the present disclosure or of any exemplified term. Likewise, the present disclosure is not limited to various embodiments given herein. Numbering terms such as "first", "second" or "third" can be used to describe various components, signals or the like, which are for distinguishing one component/signal from another one only, and are not intended to, nor should be construed to impose any substantive limitations on the components, signals or the like.

First Embodiment

[0029] Referring to FIG. **1**, a first embodiment of the present disclosure provides a method of manufacturing a micro LED display includes the steps as follows.

[0030] First, as shown in FIG. **1** and FIG. **2**, a wafer level substrate **1** is provided and includes a plurality of control circuits **11**, and each of the control circuits **11** has a conductive contact **110** (step S**100**). Further, the wafer level substrate **1** includes a wafer body **10**, a plurality of control circuits **11** built in the wafer body **10**, and a plurality of ground circuits **12** built in the wafer body **10**. In addition, each of the control circuits **11** has a conductive contact **110** exposed outside of the wafer body **10** and each of the ground circuits **12** has a ground contact **120** exposed outside the wafer body **10**. For instance, the wafer level substrate can be a silicon wafer, epitaxial silicon wafer, argon anneal silicon wafer, hai silicon wafer, or silicon on insulator silicon wafer, and the control circuit can be a complementary metal-oxide-semiconductor (CMOS) control circuit, which has a source S, a drain D, and a gate G, but the present disclosure is not limited thereto.

[0031] Next, as shown in FIG. **1**, FIG. **3** and FIG. **4**, a composite structure C and the wafer level substrate **1** are connected by an adhesive layer **2** (step S**102**(A)). For instance, the thermal expansion coefficient of the adhesive layer **2** is the same as or similar to that of the wafer level substrate **1**, and the adhesive layer **2** can be, but is not limited to, a polyetheretherketone (PEEK) adhesive layer, a benzocyclobutene (BCB) adhesive layer or a hydrogen silsesquioxane (HSQ) adhesive layer.

[0032] For example, as shown in FIG. **1**, FIG. **3** and FIG. **5**, step S**102** further includes: first, in FIG. **3**, forming the adhesive layer **2** on the wafer level substrate **1** (step S**1021**); and then as shown in FIG. **5**, adhering the composite structure C to the adhesive layer **2** to connect the composite structure C and the wafer level substrate **1** to each other (step

S1022(A)). However, the abovementioned example is merely one of the possible embodiments and is not intended to limit the present disclose.

[0033] For example, as shown in FIG. **1**, FIG. **4** and FIG. **5**, step S**102** further includes: first, in FIG. **4**, forming the adhesive layer **2** on the composite structure C (step S**1023**); and then as shown in FIG. **5**, adhering the adhesive layer **2** to the wafer level substrate **1** to connect the composite structure C and the wafer level substrate **1** to each other (step S**1024**(A)). However, the abovementioned example is merely one of the possible embodiments and is not intended to limit the present disclose.

[0034] Next, as shown in FIG. **1**, FIG. **5** and FIG. **6**, a basal layer C**1** of the composite structure C (step S**104**(A)) is removed and a retention layer C**2** of the composite structure C (step S**106**(A)) is retained. For instance, the basal layer C**1** of the composite structure C can be a sapphire material layer, and the retention layer C**2** of the composite structure C can be a gallium nitride material layer. Furthermore, the basal layer C**1** may also be a quartz basal layer, a glass basal layer, a tantalum basal layer or a basal layer of any material, but the present disclosure is not limited thereto.

[0035] For example, as shown in FIG. **1**, FIG. **5** and FIG. **6**, step S**104** further includes: first, in FIG. **5**, projecting a laser source L generated by a laser generating module M**1** onto a contact interface between the basal layer C**1** and the retention layer C**2** to reduce a bonding force between the basal layer C**1** and the retention layer C**2** (step S**1041**); and then shown in FIG. **6**, removing the basal layer C**1** from the retention layer C**2** by a removal module M**2** to retain the retention layer C**2** being exposed on the adhesive layer M**2** (step S**1042**). In addition, the removal module M**2** can be a vacuum cup or any clamping device. However, the abovementioned example is merely one of the possible embodiments and is not intended to limit the present disclose.

[0036] For example, as shown in FIG. **1**, FIG. **5** and FIG. **6**, step S**104** further includes: first, in FIG. **5**, detecting a position of a contact interface between the basal layer C**1** and the retention layer C**2** by a position detecting module M**3**, which includes a sensing element M**31** for receiving a detection wave (step S**1043**); and then as shown in FIG. **5**, projecting the laser source L generated by the laser generating module M**1** onto the contact interface between the basal layer C**1** and the retention layer C**2**, so as to reduce the bonding force between the basal layer C**1** and the retention layer C**2** (step S**1044**); and then shown in FIG. **6**, removing the basal layer C**1** from the retention layer C**2** by the removal module M**2** to retain the retention layer C**2** being exposed on the adhesive layer M**2** (step S**1045**). In addition, the position detecting module M**3** may further include an emission element M**32** for emitting a detection wave. Further, the detection wave that the sensing element M**31** received may be provided by the emission element M**32** or the laser generating module M**1**. However, the abovementioned example is merely one of the possible embodiments and is not intended to limit the present disclose.

[0037] Next, as shown in FIG. **1**, FIG. **6** and FIG. **7**, the retention layer C**2** of the composite structure C is processed into a plurality of light emitting diode structures **30** disposed on the adhesive layer **2** (step S**106**(A)). For instance, the retention layer C**2** may be made into a plurality of light emitting diode structures **30** by semiconductor or non-semiconductor processing. Each of the light emitting diode structures **30** has a first electrode end **301** and a second electrode end **302**, and the first electrode end **301** and the second electrode end **302** are further produced on the corresponding light emitting diode structure **30** after the corresponding light emitting **30** was made. In addition, each of the light emitting diode structures **30** includes an n-type conductive layer N, a light emitting layer M and a p-type conductive layer P. The n-type conductive layer N can be n-GaN layer, the light emitting layer can be multiple quantum well (MQW), and the p-type conductive layer P can be p-GaN layer, but the present disclosure is not limited thereto.

[0038] Next, as shown in FIG. **1**, FIG. **7** and FIG. **8**, an insulating layer **4** is formed on the wafer level substrate **1** and the light emitting diode structures **30** (step S**108**(A)). For instance, each of the conductive contacts **110** of the control circuits **11**, each of the ground contacts **120** of the ground circuits **12**, and each of the first electrode ends **301** and each of the second electrode ends **302** of the light emitting structures **30** are entirely or partially exposed from the insulating layer **4**. In addition, the insulating layer **4** may be a single insulator or composed of a plurality of insulators, but the present disclosure is not limited thereto.

[0039] Next, as shown in FIG. **1**, FIG. **8** and FIG. **9**, a conductive structure **5** is formed to electrically connect between the corresponding light emitting diode structure **30** and the corresponding control circuit **11** (step S**110**(A)). For instance, the light emitting diode structure **30** can be, but is not limited to, a red light emitting diode, a green light emitting diode, or a blue light emitting diode.

[0040] Furthermore, as shown in FIG. **9**, the conductive structure **5** includes a plurality of first conductive layers **51** and a plurality of second conductive layers **52**. Each of the first conductive layers **51** is electrically connected between the corresponding first electrode end **301** and the corresponding conductive contact **110**, and each of the second conductive layers **52** is electrically connected between the corresponding second electrode end **302** and the corresponding ground contact **120**.

[0041] More particularly, as shown in FIG. **9**, each of the first conductive layers **51** can extend along the insulating layer **4** and completely cover the corresponding first electrode end **301** and the corresponding conductive contact **110**, and each of the second conductive layers **52** can extend along the insulating layer **4** and completely covers the corresponding second electrode end **302** and the corresponding ground contact **120**.

[0042] Accordingly, as shown in FIG. **9**, the first embodiment of the present disclosure provides a micro LED display Z including a wafer level substrate **1**, an adhesive layer **2**, a light emitting assembly **3**, and a conductive structure **5**. The wafer level substrate **1** includes a plurality of control circuits **11**. Each of the control circuits **11** has a conductive contact **110**. The adhesive layer **2** is disposed on the wafer level substrate **1**. The light emitting assembly **3** includes a plurality of light emitting diodes structures **30** disposed on the adhesive layer **2**. The conductive structure **5** is electrically connected between the corresponding light emitting diodes structure **30** and the corresponding control circuit **11**.

[0043] For example, as shown in FIG. **9**, the first embodiment of the present disclosure provides the micro LED display Z including a wafer level substrate **1**, an adhesive layer **2**, a light emitting assembly **3**, an insulating layer **4** and a conductive structure **5**. The wafer level substrate **1** includes a wafer body **10**, a plurality of control circuits **11** which are built in the wafer body **10**, and a plurality of

ground circuits **12** which are built in the wafer body **10**. In addition, each of the control circuits **11** has a conductive contact **110** exposed outside the wafer body **10** and each of the ground circuits **12** has a ground contact **120** exposed outside of the wafer body **10**. The adhesive layer **2** is disposed on the wafer body **10**. The light emitting assembly **3** includes a plurality of light emitting diodes structures **30** which are disposed on the adhesive layer **2** without contacting the wafer level substrate **1**. Each of the light emitting diode structures **30** has a first electrode end **301** and a second electrode end **302**. The insulating layer **4** is formed on the wafer level substrate **1** and the light emitting assemblies **3**. The conductive contact **110** of each of the control circuits **11**, the ground contact **120** of each of the ground circuits **12**, and the first electrode end **301** and the second electrode end **302** of each of the light emitting diode structures **30** are exposed from the insulating layer **4**. The conductive structure **5** includes a plurality of first conductive layers **51** and a plurality of second conducive layers **52**. Each of the first conductive layers **51** is electrically connected between the corresponding first electrode end **301** and the corresponding conductive contact **110**, and each of the second conductive layers **52** is electrically connected between the corresponding second electrode end **302** and the corresponding ground contact **120**. Therefore, the light emitting diode structures **30** and the wafer level substrate **1** can be separated by the adhesive layer **2** without contacting each other.

Second Embodiment

[0044] Referring to FIG. **10** to FIG. **15**, a second embodiment of the present disclosure provides a micro LED display Z and a method of manufacturing a micro LED display.

[0045] According to a comparison between FIG. **10** and FIG. **1**, a comparison between FIG. **11** and FIG. **5**, a comparison between FIG. **12** and FIG. **6**, a comparison between FIG. **13** and FIG. **7**, a comparison between FIG. **14** and FIG. **8**, and a comparison between FIG. **15** and FIG. **9**, the second embodiment of the method of manufacturing the micro LED display includes: first, as shown in FIG. **10** and FIG. **11**, connecting the plurality of composite structures C with the wafer level substrate **1** by the adhesive layer **2** (step S**102**(B)); next, as shown in FIG. **10** and FIG. **12**, removing the basal layer C**1** of each of the composite structures C and remaining the retention layer C**2** of each of the composite structures C (step S**104**(B)); and then, as shown in FIG. **10** and FIG. **13**, processing the retention layers C**2** of the composite structures C into the plurality of light emitting diode structures **30** which are disposed on the adhesive layer **2** (step S**106**(B)); and as shown in FIG. **10** and FIG. **14**, forming the insulating layer **4** on the wafer level substrate **1** and the light emitting diodes structures **30** (step S**106**(B)); lastly, as shown in FIG. **10** and FIG. **15**, forming the conductive structure **5** to electrically connect between the corresponding light emitting diode structure **30** and the corresponding control circuit **11** (step S**110**(B)).

[0046] Furthermore, as shown in FIG. **15**, each of the light emitting assemblies **3** includes the plurality of light emitting diodes structures **30** which are disposed on the adhesive layer **2** without contacting the wafer level substrate **1**. The insulating layer **4** is formed on the wafer level substrate **1** and the light emitting assemblies **3**, and the light emitting assemblies **3** are disposed adjacent to each other so that the light emitting diode structures **30** of the light emitting assemblies **3** are arranged into a pixel array. For instance, the adhesive layer **2** could be in place of a plurality of adhesive bodies, which are corresponding to the light emitting diode structures **30**. In other words, each of the light emitting diode structures **30** is disposed on the wafer level substrate **1** with the corresponding adhesive body. In addition, each of the light emitting assemblies **3** in the second embodiment actually includes multiple light emitting diode structures **30**, but each of the light emitting assemblies **3** as shown in FIG. **11** to FIG. **15** has only one of the light emitting diode structures **30** as an example.

[0047] Accordingly, in the second embodiment, each of the light emitting assemblies **3** actually includes multiple light emitting diode structures **30**, so that "the light emitting assemblies **3** which includes the plurality of light emitting diode structures **30**" can be adhered on "the wafer level substrate **1** which has the plurality of control circuits **11**" by the adhesive layer **2**. In other words, in the second embodiment, by using the adhesive layer **2**, the light emitting assemblies **3** are attached to the wafer level substrate **1**, so that the micro LED display Z can provide a larger display area by splicing the plurality of light emitting assemblies **3** together Moreover, the step S**102**(B) further includes: forming the adhesive layer **2** on the wafer level substrate **1** (step S**1021**), and then adhering the composite structure C to the adhesive layer **2** to connect the wafer level substrate **1** and the composite structure C together (step S**1022**(B)). Or, the step S**102**(B) further includes: forming the adhesive layer **2** on the wafer level substrate **1** (step S**1023**), and then adhesive the adhesive layer **2** on the composite structure C to connect the wafer level substrate **1** and the composite structure C together (step S**1024**(B)).

[0048] In conclusion, by combining the features of "the adhesive layer **2** is disposed on the wafer level substrate **1** and each of the light emitting assemblies **3** includes the light emitting diode structures **30** disposed on the adhesive layer **2**" and "connecting a plurality of composite structures C and the wafer level substrate **1** by an adhesive layer **2**, removing a basal layer C**1** of each of the composite structures C and remaining a retention layer C**2** of each of the composite structures C, and processing the retention layers C**2** of the composite structures C into a plurality of light emitting diode structures **30** which are disposed on the adhesive layer **2**", "the light emitting assemblies **3** which includes the plurality of light emitting diode structures **30**" and "the wafer level substrate **1** which has the plurality of control circuits **11**" can be connected to each other by the adhesive layer **2**.

[0049] Notably, since the retention layer C**2** can be fabricated into the plurality of light emitting diode structures **30** by semiconductor processing, the size of the light emitting diode structures **30** can be reduced, and the distance between two adjacent light emitting diode structures **30** can be shortened to effectively enhance the image resolution of the micro LED display Z.

[0050] Furthermore, each of the light emitting assemblies **3** actually includes a plurality of the light emitting diode structures **30**, so that "each of the light emitting assemblies **3** which includes the plurality of the light emitting diode structures **30**" can be attached on "the wafer level substrate **1** which has the plurality of control circuits **11**" by the adhesive layer **2**. In other words, in the second embodiment, by using the adhesive layer **2**, the light emitting assemblies **3** are attached to the wafer level substrate **1**, so that the micro

LED display Z can provide a larger display area by splicing the plurality of light emitting assemblies **3** together.

[0051] The foregoing description of the exemplary embodiments of the disclosure has been presented only for the purposes of illustration and description and is not intended to be exhaustive or to limit the disclosure to the precise forms disclosed. Many modifications and variations are possible in light of the above teaching.

[0052] The embodiments were chosen and described in order to explain the principles of the disclosure and their practical application so as to enable others skilled in the art to utilize the disclosure and various embodiments and with various modifications as are suited to the particular use contemplated. Alternative embodiments will become apparent to those skilled in the art to which the present disclosure pertains without departing from its spirit and scope.

What is claimed is:

1. A micro LED display, comprising:

a wafer level substrate including a wafer body, a plurality of control circuits built in the wafer body, and a plurality of ground circuits built in the wafer body, wherein each of the control circuits has a conductive contact exposed outside of the wafer body, wherein each of the ground circuits has a ground contact exposed outside of the wafer body;

an adhesive layer disposed on the wafer body;

a plurality of light emitting assemblies, wherein each of the light emitting assemblies includes a plurality of light emitting diode structures disposed on the adhesive layer without contacting the wafer level substrate and each of the light emitting diode structures has a first electrode end and a second electrode end;

an insulating layer formed on the wafer level substrate and the light emitting assemblies, wherein the conductive contact of each of the control circuits, the ground contact of each of the ground circuits, and the first electrode end and the second electrode end of each of the light emitting diode structures are exposed from the insulating layer; and

a conductive structure including a plurality of first conductive layers and a plurality of second conducive layers, wherein each of the first conductive layers is electrically connected between the corresponding first electrode end and the corresponding conductive contact, and each of the second conductive layers is electrically connected between the corresponding second electrode end and the corresponding ground contact;

wherein the light emitting assemblies are disposed adjacent to each other, such that the light emitting diode structures of the light emitting assemblies are arranged into a pixel array.

2. The micro LED display according to claim **1**, wherein the wafer level substrate is a polished germanium wafer, epitaxial silicon wafer, argon anneal silicon wafer, hai silicon wafer or silicon on insulator silicon wafer; and the control circuit is a CMOS control circuit; wherein the thermal expansion coefficient of the adhesive layer is the same as or similar to that of the wafer level substrate, the adhesive layer is a polyetheretherketone adhesive layer, a benzocyclobutene adhesive layer or a hydrogen silsesquioxane adhesive layer; wherein each of the light emitting diode structures includes a n-type conductive layer, a light emitting layer and a p-type conductive layer, the n-type conductive layer is a n-type gallium nitride material layer, the light emitting layer is a multiple quantum well structure layer, and the p-type conductive layer is a p-type gallium nitride material layer; and wherein each of the first conductive layers extends along the insulating layer and completely covers the corresponding first electrode end and the corresponding conductive contact, and each of the second conductive layers extends along the insulating layer and completely covers the corresponding second electrode end and the corresponding ground contact.

3. A micro LED display, comprising:

a wafer level substrate including a plurality of control circuits, wherein each of the control circuits has a conductive contact;

an adhesive layer disposed on the wafer level substrate;

a plurality of light emitting assemblies, wherein each of the light emitting assemblies has a plurality of light emitting diode structures disposed on the adhesive layer; and

a conductive structure electrically connected between the corresponding light emitting diode structure and the corresponding control circuit;

wherein the light emitting assemblies are disposed adjacent to each other, such that the light emitting diode structures of the light emitting assemblies are arranged into a pixel array.

4. A method of manufacturing a micro LED display comprising the following steps:

providing a wafer level substrate including a plurality of control circuits, wherein each of the control circuits has a conductive contact;

connecting a plurality of composite structures and the wafer level substrate by an adhesive layer;

removing a basal layer of each of the composite structures and remaining a retention layer of each of the composite structures;

processing the retention layers of the composite structures into a plurality of light emitting diode structures disposed on the adhesive layer; and

forming a conductive structure to be electrically connected between the corresponding light emitting diode structure and the corresponding control circuit.

5. The method of manufacturing a micro LED display according to claim **4**, wherein the wafer level substrate includes a wafer body and a plurality of ground circuits built in the wafer body, and a plurality of control circuits are built in the wafer body, and the conductive contact of each of the control circuits is exposed outside of the wafer body, and each of the ground circuits has a ground contact exposed outside of the wafer body; wherein the light emitting diode structures and the wafer level substrate are separated from each other by the adhesive layer, and each of the light emitting diode structures has a first electrode end and a second electrode end.

6. The method of manufacturing a micro LED display according to claim **5** further including the following steps before the step of forming the conductive structure:

forming an insulating layer on the wafer level substrate and the light emitting diode structures and the conductive contact of each of the control circuits, the ground contact of each of the control circuits, and the first electrode end and the second electrode end of each light emitting diode structure are exposed from the insulating layer;

wherein the conductive structure includes a plurality of first conductive layers and a plurality of second conducive layers, wherein each of the first conductive layers is electrically connected between the corresponding first electrode end and the corresponding conductive contact, and each of the second conductive layers is electrically connected between the corresponding second electrode end and the corresponding ground contact;

wherein each of the first conductive layers extends along the insulating layer and completely covers the corresponding first electrode end and the corresponding conductive contact, and each of the second conductive layers extends along the insulating layer and completely covers the corresponding second electrode end and the corresponding ground contact.

7. The method of manufacturing a micro LED display according to claim **4**, wherein the basal layer of each of the composite structures is a sapphire material layer, and the retention layer of each of the composite structures is a gallium nitride material layer; wherein the step of removing the basal layer of each of the composite structures and remaining the retention layer of each of the composite structures further includes the following steps:

projecting a laser source generated by a laser generating module onto a contact interface between the basal layer and the retention layer to reduce the bonding force between the basal layer and the retention layer, and

removing the basal layer from the retention layer by a removal module to retain the retention layer being exposed on the adhesive layer.

8. The method of manufacturing a micro LED display according to claim **4**, wherein the basal layer of each of the composite structures is a sapphire material layer, and the retention layer of each of the composite structures is a gallium nitride material layer; wherein the step of removing the basal layer of each of the composite structures and remaining the retention layer of each of the composite structures further includes the following steps:

detecting a position of a contact interface between the basal layer and the retention layer by a position detecting module which includes at least one sensing element for receiving a detection wave;

projecting a laser source generated by a laser generating module onto the contact interface between the basal layer and the retention layer to reduce the bonding force between the basal layer and the retention layer, and

removing the basal layer from the retention layer by a removal module to retain the retention layer on the adhesive layer and being exposed.

9. The method of manufacturing a micro LED display according to claim **4**, wherein the step of connecting the plurality of composite structures with the wafer level substrate by the adhesive layer further includes the following steps:

forming the adhesive layer on the wafer level substrate, and

adhering the composite structures to the adhesive layer to connect each of the composite structures with the wafer level substrate.

10. The method of manufacturing a micro LED display according to claim **4**, wherein the step of connecting the plurality of composite structures with the wafer level substrate by the adhesive layer further includes the following steps:

forming the adhesive layer on composite structures, and

adhering the adhesive layer to the wafer level substrate to connect each of the composite structures with the wafer level substrate.

* * * * *

专利名称(译)	微型LED显示器及其制造方法		
公开(公告)号	US20190319064A1	公开(公告)日	2019-10-17
申请号	US16/154132	申请日	2018-10-08
[标]发明人	LIAO CHIEN SHOU		
发明人	LIAO, CHIEN-SHOU		
IPC分类号	H01L27/15 H01L25/075 H01L33/62		
CPC分类号	H01L25/0753 H01L33/62 H01L2933/0066 H01L27/156 G09F9/33 H01L25/167		
优先权	107112397 2018-04-11 TW		
外部链接	Espacenet USPTO		

摘要(译)

提供了一种微型LED显示器及其制造方法。微型LED显示器包括晶片级基板，粘合剂层，多个发光组件和导电结构。晶片级基板包括多个控制电路，其中每个控制电路具有导电触点。粘合剂层设置在晶片级基板上。每个发光组件包括设置在粘合层上的多个发光二极管结构。导电结构电连接在彼此对应的发光二极管结构和控制电路之间。