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(54) **SYSTEM HAVING TRANSFER HEAD FOR TRANSFERRING MICRO LED**

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(57) **ABSTRACT**

The present invention relates to a system having a transfer head for transferring a micro light-emitting diode (micro LED) from a first substrate to a second substrate. More particularly, the present invention relates to a system having a transfer head for transferring a micro LED, the system being configured such that the transfer head does not use an electrostatic force and preventing the generation of an electrostatic force which may cause a problem. In addition, the present invention relates to a system having a transfer head for transferring a micro LED, the system employing a suction structure using a suction force to transfer a micro LED by a porous member, thereby solving problems of the related art.

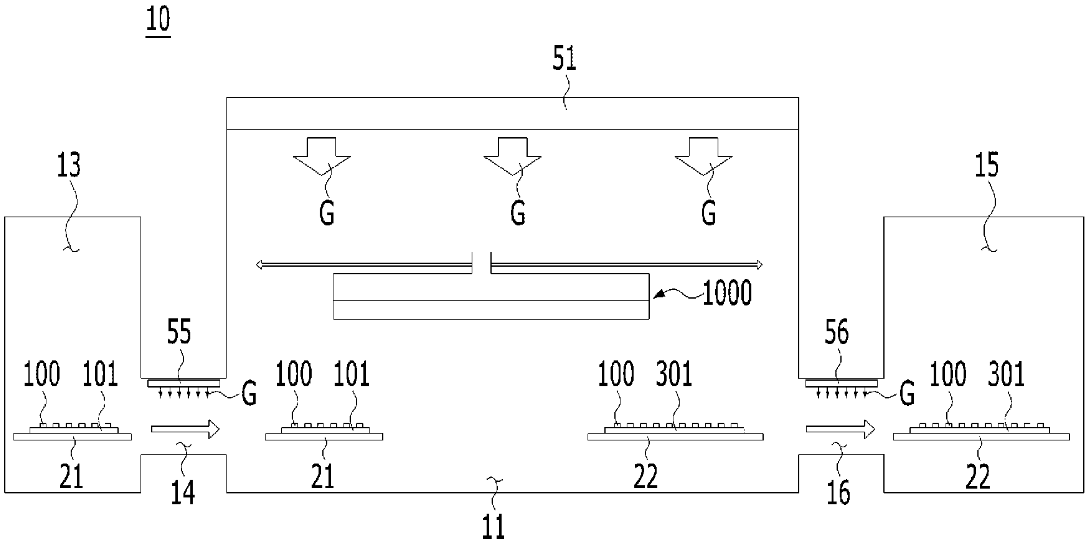
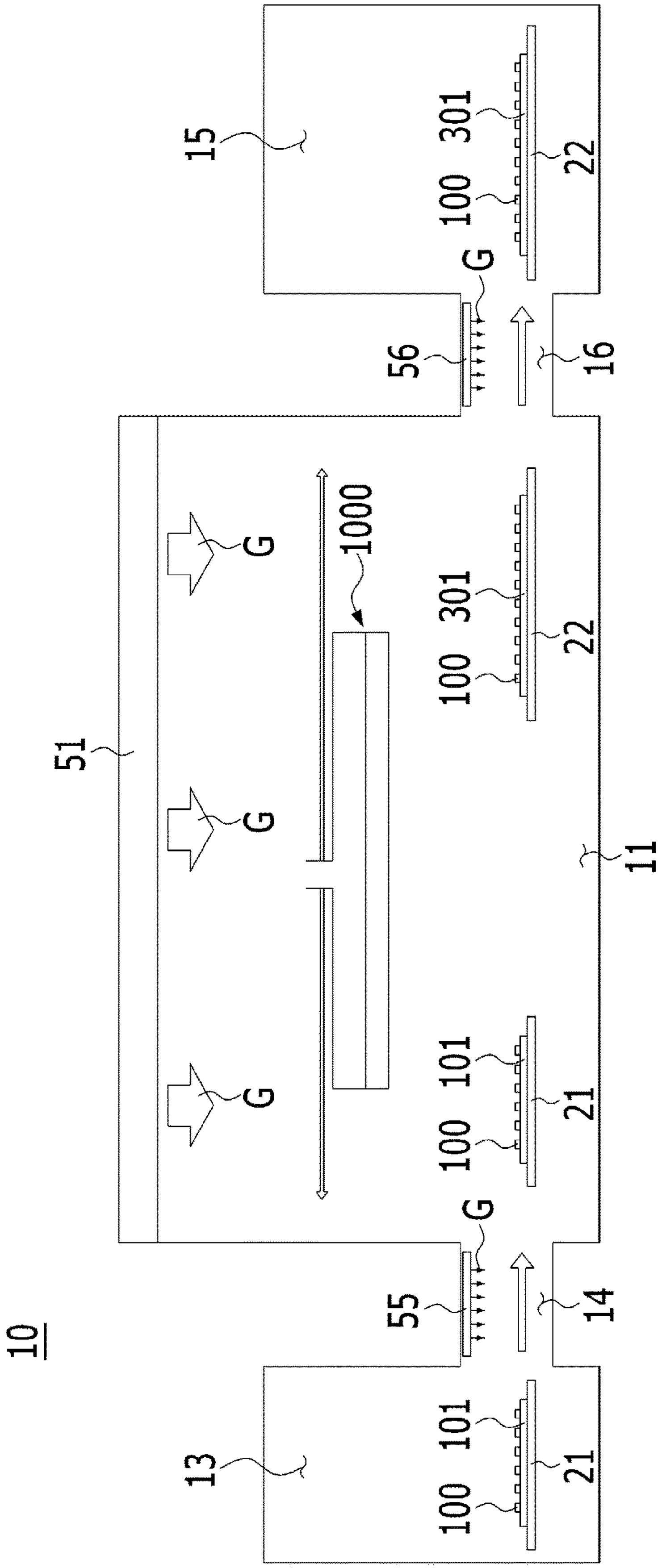


FIG. 1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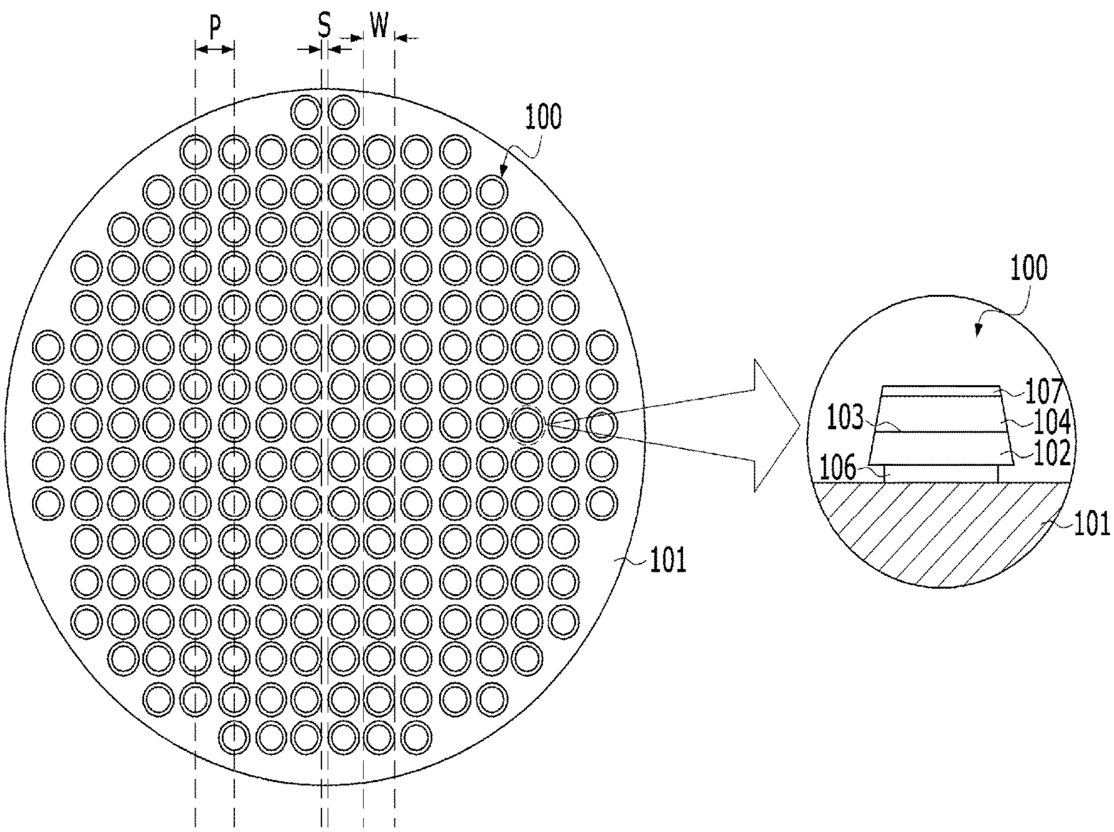
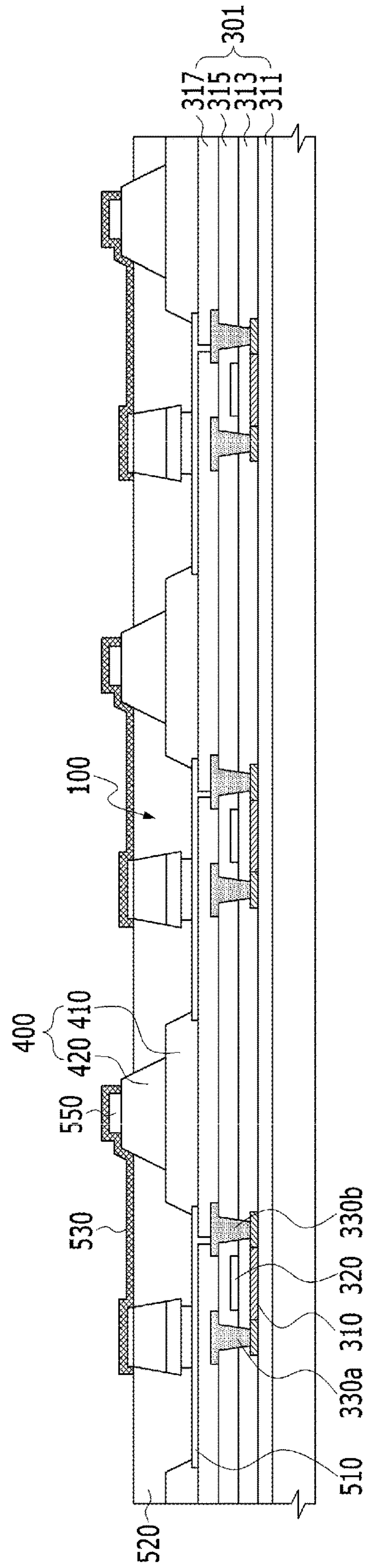


FIG. 2

FIG. 3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330a
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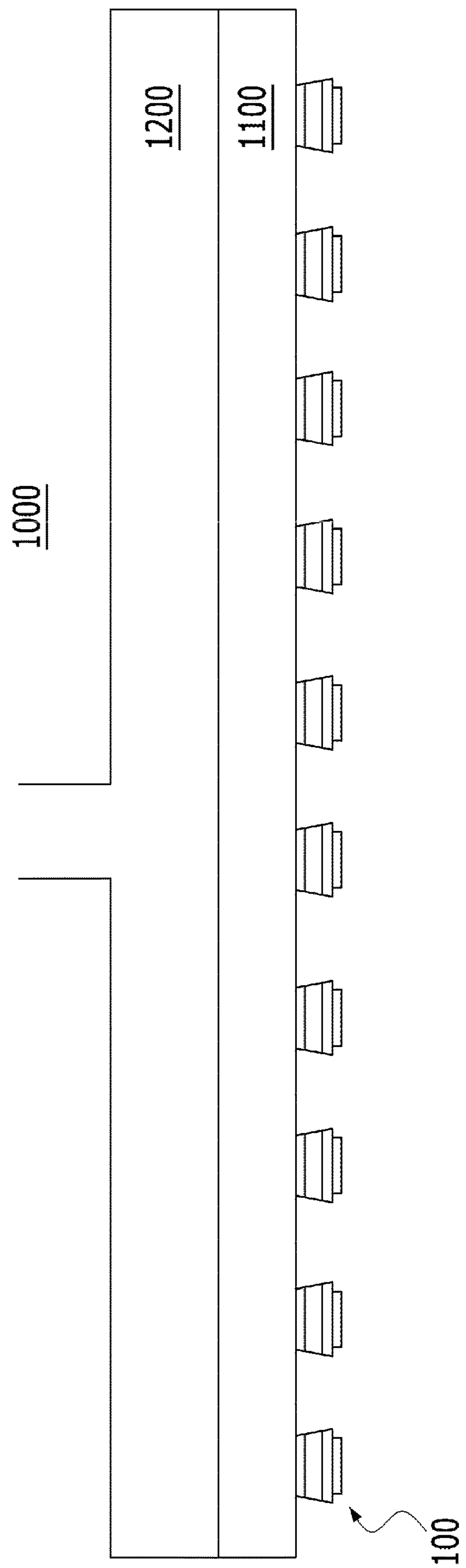


FIG. 4

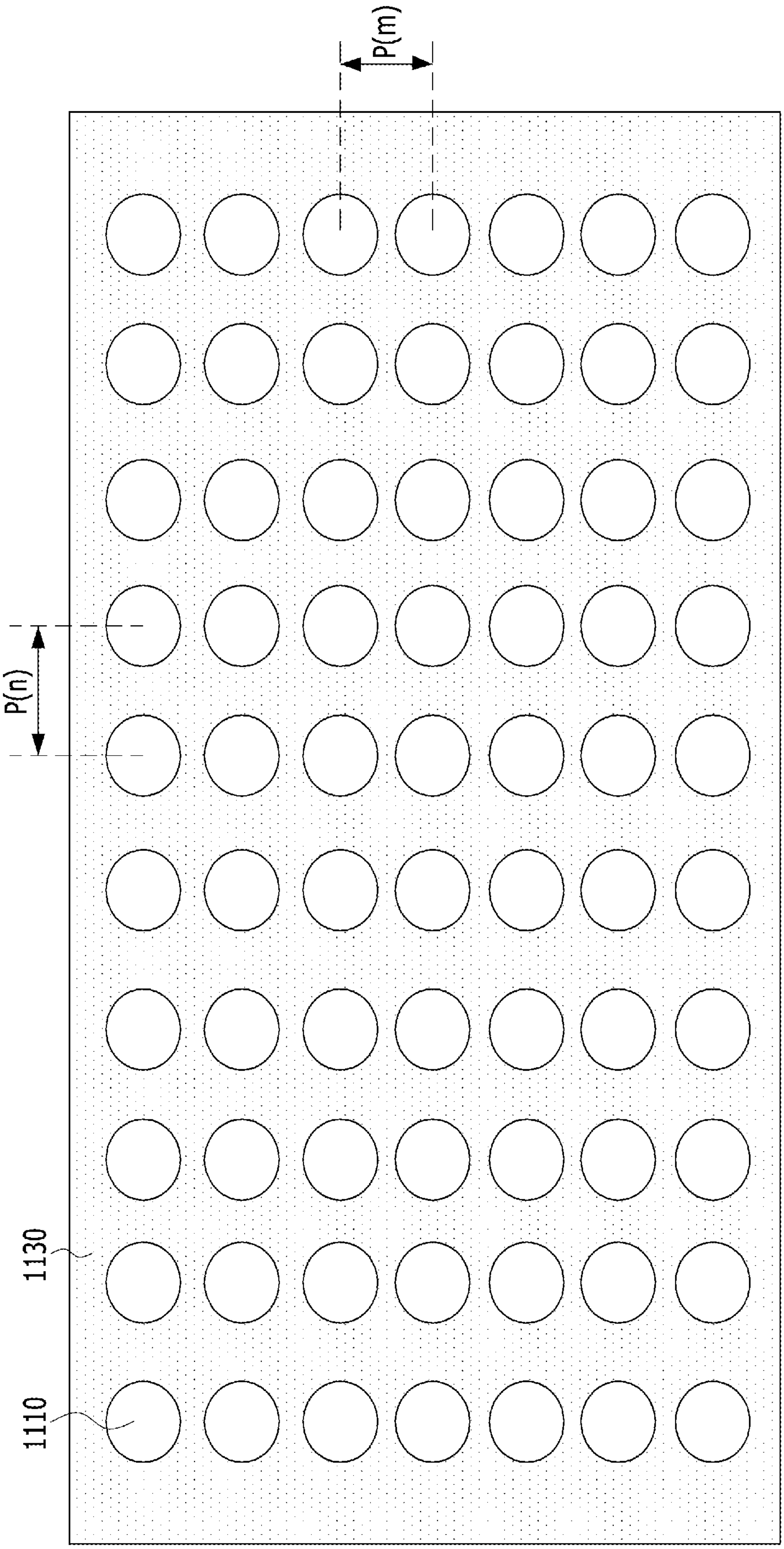


FIG. 5A

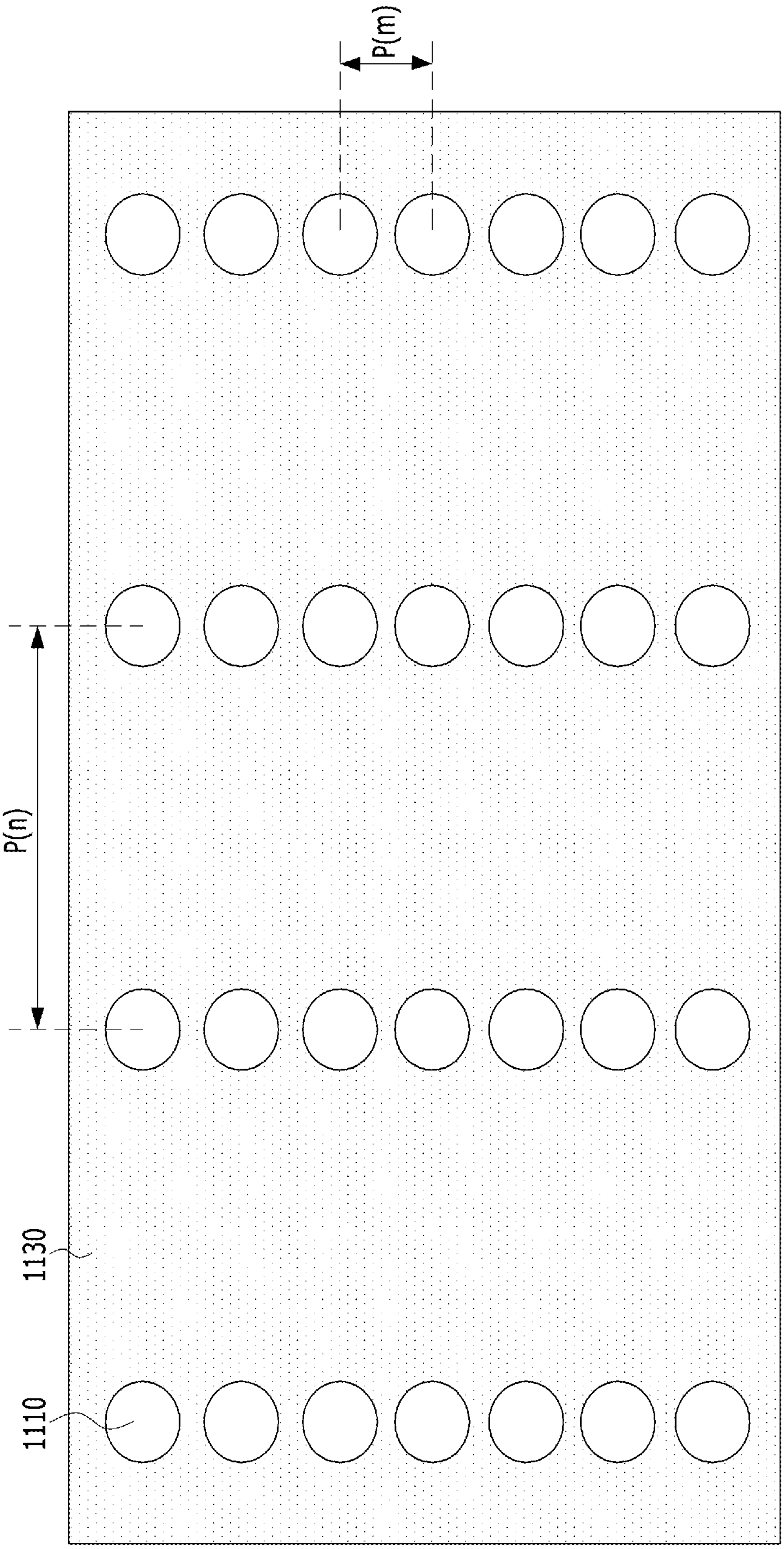
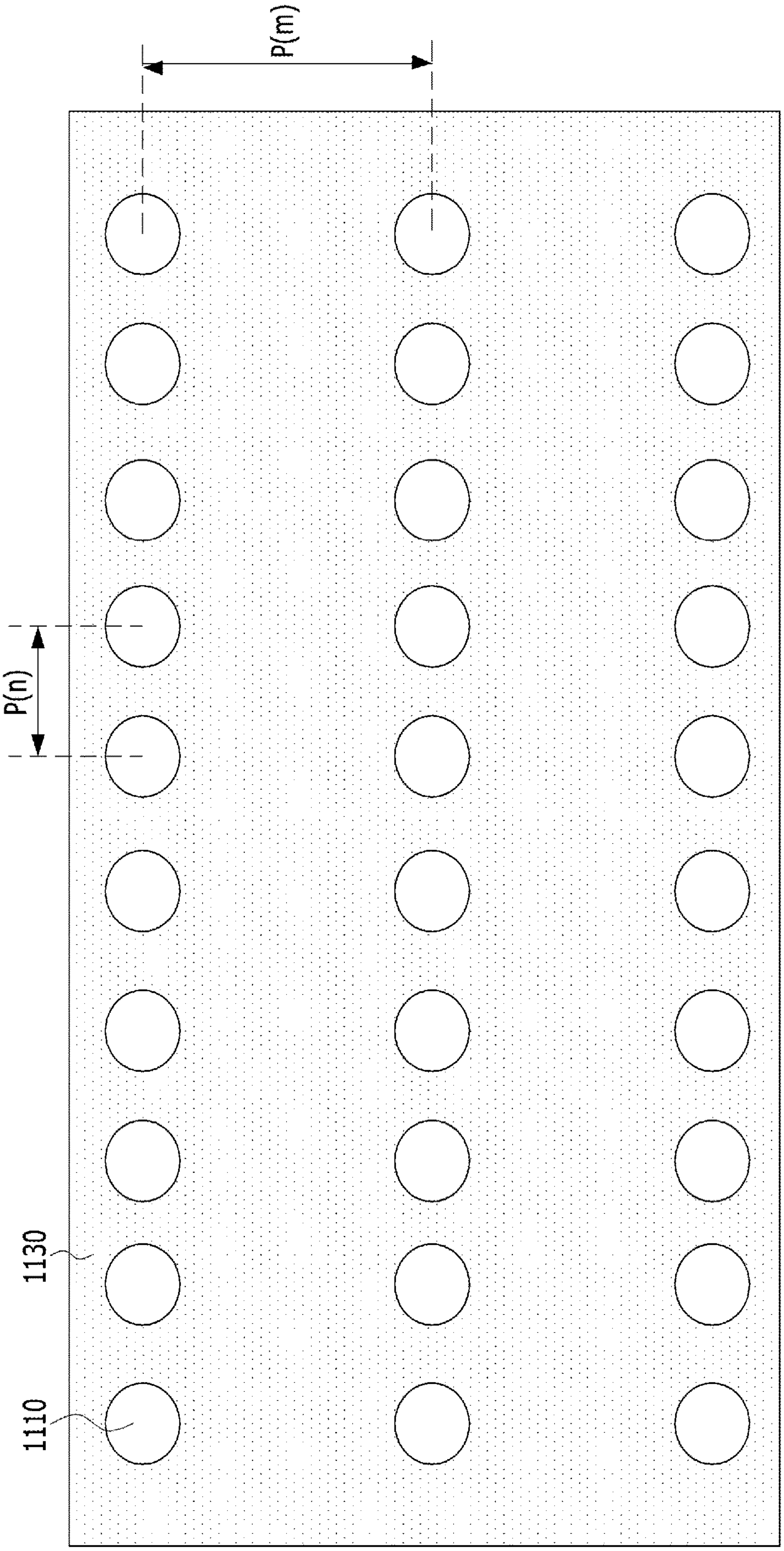


FIG. 5B

FIG. 5C



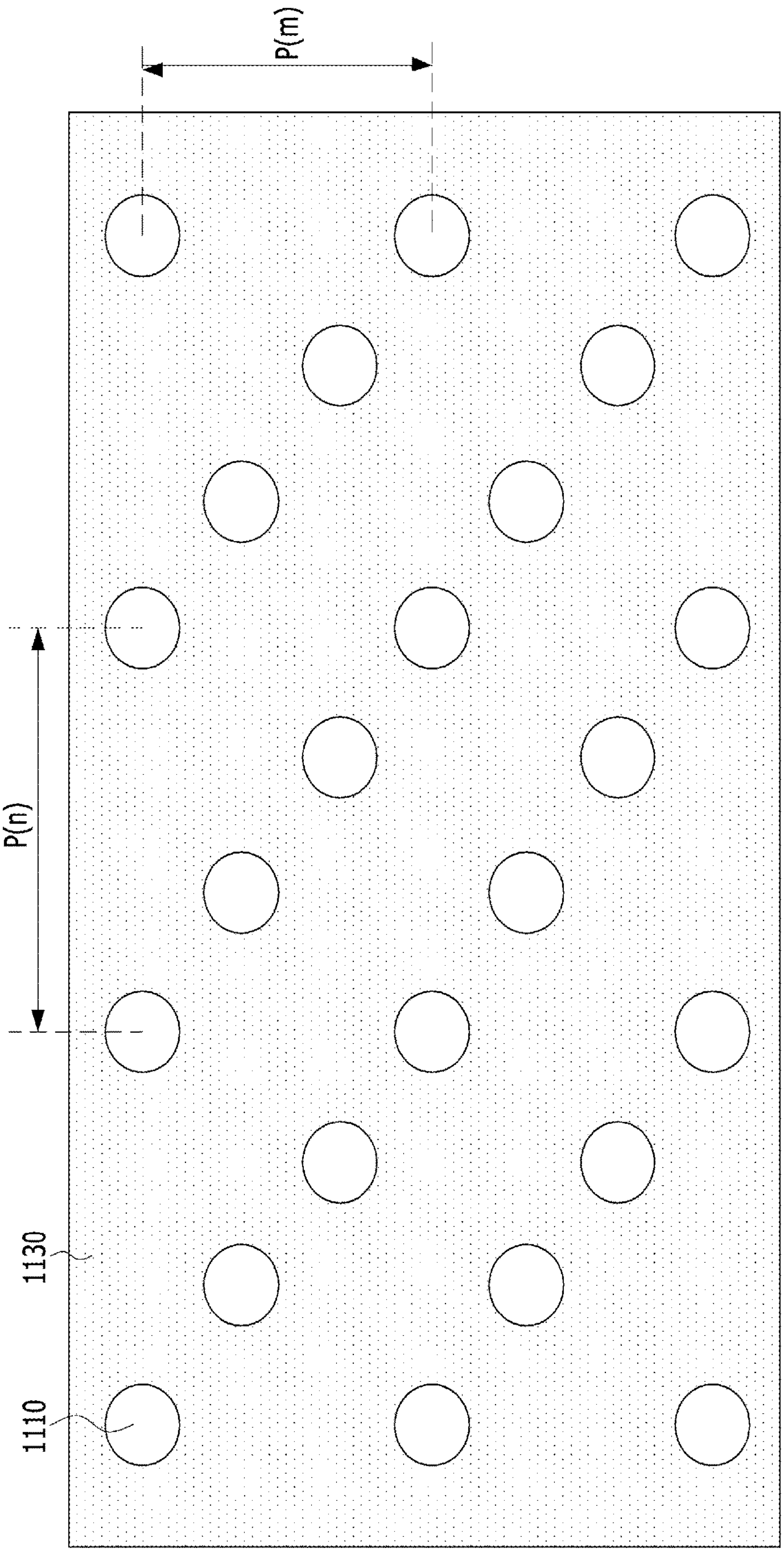


FIG. 5D

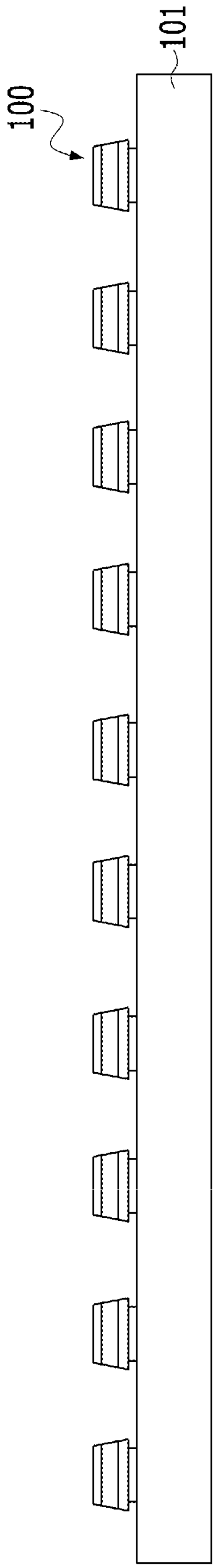


FIG. 6A

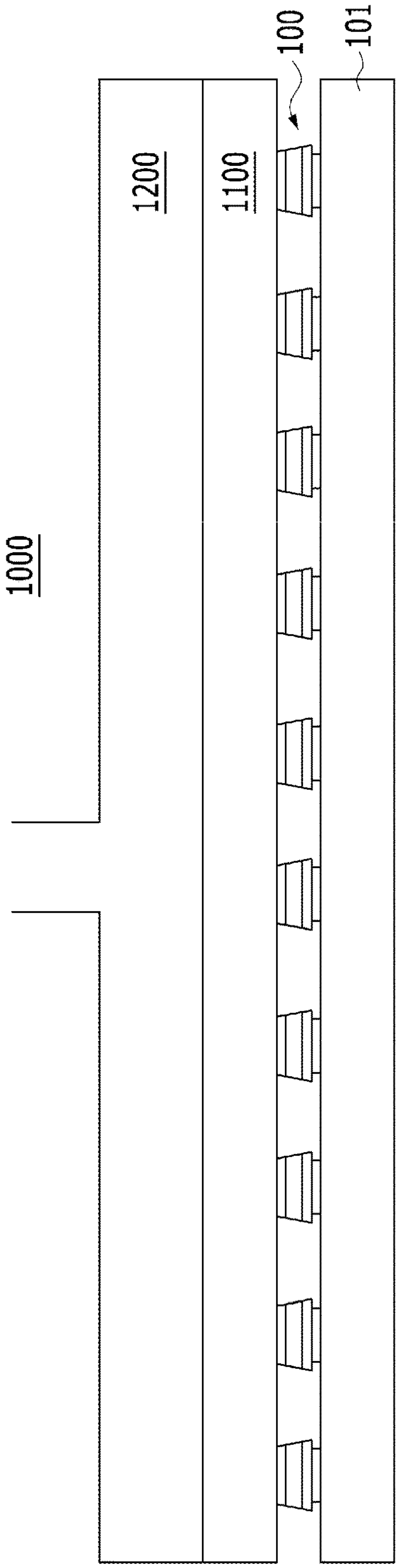


FIG. 6B

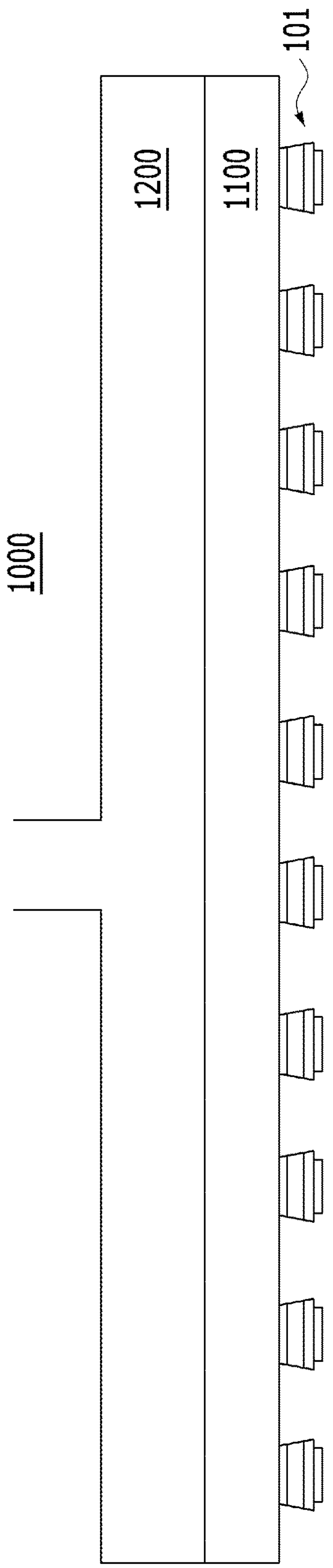


FIG. 6C

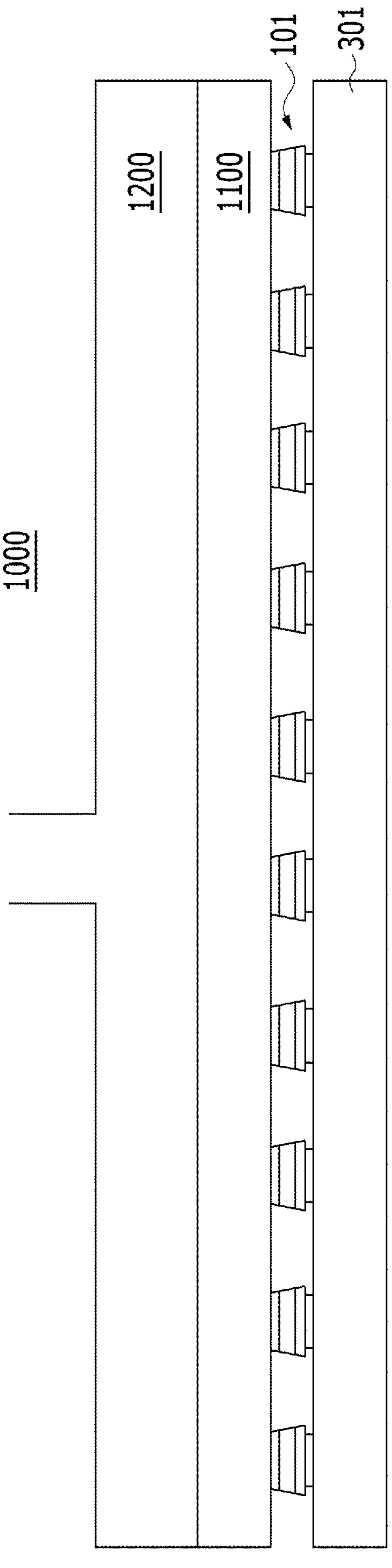


FIG. 6D

FIG. 7

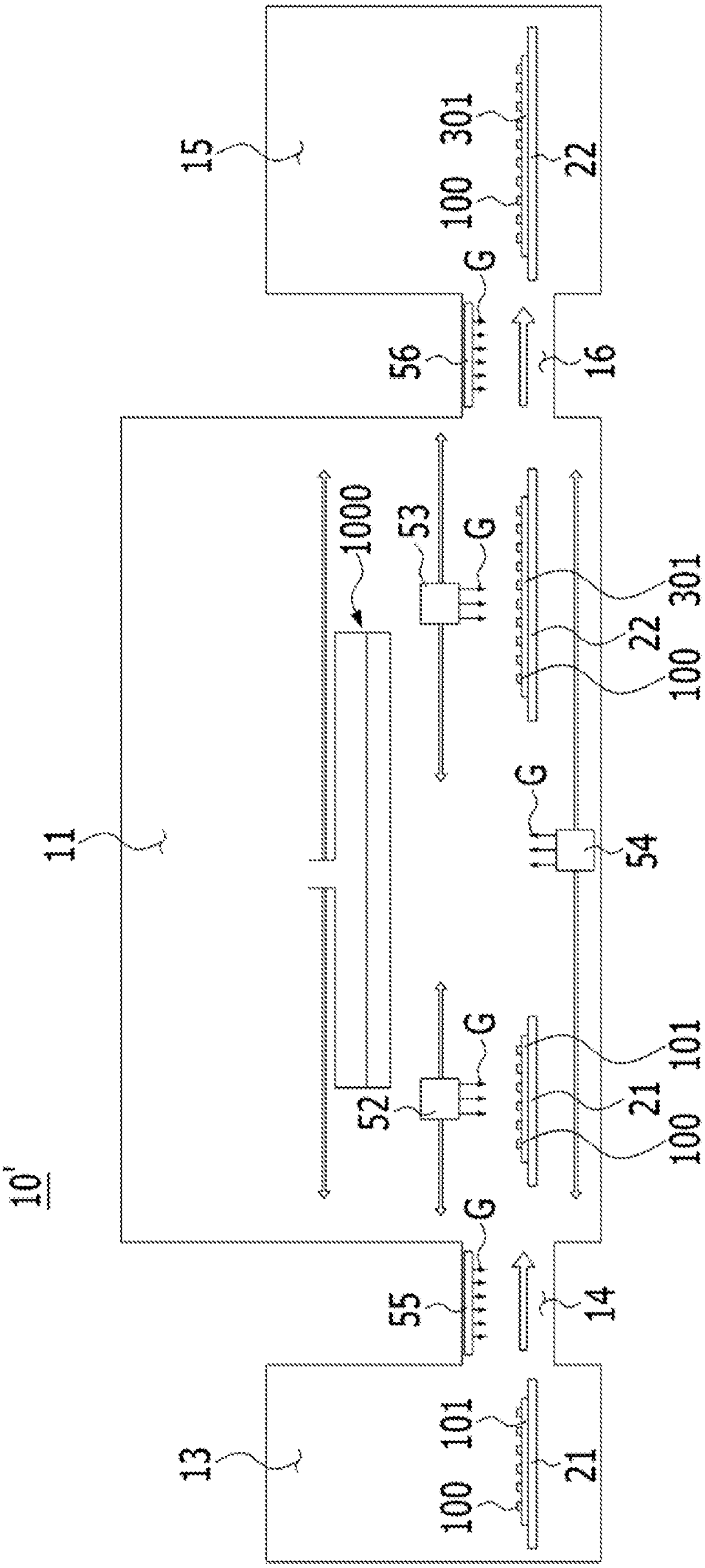

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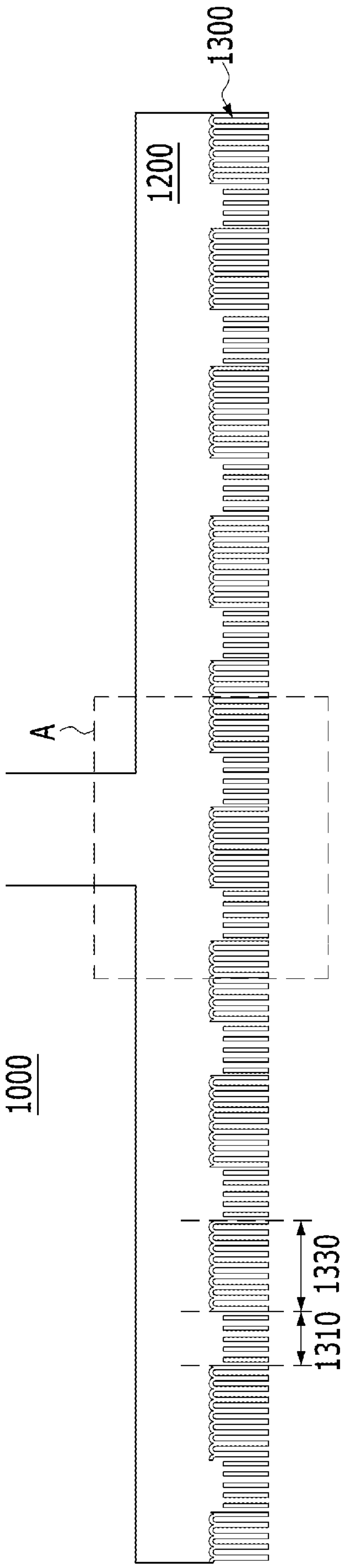
FIG. 8



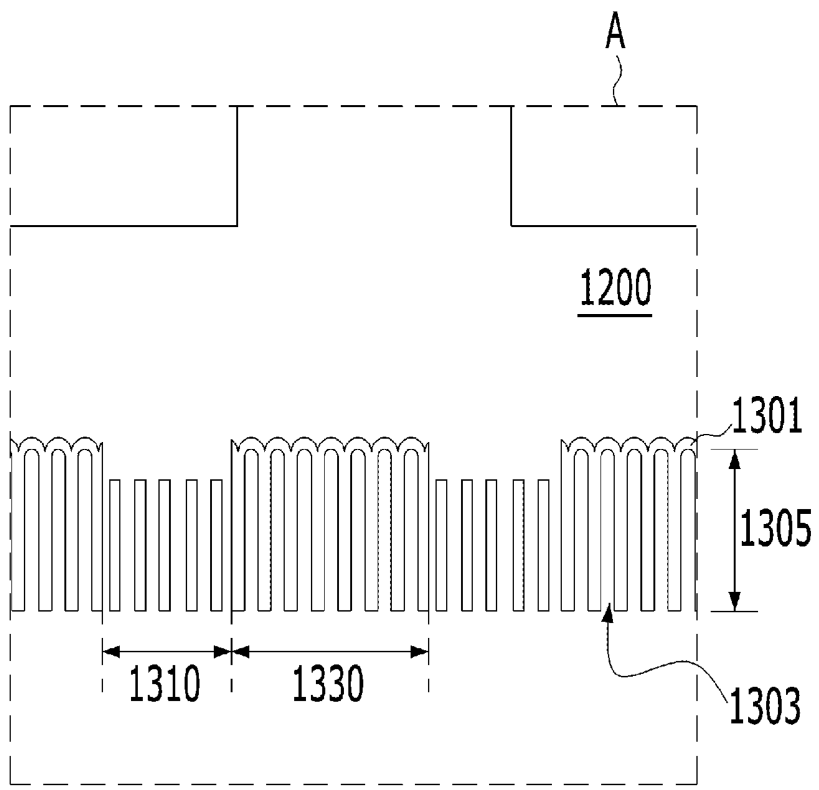


FIG. 9

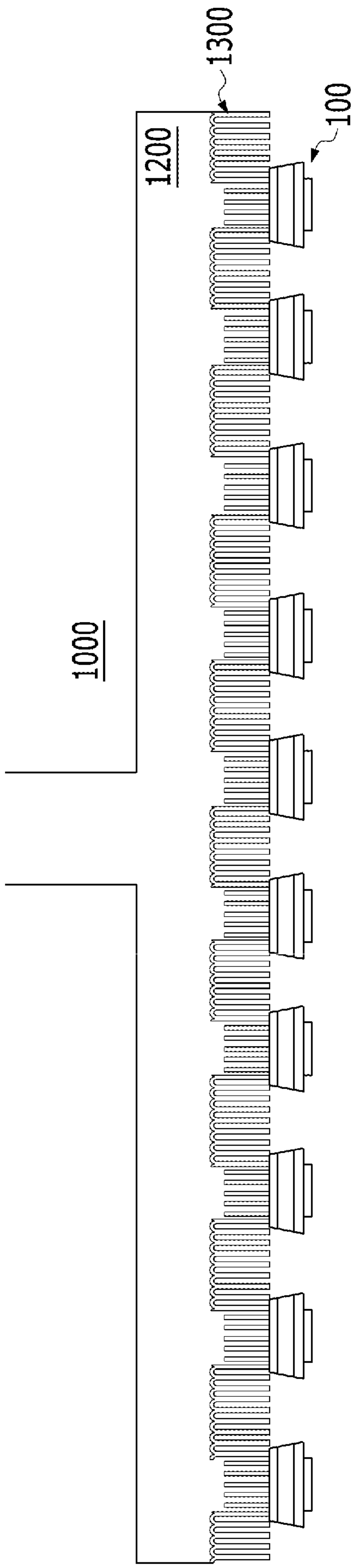


FIG. 10

FIG. 11

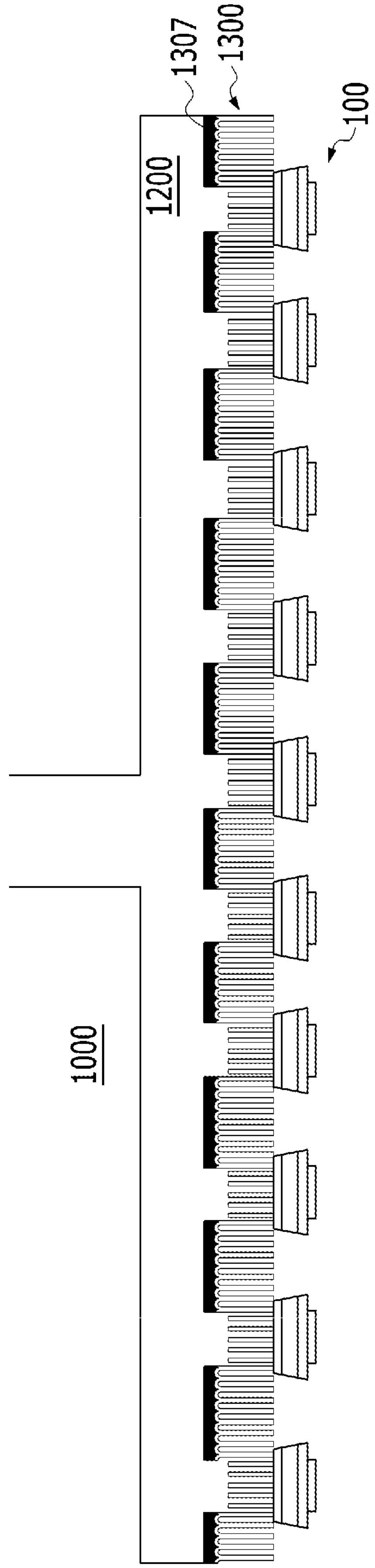


FIG. 12

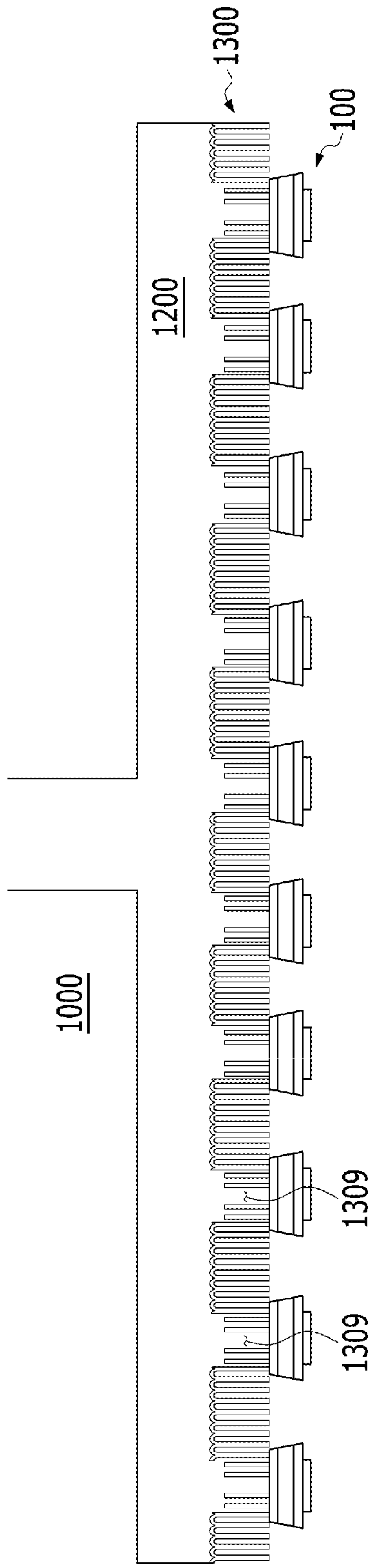
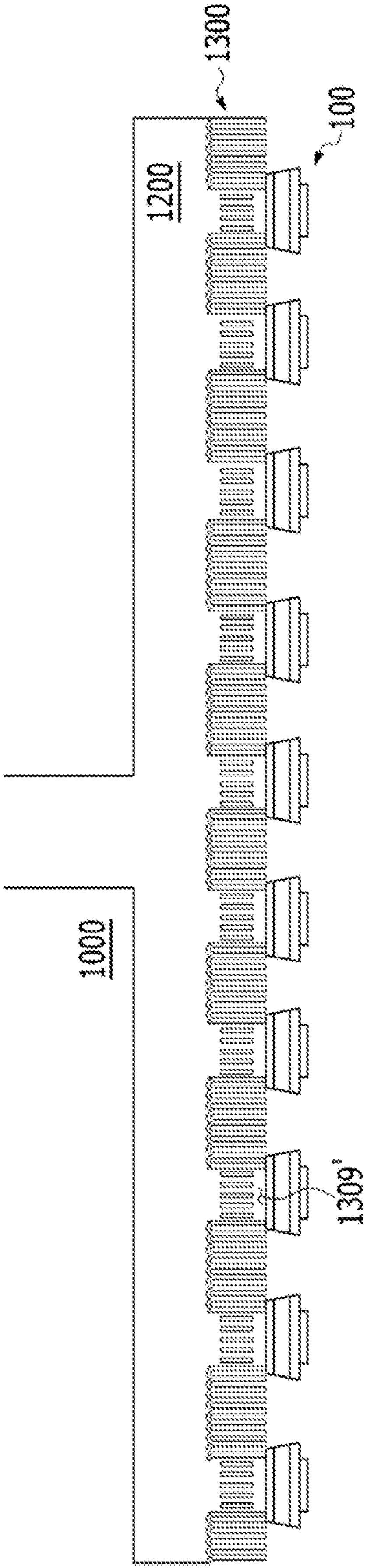


FIG. 13



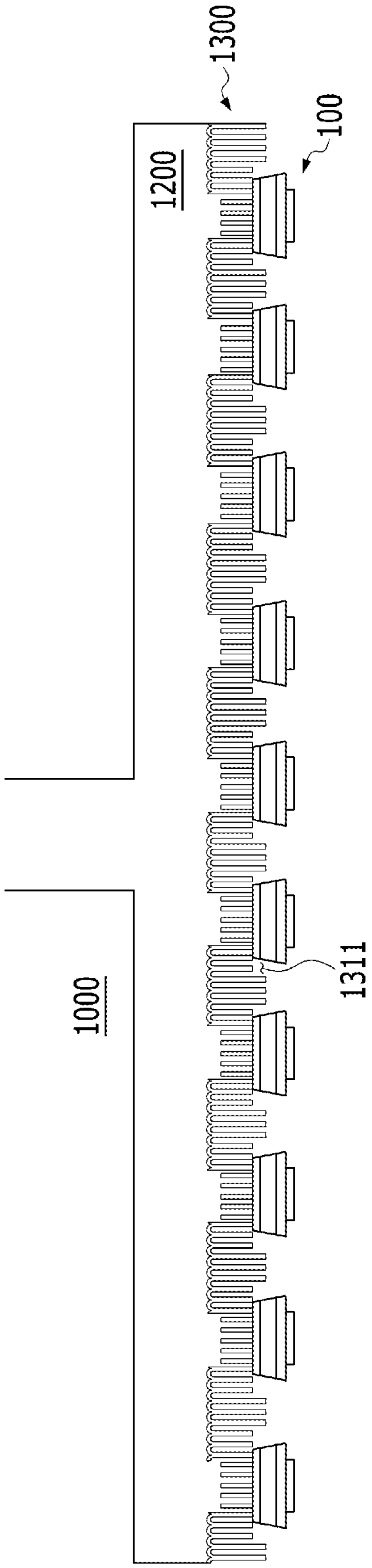


FIG. 14

FIG. 15

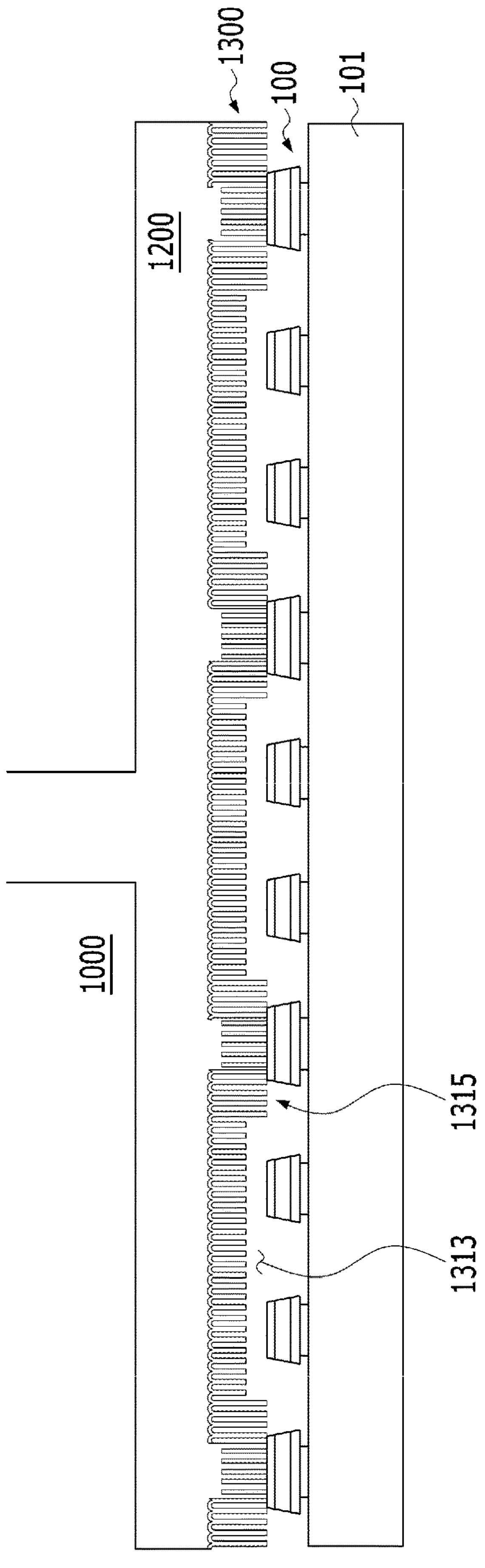


FIG. 16

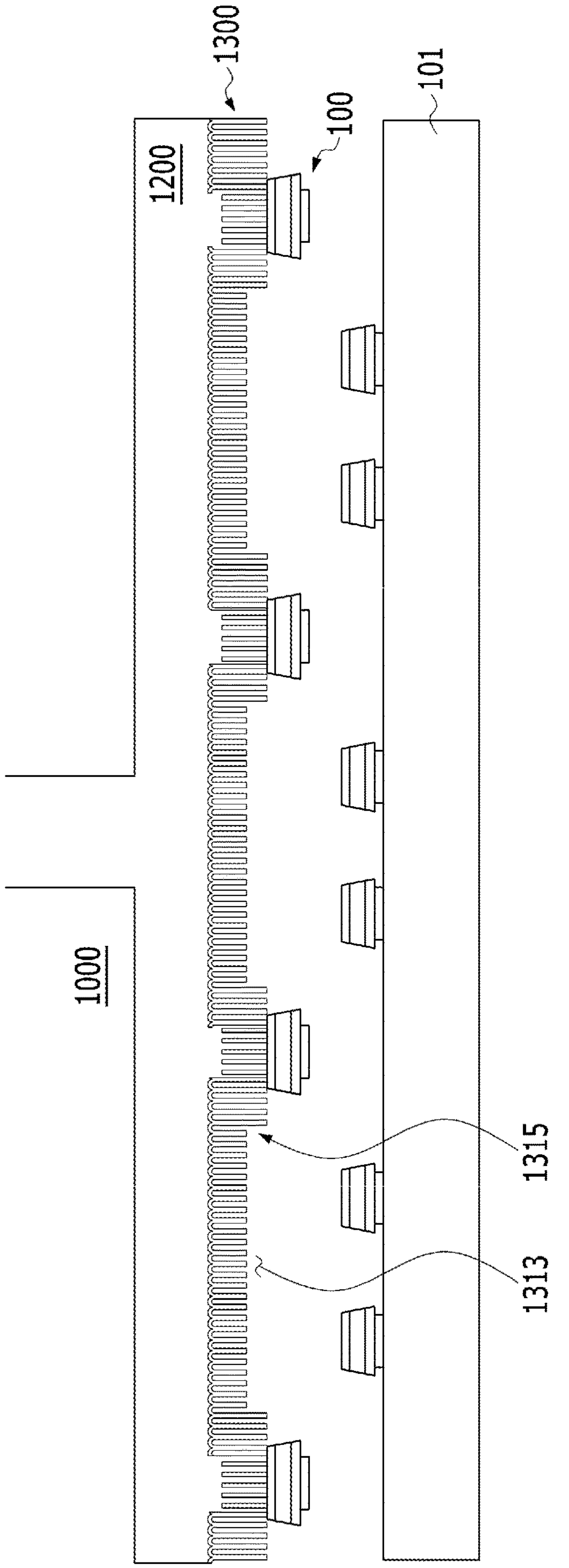


FIG. 17

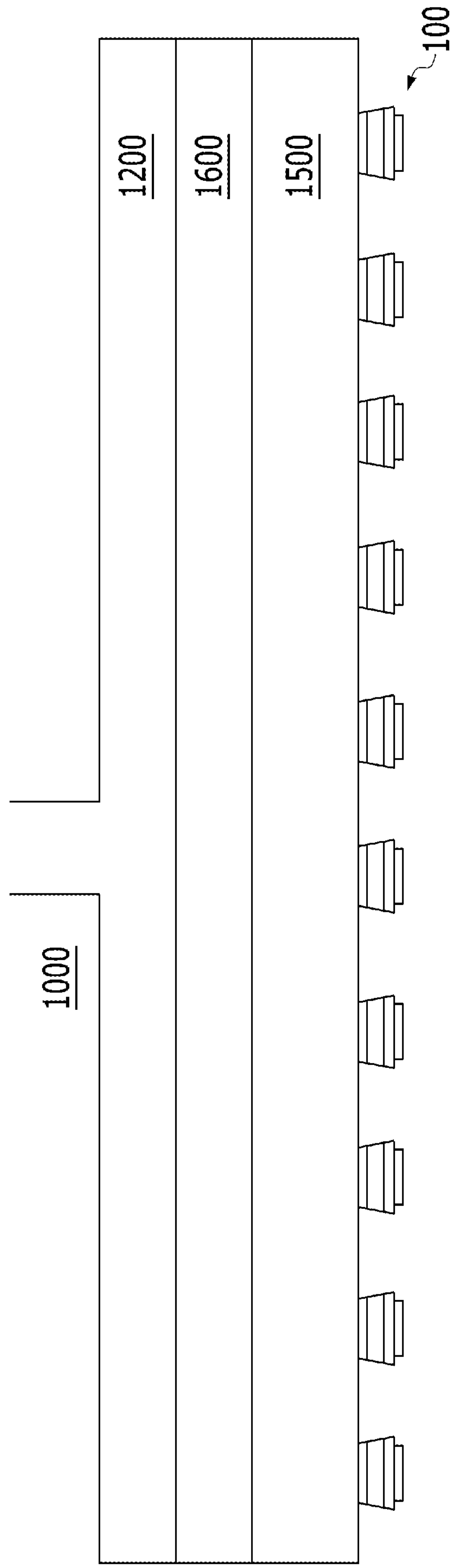
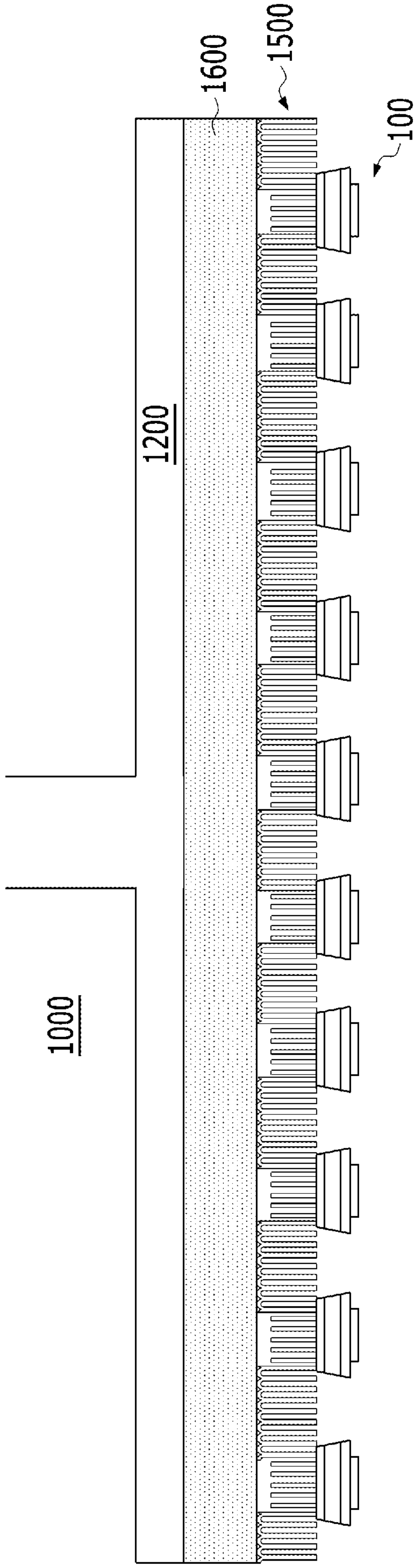


FIG. 18



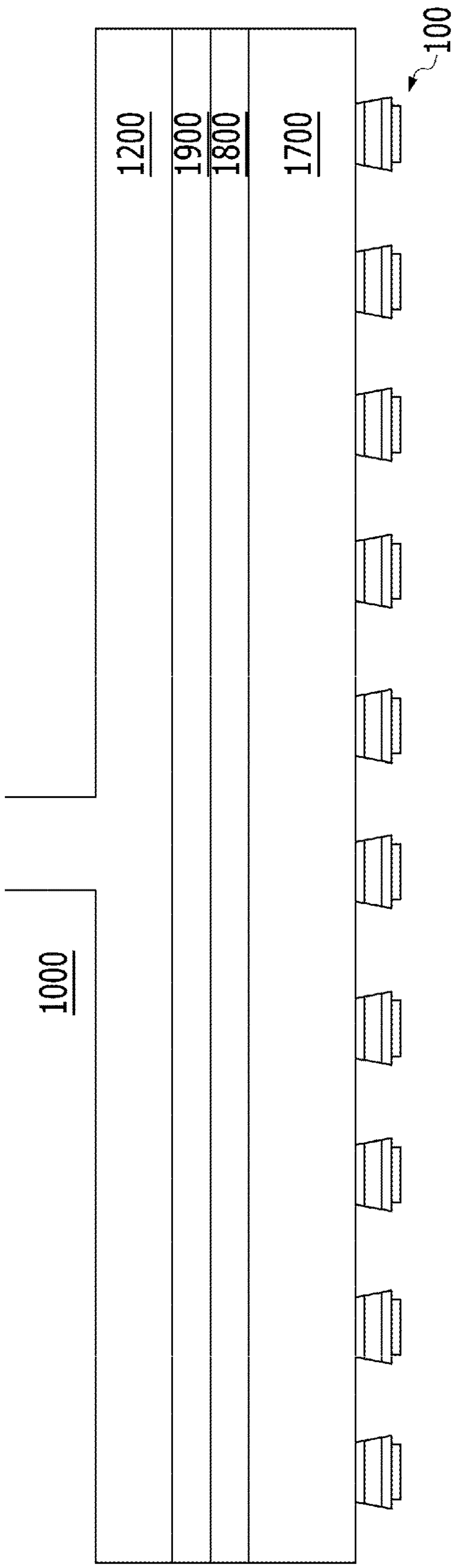


FIG. 19

FIG. 20

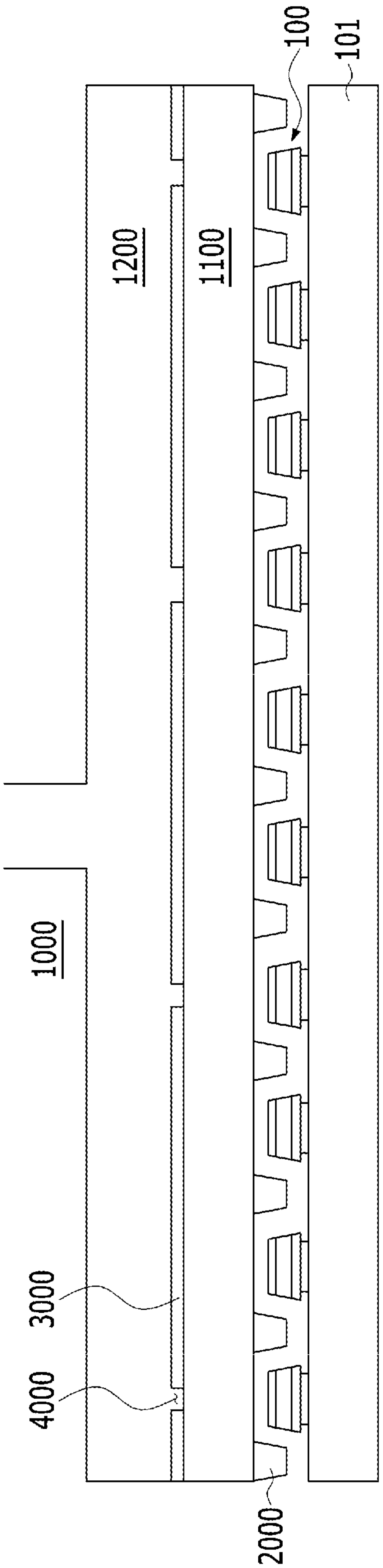


FIG. 21

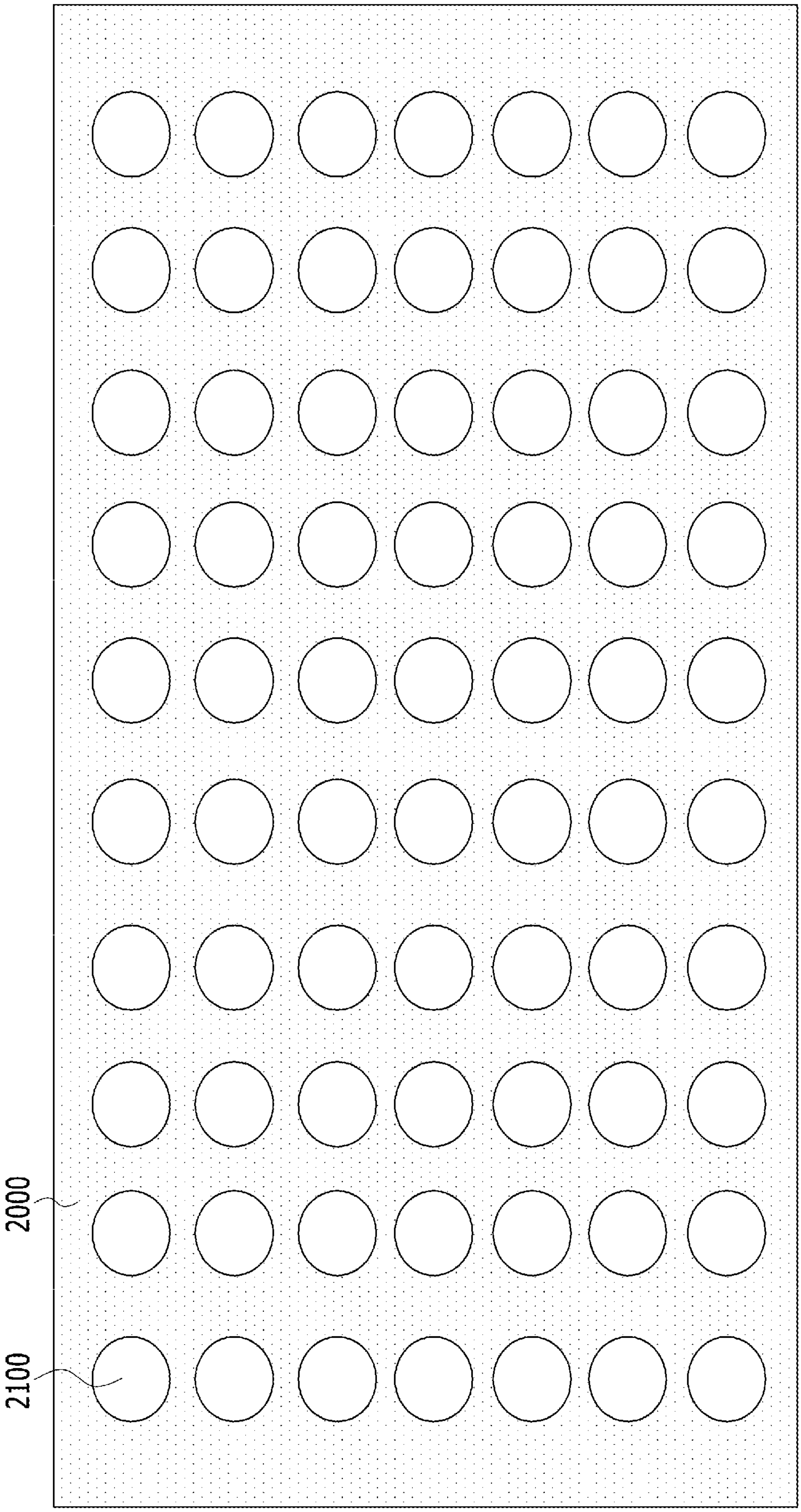


FIG. 22

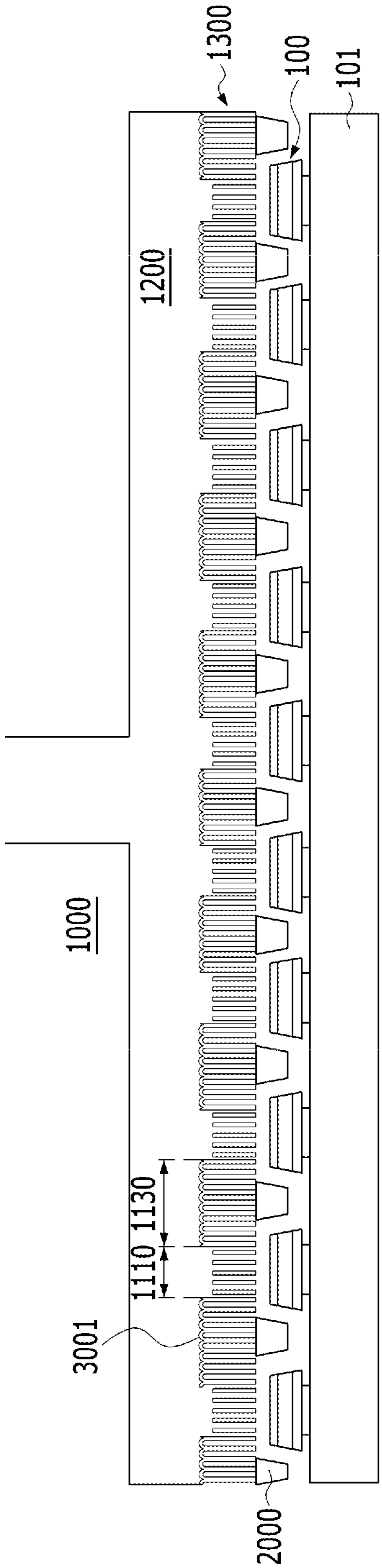


FIG. 23

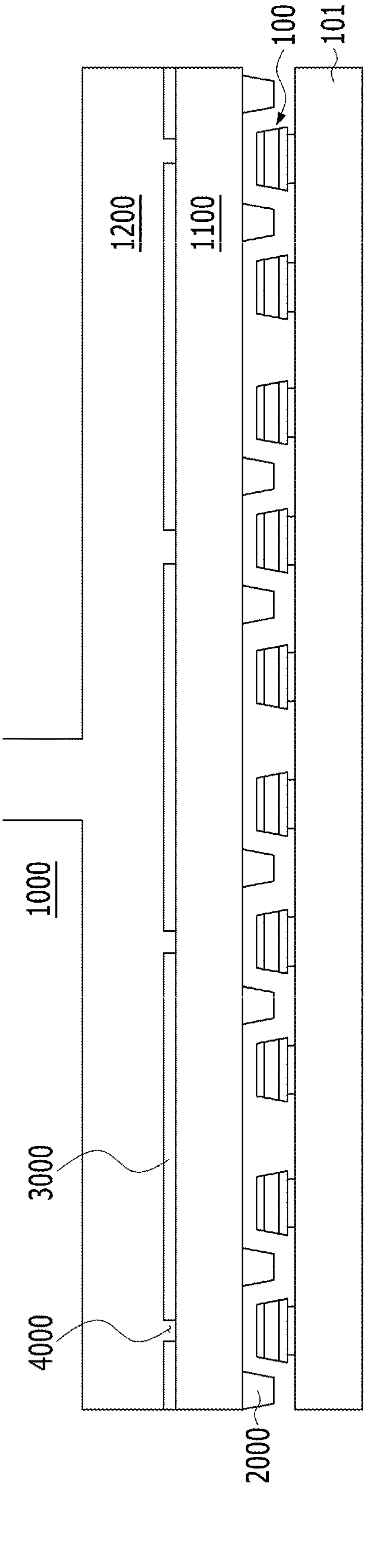
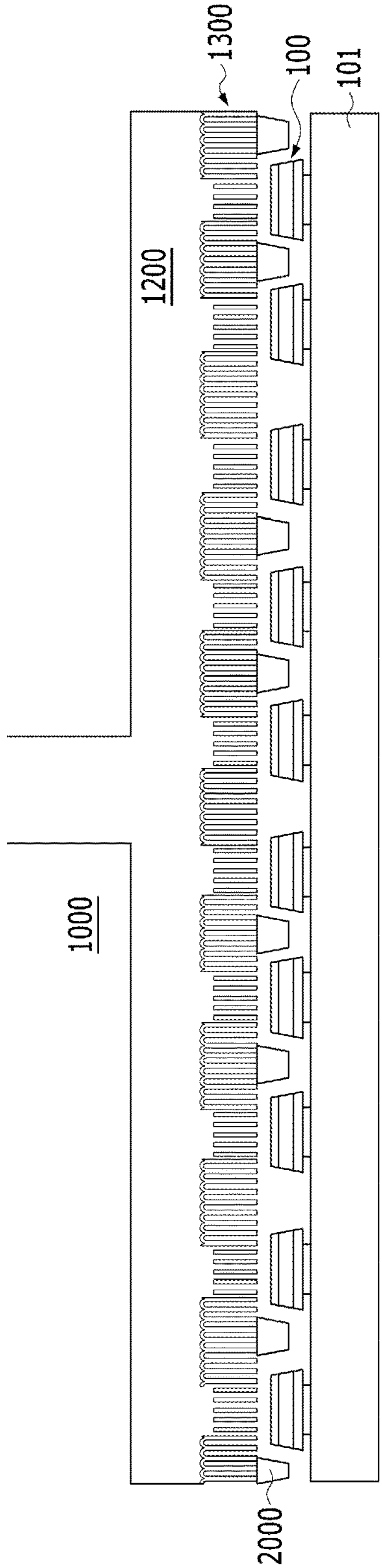


FIG. 24



SYSTEM HAVING TRANSFER HEAD FOR TRANSFERRING MICRO LED

CROSS REFERENCE TO RELATED APPLICATION

[0001] The present application claims priority to Korean Patent Application No. 10-2018-0036959, filed Mar. 30, 2018, the entire contents of which is incorporated herein for all purposes by this reference.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to a system having a transfer head for transferring a micro light-emitting diode (micro LED) from a first substrate to a second substrate.

Description of the Related Art

[0003] Currently, the display market is still dominated by LCDs, but OLEDs are quickly replacing LCDs and emerging as mainstream products. In a current situation where display makers are rushing to participate in the OLED market, micro light-emitting diode (hereinafter, referred to as micro LED) displays have emerged as another next generation display. Liquid crystal and organic materials are the core materials of LCDs and OLEDs, respectively, whereas the micro LED display uses 1 μm to 100 μm of an LED chip itself as light emitting material.

[0004] Since the term "micro LED" emerged in a patent "MICRO-LED ARRAYS WITH ENHANCED LIGHT EXTRACTION" in 1999 (Korean Patent No. 10-0731673, hereinafter referred to as 'Related Art 1') disclosed by Cree Inc., related research papers based thereon were subsequently published. In order to apply the micro LED to a display, it is necessary to develop a customized microchip based on a flexible material and/or flexible device using a micro LED device, and techniques of transferring the micrometer-sized LED chip and mounting the LED chip on a display pixel electrode are required.

[0005] Particularly, with regard to the transfer of the micro LED device to a display substrate, as the LED size is reduced to 1 μm to 100 μm, it is impossible to use a conventional pick-and-place machine, and a technology of a transfer head for higher precision is required.

[0006] Luxvue Technology Corp., USA, proposed a method of transferring a micro LED using an electrostatic head (Korean Patent Application Publication No. 10-2014-0112486, hereinafter referred to as 'Related Art 2'). A transfer principle of the Related Art 2 is that a voltage is applied to a head portion made of a silicone material so that the head portion comes into close contact with a micro LED due to electrification. However, this method may cause damage to micro LEDs due to electrification caused by the voltage applied to the head portion during induction of static electricity.

[0007] In addition, even when micro LEDs are gripped by a method different from the Related Art 2 (for example, a grip force by vacuum, etc.), an undesirable electrostatic force may be generated between the micro LEDs and the transfer head.

[0008] The electrostatic force not only damages the micro LED but also causes the micro LED to stick to the transfer head when unloading the micro LEDs from the transfer head, whereby positional error occurs when unloading the micro LED or unloading of the micro LEDs is not performed at all.

[0009] In order to solve the problems of the related art described above, it is necessary to solve the above-mentioned problems while adopting the basic principles adopted in the related art. However, there is a limit to solving the problems because such problems are derived from the basic principles adopted in the related art. Therefore, applicants of the present invention have not only solved the problems of the related art but also proposed an advanced method which has not been considered in the related art.

DOCUMENTS OF RELATED ART

[0010] (Patent Document 1) Korean Patent No. 10-0731673; and

[0011] (Patent Document 2) Korean Patent Application Publication No. 10-2014-0112486

SUMMARY OF THE INVENTION

[0012] Accordingly, the present invention has been made keeping in mind the above problems occurring in the related art, and an objective of the present invention is to provide a system having a transfer head for transferring a micro LED, the system being configured such that the transfer head does not use an electrostatic force and preventing the generation of an electrostatic force which may cause a problem.

[0013] In addition, another objective of the present invention is to provide a system having a transfer head for transferring a micro LED, the system employing a suction structure using a suction force to transfer a micro LED by a porous member, thereby solving problems of the related art.

[0014] In order to achieve the above objective, there is provided a system having a transfer head for transferring a micro LED, the system including: a first substrate provided in a transfer chamber and on which a micro LED is formed; a second substrate provided in the transfer chamber and on which the micro LED is mounted; a transfer head provided between the first substrate and the second substrate in the transfer chamber and transferring the micro LED; and a spraying unit provided in the transfer chamber spraying ionized gas.

[0015] In addition, the spraying unit may be configured as a spraying unit for a transfer chamber to replace the atmosphere in the transfer chamber with the ionized gas.

[0016] In addition, the spraying unit may be configured as a spraying unit for the first substrate to spray the ionized gas on an upper surface of the first substrate.

[0017] In addition, the spraying unit may be configured as a spraying unit for the second substrate to spray the ionized gas on an upper surface of the second substrate.

[0018] In addition, the spraying unit may be configured as a spraying unit for the transfer head to spray the ionized gas on a lower surface of the micro LED gripped by the transfer head.

[0019] As described above, a system having a transfer head for transferring a micro LED according to the present invention has the following effects.

[0020] According to the present invention, it is possible to prevent the generation of an electrostatic force by employing a spraying unit, whereby it is possible to prevent positional error when unloading a micro LED or to prevent the micro

LED from sticking to a transfer head, which may cause unloading thereof to not be performed at all.

[0021] In addition, it is possible for a transfer head to easily transfer a micro LED from a first substrate to a second substrate by a porous member.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

[0023] FIG. **1** is a view illustrating a system for transferring a micro LED according to a first embodiment of the present invention;

[0024] FIG. **2** is a view illustrating micro LEDs formed on a first substrate of FIG. **1**;

[0025] FIG. **3** is a view illustrating micro LEDs mounted on a second substrate of FIG. **1**;

[0026] FIG. **4** is a view illustrating a state in which a transfer head of FIG. **1** grips micro LEDs;

[0027] FIGS. **5**A to **5**D are views illustrating examples of a grip area and a non-grip area of the transfer head of FIG. **4**;

[0028] FIGS. **6**A to **6**D are views illustrating a method of transferring micro LEDs using the transfer head of FIG. **4**;

[0029] FIG. **7** is a view illustrating a system for transferring a micro LED according to a second embodiment of the present invention;

[0030] FIG. **8** is a view illustrating a first modification of the transfer head according to the present invention;

[0031] FIG. **9** is an enlarged view of a portion 'A' of FIG. **8**;

[0032] FIG. **10** is a view illustrating a state in which the transfer head of FIG. **8** grips micro LEDs;

[0033] FIG. **11** is a view illustrating a state in which a second modification of the transfer head grips micro LEDs;

[0034] FIG. **12** is a view illustrating a state in which a third modification of the transfer head grips micro LEDs;

[0035] FIG. **13** is a view illustrating a state in which a fourth modification of the transfer head grips micro LEDs;

[0036] FIG. **14** is a view illustrating a state in which a fifth modification of the transfer head grips micro LEDs;

[0037] FIGS. **15** and **16** are views illustrating a state in which a sixth modification of the transfer head grips micro LEDs;

[0038] FIG. **17** is a view illustrating a state in which a seventh modification of the transfer head grips micro LEDs;

[0039] FIG. **18** is a view illustrating a state in which an eighth modification of the transfer head grips micro LEDs;

[0040] FIG. **19** is a view illustrating a state in which a ninth modification of the transfer head grips micro LEDs;

[0041] FIG. **20** is a view illustrating a state in which a tenth modification of the transfer head grips micro LEDs;

[0042] FIG. **21** is a view illustrating various embodiments of a dam of the transfer head of FIG. **20**;

[0043] FIG. **22** is a view illustrating a state in which an eleventh modification of the transfer head grips micro LEDs;

[0044] FIG. **23** is a view illustrating a state in which a twelfth modification of the transfer head grips micro LEDs; and

[0045] FIG. **24** is a view illustrating a state in which a thirteenth modification of the transfer head grips micro LEDs.

DETAILED DESCRIPTION OF THE INVENTION

[0046] Contents of the description below merely exemplify the principle of the invention. Therefore, those of ordinary skill in the art may implement the theory of the invention and invent various apparatuses which are included within the concept and the scope of the invention even though it is not clearly explained or illustrated in the description. Furthermore, in principle, all the conditional terms and embodiments listed in this description are clearly intended for the purpose of understanding the concept of the invention, and one should understand that this invention is not limited to the exemplary embodiments and the conditions.

[0047] The above described objectives, features, and advantages will be more apparent through the following detailed description related to the accompanying drawings, and thus those of ordinary skill in the art may easily implement the technical spirit of the invention.

[0048] The embodiments of the present invention are described with reference to cross-sectional views and/or perspective views which schematically illustrate ideal embodiments of the present invention. For explicit and convenient description of the technical content, sizes or thicknesses of films and regions and diameters of holes in the figures may be exaggerated. Therefore, variations from the shapes of the illustrations as a result, for example, of manufacturing techniques and/or tolerances, are to be expected. In addition, a limited number of multiple micro LEDs are illustrated in the drawings. Thus, the embodiments should not be construed as limited to the particular shapes of regions illustrated herein but are to include deviations in shapes that result, for example, from manufacturing.

[0049] Wherever possible, the same reference numerals will be used throughout different embodiments and the description to refer to the same or like elements or parts. In addition, the configuration and operation already described in other embodiments will be omitted for convenience.

[0050] System **10** for Transferring a Micro LED According to a First Embodiment of the Present Invention

[0051] Hereinbelow, a system **10** for transferring a micro LED according to a first embodiment of the present invention will be described with reference to FIGS. **3** and **4**.

[0052] FIG. **1** is a view illustrating a system for transferring a micro LED according to a first embodiment of the present invention; FIG. **2** is a view illustrating micro LEDs formed on a first substrate of FIG. **1**; FIG. **3** is a view illustrating micro LEDs mounted on a second substrate of FIG. **1**; FIG. **4** is a view illustrating a state in which a transfer head of FIG. **1** grips micro LEDs; FIGS. **5**A to **5**D are views illustrating examples of a grip area and a non-grip area of the transfer head of FIG. **4**; and FIGS. **6**A to **6**D are views illustrating a method of transferring micro LEDs using the transfer head of FIG. **4**.

[0053] Referring to FIG. **1**, a system **10** for transferring a micro LED according to the first embodiment of the present invention includes: a transfer chamber **11** in which micro LEDs **100** are transferred; a loading chamber **13** communicating with the transfer chamber **11** and providing a space for transferring a first substrate **101** to the transfer chamber **11**; and an unloading chamber **15** communicating with the transfer chamber **11** and providing a space for transferring a second substrate **301** whose transfer is completed in the transfer chamber **11**.

[0054] The loading chamber **13** communicates with the transfer chamber **11** through a first passage **14**. In addition, the loading chamber **13** receives the first substrate **101** from an external process chamber and functions to provide a space for transferring the first substrate **101** to the transfer chamber **11** in order to perform a transfer process in which the micro LEDs **100** formed on the first substrate **101** are mounted on the second substrate **301**.

[0055] A first base **21** transfers the first substrate **101** from the loading chamber **13** to the transfer chamber **11**.

[0056] The first substrate **101** is seated on the first base **21**, and the first base **21** is provided to be movable between the loading chamber **13** and the transfer chamber **11** through the first passage **14** along the X-axis. Therefore, as the first base **101** moves from the loading chamber **13** to the transfer chamber **11**, the first substrate **101** seated on the first base **21** is transferred from the loading chamber **13** to the transfer chamber **11**.

[0057] The unloading chamber **15** communicates with the transfer chamber **11** through a second passage **16**. In addition, the unloading chamber **15** functions to provide a space for transferring the second substrate **301** on which the micro LEDs **100** are mounted after the transfer process is completed to the external process chamber.

[0058] A second base **22** transfers the second substrate **301** from the transfer chamber **11** to the unloading chamber **15**.

[0059] The second substrate **301** is seated on the second base **22**, and the second base **22** is provided to be movable between the transfer chamber **11** and the unloading chamber **15** through the second passage **16** along the X-axis. Therefore, as the second base **22** moves from the transfer chamber **11** to the unloading chamber **15**, the second substrate **301** seated on the second base **22** is transferred from the transfer chamber **11** to the unloading chamber **15**.

[0060] The transfer chamber **11** is disposed between the loading chamber **13** and the unloading chamber **15** and functions to provide a space where the micro LEDs **100** are transferred by a transfer head **1000**. In this case, the transfer chamber **11** communicates with the loading chamber **13** and the unloading chamber **15** through the first passage **14** and the second passage **16**, respectively.

[0061] The transfer chamber **11** includes: the first substrate **101** disposed in the transfer chamber **11** and on which the micro LEDs **100** are formed; the second substrate **301** disposed in the transfer chamber **11** and on which the micro LEDs **100** are mounted; the transfer head **1000** provided between the first substrate **101** and the second substrate **301** in the transfer chamber **11** to transfer the micro LEDs **100**; and a spraying unit spraying ionized gas G.

[0062] The first substrate **101** is seated on the top of the first base **21** to be disposed in the transfer chamber **11**, and the second substrate **301** is seated on the top of the second base **22** to be disposed in the transfer chamber **11**.

[0063] Hereinbelow, the micro LEDs **100** transferred by the transfer head **1000** and the first substrate **101** on which the micro LEDs **100** are formed will be described.

[0064] As illustrated in FIG. **2**, the micro LEDs **100** are fabricated and positioned on the first substrate **101**. In other words, the micro LEDs **100** are formed on the first substrate **101**.

[0065] The first substrate **101** may be formed into a conductive substrate or an insulating substrate. For example, the first substrate **101** is formed of at least one selected from among the group consisting of sapphire, SiC, Si, GaAs, GaN, ZnO, GaP, InP, Ge, and Ga_2O_3.

[0066] Each of the micro LEDs **100** includes: a first semiconductor layer **102**; a second semiconductor layer **104**; an active layer **103** provided between the first semiconductor layer **102** and the second semiconductor layer **104**; a first contact electrode **106**; and a second contact electrode **107**.

[0067] The first semiconductor layer **102**, the active layer **103**, and the second semiconductor layer **104** may be formed by performing metalorganic chemical vapor deposition (MOCVD), chemical vapor deposition (CVD), plasma-enhanced chemical vapor deposition (PECVD), molecular-beam epitaxy (MBE), hydride vapor phase epitaxy (HVPE), or the like.

[0068] The first semiconductor layer **102** may be implemented, for example, as a p-type semiconductor layer. A p-type semiconductor layer may be a semiconductor material having a composition formula of $In_xAl_yGa_{1-x-y}N$ ($0 \le x \le 1$, $0 \le y \le 1$, $0 \le x+y \le 1$), for example, GaN, AlN, AlGaN, InGaN, InN, InAlGaN, AlInN, and the like, and the layer may be doped with a p-type dopant such as Mg, Zn, Ca, Sr, and Ba.

[0069] The second semiconductor layer **104** may be implemented, for example, as an n-type semiconductor layer. An n-type semiconductor layer may be a semiconductor material having a composition formula of $In_xAl_yGa_{1-x-y}N$ ($0 \le x \le 1$, $0 \le y \le 1$, $0 \le x+y \le 1$), for example, GaN, AlN, AlGaN, InGaN, InNInAlGaN, AlInN, and the like, and the layer may be doped with an n-type dopant such as Si, Ge, and Sn.

[0070] However, the present invention is not limited to this. The first semiconductor layer **102** may include an n-type semiconductor layer, and the second semiconductor layer **104** may include a p-type semiconductor layer.

[0071] The active layer **103** is a region where electrons and holes are recombined. As the electrons and the holes are recombined, the active layer **103** transits to a low energy level and generates light having a wavelength corresponding thereto. The active layer **103** may be formed of a semiconductor material having a composition formula of $In_xAl_yGa_{1-x-y}N$ ($0 \le x \le 1$, $0 \le y \le 1$, $0 \le x+y \le 1$) and may have a single quantum well structure or a multi quantum well (MQW) structure. In addition, the active layer **103** may have a quantum wire structure or a quantum dot structure.

[0072] The first semiconductor layer **102** may be provided with the first contact electrode **106**, and the second semiconductor layer **104** may be provided with the second contact electrode **107**. The first contact electrode **106** and/or the second contact electrode **107** may include one or more layers and may be formed of various conductive materials including a metal, conductive oxide, and conductive polymer.

[0073] The multiple micro LEDs **100** formed on the first substrate **101** are separated into individual pieces by cutting along a cutting line using a laser or the like or by etching. Then, it is possible to separate the individual micro LEDs **100** from the first substrate **101** by a laser lift-off process.

[0074] In FIG. **1**, the letter 'P' denotes a pitch distance between the micro LEDs **100**, 'S' denotes a separation distance between the micro LEDs **100**, and 'W' denotes a width of each micro LED **100**.

[0075] Hereinbelow, the second substrate **301** on which the micro LEDs **100** are mounted will be described.

[0076] When the micro LEDs **100** are transferred to and mounted on the second substrate **301** by the transfer head

1000, the second substrate **301** is configured into a micro LED structure having the micro LEDs **100** as illustrated in FIG. **3**.

[0077] The second substrate **301** may include various materials. For example, the second substrate **301** may be made of a transparent glass material having SiO_2 as a main component. However, materials of the second substrate **301** are not limited to this, and the second substrate **301** may be made of a transparent plastic material and have solubility. The plastic material may be an organic insulating substance selected from the group consisting of polyethersulfone (PES), polyacrylate (PAR), polyetherimide (PEI), polyethylene naphthalate (PEN), polyethylene terephthalate (PET), polyphenylene sulfide (PPS), polyallylate, polyimide, polycarbonate (PC), cellulose triacetate (TAC), and cellulose acetate propionate (CAP).

[0078] In the case of a bottom emission type in which an image is implemented in a direction of the second substrate **301**, the second substrate **301** is required to be formed of a transparent material. However, in the case of a top emission type in which an image is implemented in a direction opposite to the second substrate **301**, the second substrate **301** is not required to be formed of a transparent material. In this case, the second substrate **301** may be formed of metal.

[0079] In the case of forming the second substrate **301** using metal, the second substrate **301** may be formed of at least one metal selected from among the group consisting of iron, chromium, manganese, nickel, titanium, molybdenum, stainless steel (SUS), Invar, Inconel, and Kovar, but is not limited thereto.

[0080] The second substrate **301** may include a buffer layer **311**. The buffer layer **311** provides a flat surface and blocks foreign matter or moisture from penetrating therethrough. For example, the buffer layer **311** may be formed of an inorganic substance such as silicon oxide, silicon nitride, silicon oxynitride, aluminum oxide, aluminum nitride, titanium oxide, and titanium nitride, or an organic substance such as polyimide, polyester, and acrylic. Alternatively, the buffer layer **311** may be formed in a stacked manner with the exemplified substances.

[0081] A thin-film transistor (TFT) may include an active layer **310**, a gate electrode **320**, a source electrode **330***a*, and a drain electrode **330***b*.

[0082] Hereinafter, a case where a TFT is a top gate type in which the active layer **310**, the gate electrode **320**, the source electrode **330***a*, and the drain electrode **330***b* are sequentially formed will be described. However, the present embodiment is not limited thereto, and various types of TFTs such as a bottom gate TFT may be employed.

[0083] The active layer **310** may contain a semiconductor material, such as amorphous silicon and polycrystalline silicon. However, the present embodiment is not limited thereto, and the active layer **310** may contain various materials. As an alternative embodiment, the active layer **310** may contain an organic semiconductor material or the like.

[0084] As another alternative embodiment, the active layer **310** may contain an oxide semiconductor material. For example, the active layer **310** may contain an oxide of a metal element selected from Groups 12, 13, and 14 elements such as zinc (Zn), indium (In), gallium (Ga), tin (Sn), cadmium (Cd), and germanium (Ge), and a combination thereof.

[0085] A gate dielectric layer **313** is formed on the active layer **310**. The gate dielectric layer **313** serves to isolate the active layer **310** and the gate electrode **320**. The gate dielectric layer **313** may be formed into a multilayer or a single layer of a film made of an inorganic substance such as silicon oxide and/or silicon nitride.

[0086] The gate electrode **320** is provided on the gate dielectric layer **313**. The gate electrode **320** may be connected to a gate line (not illustrated) applying an on/off signal to the TFT.

[0087] The gate electrode **320** may be made of a low-resistivity metal. In consideration of adhesion with an adjacent layer, surface flatness of layers to be stacked, and processability, the gate electrode **320** may be formed into a multilayer or a single layer, which is made of at least one metal selected from among the group consisting of aluminum (Al), platinum (Pt), palladium (Pd), silver (Ag), magnesium (Mg), gold (Au), nickel (Ni), neodymium (Nd), iridium (Ir), chromium (Cr), lithium (Li), calcium (Ca), molybdenum (Mo), titanium (Ti), tungsten (W), and copper (Cu).

[0088] An interlayer dielectric film **315** is provided on the gate electrode **320**. The interlayer dielectric film **315** isolates the source electrode **330***a* and the drain electrode **330***b*, and the gate electrode **320**. The interlayer dielectric film **315** may be formed into a multilayer or single layer of a film made of an inorganic substance. For example, the inorganic substance may be a metal oxide or a metal nitride. Specifically, the inorganic substance may include silicon dioxide (SiO_2), silicon nitrides (SiN_x), silicon oxynitride (SiON), aluminum oxide (Al_2O_3), titanium dioxide (TiO_2), tantalum pentoxide (Ta_2O_5), hafnium dioxide (HfO_2), or zirconium dioxide (ZrO_2).

[0089] The source electrode **330***a* and the drain electrode **330***b* are provided on the interlayer dielectric film **315**. The source electrode **330***a* and the drain electrode **330***b* may be formed into a multilayer or a single layer, which is made of at least one metal selected from among the group consisting of aluminum (Al), platinum (Pt), palladium (Pd), silver (Ag), magnesium (Mg), gold (Au), nickel (Ni), neodymium (Nd), iridium (Ir), chromium (Cr), lithium (Li), calcium (Ca), molybdenum (Mo), titanium (Ti), tungsten (W), and copper (Cu). The source electrode **330***a* and the drain electrode **330***b* are electrically connected to a source region and a drain region of the active layer **310**, respectively.

[0090] A planarization layer **317** is provided on the TFT. The planarization layer **317** is configured to cover the TFT, thereby eliminating steps caused by the TFT and planarizing the top surface. The planarization layer **317** may be formed into a single layer or a multilayer of a film made of an organic substance. The organic substance may include a general-purpose polymer such as polymethyl methacrylate (PMMA) and polystyrene (PS); a polymer derivative having phenols; polyacrylates; polyimides, poly(aryl ethers); polyamides; fluoropolymers; poly-p-xylenes; and polyvinyl alcohols; and a combination thereof. In addition, the planarization layer **317** may be formed into a multi-stack including an inorganic insulating layer and an organic insulating layer.

[0091] A first electrode **510** is provided on the planarization layer **317**. The first electrode **510** may be electrically connected to the TFT. Specifically, the first electrode **510** may be electrically connected to the drain electrode **330***b* through a contact hole formed in the planarization layer **317**. The first electrode **510** may have various shapes. For example, the first electrode **510** may be patterned in an island layout. A bank layer **400** defining a pixel region may be disposed on the planarization layer **317**. The bank layer **400** may include a recess where the micro LED **100** will be received. The bank layer **400** may include, for example, a first bank layer **410** defining the recess. A height of the first bank layer **410** may be determined by a height and viewing angle of the micro LED **100**. A size (width) of the recess may be determined by resolution, pixel density, and the like, of a display device. In an embodiment, the height of the micro LED **100** may be greater than the height of the first bank layer **410**. The recess may have a quadrangular cross section, but is not limited to this. The recess may have various cross section shapes, such as polygonal, rectangular, circular, conical, elliptical, and triangular.

[0092] The bank layer **400** may further include a second bank layer **420** on the first bank layer **410**. The first bank layer **410** and the second bank layer **420** have a step difference, and a width of the second bank layer **420** may be smaller than the width of the first bank layer **410**. A conductive layer **550** may be disposed on the second bank layer **420**. The conductive layer **550** may be disposed in a direction parallel to a data line or a scan line, and may be electrically connected to a second electrode **530**. However, the present invention is not limited thereto. The second bank layer **420** may be omitted, and the conductive layer **550** may be disposed on the first bank layer **410**. Alternatively, the second bank layer **420** and the conductive layer **550** may be omitted, and the second electrode **530** may be formed over the entire second substrate **301** such that the second electrode **530** serves as a shared electrode that pixels (P) share. The first bank layer **410** and the second bank layer **420** may include a material absorbing at least a part of light, a light reflective material, or a light scattering material. The first bank layer **410** and the second bank layer **420** may include an insulating material that is translucent or opaque to visible light (e.g., light in a wavelength range of 380 nm to 750 nm).

[0093] For example, the first bank layer **410** and the second bank layer **420** may be formed of a thermoplastic such as polycarbonate (PC), polyethylene terephthalate (PET), polyethersulfone, polyvinyl butyral, polyphenylene ether, polyamide, polyetherimide, polynorbornene, poly(methyl methacrylate) resin, and cyclic polyolefin resin, a thermosetting plastic such as epoxy resin, phenolic resin, urethane resin, acrylic resin, vinyl ester resin, polyimide resin, urea resin, and melamine resin, or an organic insulating substance such as polystyrene, polyacrylonitrile, and polycarbonate, but are not limited thereto.

[0094] As another example, the first bank layer **410** and the second bank layer **420** may be formed of an inorganic insulating substance such as inorganic oxide and inorganic nitride including SiO_x, SiN_x, SiN_xO_y, AlO_x, TiO_x, TaO_x, and ZnO_x, but are not limited thereto. In an embodiment, the first bank layer **410** and the second bank layer **420** may be formed of an opaque material such as a material of a black matrix. A material of the insulating black matrix may include a resin or a paste including organic resin, glass paste, and black pigment; metal particles such as nickel, aluminum, molybdenum, and alloys thereof; metal oxide particles (e.g., chromium oxide); metal nitride particles (e.g., chromium nitride), or the like. In an alternate embodiment, the first bank layer **410** and the second bank layer **420** may be a distributed Bragg reflector (DBR) having high reflectivity or a mirror reflector formed of metal.

[0095] The micro LED **100** is disposed in the recess. The micro LED **100** may be electrically connected to the first electrode **510** at the recess.

[0096] The micro LED **100** emits light having wavelengths of different colors such as red, green, blue, white, and the like. With the micro LED **100**, it is possible to realize white light by using fluorescent materials or by combining colors. The micro LED **100** has a size of 1 μm to 100 μm. The micro LEDs **100** are picked up from the first substrate **101** individually or collectively by a transfer head according to the embodiment of the present invention, transferred to the second substrate **301**, and received in the recess of the second substrate **301**.

[0097] The micro LED **100** includes a p-n diode, the first contact electrode **106** disposed on one side of the p-n diode, and the second contact electrode **107** disposed on the opposite side of the first contact electrode **106**. The first contact electrode **106** may be connected to the first electrode **510**, and the second contact electrode **107** may be connected to the second electrode **530**.

[0098] The first electrode **510** may include: a reflective layer formed of Ag, Mg, Al, Pt, Pd, Au, Ni, Nd, Ir, Cr, or a compound thereof; and a transparent or translucent electrode layer provided on the reflective layer. The transparent or translucent electrode layer may be formed of at least one selected from among the group consisting of indium tin oxide (ITO), indium zinc oxide (IZO), zinc oxide (ZnO), indium oxide (In_2O_3), indium gallium oxide (IGO), and aluminum zinc oxide (AZO).

[0099] A passivation layer **520** surrounds the micro LED **100** in the recess. The passivation layer **520** covers the recess and the first electrode **510** by filling a space between the bank layer **400** and the micro LED **100**. The passivation layer **520** may be formed of an organic insulating substance. For example, the passivation layer **520** may be formed of acrylic, poly (methyl methacrylate) (PMMA), benzocyclobutene (BCB), polyimide, acrylate, epoxy, and polyester, but is not limited thereto.

[0100] The passivation layer **520** is formed to have a height not covering an upper portion of the micro LED **100**, for example, a height not covering the second contact electrode **107**, whereby the second contact electrode **107** is exposed. The second electrode **530** may be formed on the passivation layer **520** electrically connected to the exposed second contact electrode **107** of the micro LED **100**.

[0101] The second electrode **530** may be disposed on the micro LED **100** and the passivation layer **520**. The second electrode **530** may be formed of a transparent conductive material such as ITO, IZO, ZnO, and In_2O_3.

[0102] Hereinbelow, the transfer head **1000** will be described.

[0103] As illustrated in FIG. **1**, the transfer head **1000** is disposed between the first substrate **101** and the second substrate **301** in the transfer chamber **11**, which means that the transfer head **1000** is provided to be movable between the first base **21** and the second base **22** along the X-axis, and functions to transfer the micro LEDs **100** from the first substrate **101** to the second substrate **301**.

[0104] In addition, the transfer head **1000** is movable in the Y-axis in the transfer chamber **11**, that is, movable up and down.

[0105] Since the transfer head **1000** is movable along the X-axis and the Y-axis as described above, the transfer head **1000** grips and transfers the micro LEDs **100** of the first substrate **101** seated on the first base **21** to the second substrate **301** seated on the second base **22**. Accordingly, it is possible to easily transfer the micro LEDs **100** from the first substrate **101** to the second substrate **301**.

[0106] As illustrated in FIG. **4**, the transfer head **1000** includes a porous member **1100** having pores. The transfer head **1000** functions to apply a suction force to pores of the porous member **1100** or to release the suction force applied to the pores in order to transfer the micro LEDs **100** from the first substrate **101** to the second substrate **301**.

[0107] The porous member **1100** is provided with a suction chamber **1200** at an upper portion thereof. The suction chamber **1200** is connected to a suction port supplying a suction force or releasing a suction force. The suction chamber **1200** functions to apply a suction force to the multiple pores of the porous member **1100** or to release a suction force applied to the pores according to the operation of the suction port. A structure of engaging the suction chamber **1200** to the porous member **1100** is not limited as long as the structure is suitable for preventing gas or air from leaking to other parts when applying the suction force to the porous member **1100** or releasing the applied suction force.

[0108] The gripping of the micro LEDs **100** by the above-described suction chamber **1200** may be realized by vacuum-suction. Therefore, in the following description, the description will be based on the transfer head **1000** gripping the micro LEDs **100** by vacuum-suction.

[0109] When gripping the micro LEDs **100** with vacuum-suction, the vacuum applied to the suction chamber **1200** is transferred to the multiple pores of the porous member **1100** to generate a vacuum suction force for the micro LEDs **100**. When detaching the micro LEDs **100**, the vacuum applied to the suction chamber **1200** is released to remove the vacuum from the multiple pores of the porous member **1100** whereby the vacuum suction force to the micro LEDs **100** is removed.

[0110] The porous member **1100** may be composed of a material containing a large number of pores therein, and may be configured as powders, a thin film, a thick film, or a bulk form having a porosity of about 0.2 to 0.95 in a predetermined arrangement or disordered pore structure. The pores of the porous member **1100** are classified according to pore sizes thereof: micropores having a pore diameter of 2 nm or less, mesopores having a pore diameter of 2 nm to 50 nm, and macropores having a pore diameter of 50 nm or more. The porous member **1100** may include includes at least some of micropores, mesopores, and macropores. Porous materials of the porous member **1100** are classified according to constituent components thereof: organic, inorganic (ceramic), metal, and hybrid type. The porous member **1100** includes an anodic oxide film in which pores are formed in a predetermined arrangement. The porous member **1100** is configured as powders, a coating film, or bulk. The powder may have various shapes such as a sphere, a hollow sphere, a fiber, and a tube. The powder may be used as it is in some cases, but it is also possible to prepare a coating film or a bulk shape with the powder as a starting material.

[0111] When the pores of the porous member **1100** have a disordered pore structure, the multiple pores are connected to each other inside the porous member **1100** such that air flow paths are formed which connects upper and lower portions of the porous member **1100**. When the pores of the porous member **1100** have a vertical pore structure, the inside of the porous member **1100** is pierced from top to bottom by the vertical pores such that air flow paths are formed.

[0112] The porous member **1100** includes a suction region **1110** gripping the micro LEDs **100** and a non-suction region **1130** not gripping the micro LEDs **100**. The suction region **1110** is a region where vacuum of the suction chamber **1200** is transferred and grips the micro LEDs **100**. The non-suction region **1130** is a region where the vacuum of the suction chamber **1200** is not transferred and thus does not grip the micro LEDs **100**.

[0113] The non-suction region **1130** may be embodied by forming a shielding portion on at least a part of a surface of the porous member **1100**. The shielding portion is formed to close the pores exposed at least a part of a surface of the porous member **1100**. The shielding portion may be formed on at least a part of upper and lower surfaces of the porous member **1100**. In particular, in the case where the porous member **1100** has a disordered pore structure, the shielding portion may be formed on both the upper and lower surfaces of the porous member **1100**.

[0114] The shielding portion is not limited in material, shape, and thickness as long as the shielding portion functions to close the pores exposed to the surface of the porous member **1100**. Preferably, the shielding portion may be further provided and formed of a photoresist (PR, including dry film PR) or a metal or may be provided by the own structure of the porous member **1100**. In the case the shielding portion is provided by the structure of the porous member **1100**, for example, in the case the porous member **1100** to be described later is formed of an anodic oxide film, the shielding portion may be a barrier layer or a metal base material.

[0115] A size of a horizontal area of each suction region **1110** may be smaller than a size of a horizontal area of an upper surface of each micro LED **100** to prevent vacuum leakage while the micro LED **100** is gripped by vacuum-suction, whereby it is possible to perform vacuum-suction easily.

[0116] The transfer head **1000** may be provided with a monitoring unit monitoring the degree of vacuum of the suction chamber **1200**. The monitoring unit may monitor the degree of vacuum generated in the suction chamber **1200**, and a control unit may control the degree of vacuum of the suction chamber **1200** according to the degree of vacuum of the suction chamber **1200**. When the monitoring unit monitors that the degree of vacuum of the suction chamber **1200** is lower than a predetermined range of the degree of vacuum, the control unit may determine that some of the micro LEDs **100** to be vacuum-sucked on the porous member **1100** are not vacuum-sucked or may determine that there is leakage of the vacuum, and thus instruct the transfer head **1000** to operate again. As described above, the transfer head **1000** transfers the micro LEDs **100** without error according to the degree of vacuum in the suction chamber **1200**.

[0117] In addition, the transfer head **1000** may be provided with a buffer member to buffer contact between the porous member **1100** and the micro LEDs **100**. A material of the buffer member is not limited as long as the buffer member can buffer the contact between the porous member **1100** and the micro LED **100** and has an elastic force. The buffer member may be provided between the porous member **1100** and the suction chamber **1200**, but a position where the buffer member is mounted is not limited thereto. The buffer member may be provided at any position of the transfer head **1000** as long as the buffer member at a certain position can buffer the contact between the porous member **1100** and the micro LED **100**.

[0118] In the case where a pitch distance of the micro LEDs **100** on the first substrate **101** is P(n) in a column direction and a pitch distance of the micro LEDs **100** on the growth substrate **101** in a row direction is P(m), the suction region **1110** may be provided with pitch distances equal to the pitch distances of the micro LEDs **100** on the first substrate **101** as illustrated in FIG. **5**A. In other words, when the pitch distances of the micro LEDs **100** on the first substrate **101** are P(n) in the column direction and P(m) in the row direction, pitch distances of the suction region **1110** of the transfer head **1000** are P(n) in a column direction and P(m) in a row direction. According to the above configuration, the transfer head **1000** vacuum-sucks all of the micro LEDs **100** on the first substrate **101** at the same time.

[0119] Alternatively, when pitch distances of the micro LEDs **100** on the first substrate **101** are P(n) in the column direction and P(m) in the row direction, pitch distances of the suction region **1110** of the transfer head **1000** are 3p(n) in a column direction and p(m) in a row direction as illustrated in FIG. **5**B. Here, 3p(n) means 3 times the column pitch distance p(n) illustrated in FIG. **5**A.

[0120] According to the above configuration, only the micro LEDs **100** at (3n)th column is vacuum-sucked and transferred. Here, each of the micro LEDs **100** transferred in the (3n)th column may be any one of red, green, blue, and white LEDs. With such a configuration, it is possible to transfer the micro LEDs **100** of the same luminous color mounted on the second substrate **301** at distances of 3p(n).

[0121] Alternatively, when pitch distances of the micro LEDs **100** on the first substrate **101** are P(n) in the column direction and P(m) in the row direction, pitch distances of the suction region **1110** of the transfer head **1000** are p(n) in a column direction and 3p(m) in a row direction as illustrated in FIG. **5**C. Here, 3p (m) means 3 times the row pitch distance p(m) illustrated in FIG. **5**A. According to the above configuration, only the micro LEDs **100** at (3n)th row is vacuum-sucked and transferred. Here, each of the micro LEDs **100** transferred in the (3n)th row may be any one of red, green, blue, and white LEDs. With such a configuration, it is possible to transfer the micro LEDs **100** of the same luminous color mounted on the second substrate **301** at distances of 3p(m).

[0122] Alternatively, when pitch distances of the micro LEDs **100** on the first substrate **101** are P(n) in the column direction and P(m) in the row direction, the suction region **1110** is configured in a diagonal direction such that pitch distances of the suction region **1110** of the transfer head **1000** are 3p(n) in a column direction and 3p(m) in a row direction as illustrated in FIG. **5**D. Here, each of the micro LEDs **100** transferred in the (3n)th row and (3n)th column may be any one of red, green, blue, and white LEDs. According to the above configuration, by arranging the micro LEDs **100** of the same luminous color to be mounted on the second substrate **301** with distances of 3p(n) and 3p(m), the micro LEDs **100** of the same luminous color are transferred in the diagonal direction.

[0123] In the case of the present invention, since the micro LED **100** has a circular cross-section, the suction region **1110** is also formed in a circular shape as illustrated in FIGS. **5**A to **5**D. However, the shape of the suction region **1110** may vary depending on the cross-sectional shape of the micro LED **100**. For example, when the micro LED **100** has a quadrangular cross-section, the suction region **1110** may have a quadrangular cross-section corresponding to the cross-sectional shape of the micro LED **100**.

[0124] Hereinbelow, a process for a transfer method using the transfer head **1000** will be described with reference to FIGS. **6**A to **6**D.

[0125] Referring to FIG. **6**A, the micro LEDs **100** formed on the first substrate **101** are prepared to be separable from the first substrate **101**.

[0126] Next, referring to FIG. **6**B, the transfer head **1000** is moved above the first substrate **101** and then lowered.

[0127] At this point, the porous member **1100** is applied with vacuum pressure through the suction port to vacuum-suck the micro LEDs **100**. When the transfer head **1000** grips the micro LEDs **100** by a suction force, the porous member **1100** of the transfer head **100** may be brought in close contact with the micro LEDs **100** while gripping the micro LEDs **100** by vacuum-suction. However, the micro LEDs **100** may be damaged by the close contact with the porous member **1100**. Thus, the micro LEDs **100** may be gripped on a lower surface of the porous member **1100** by a vacuum suction force while the lower surface of the porous member **1100** and upper surfaces of the micro LEDs **100** are spaced apart from each other by a predetermined distance.

[0128] Then, as illustrated in FIG. **6**C, the transfer head **1000** is lifted and moved while the vacuum suction force of the transfer head **1000** to the micro LEDs **100** is maintained.

[0129] Thereafter, as illustrated in FIG. **6**D, the transfer head **1000** is moved above the second substrate **301** and then lowered. At this point, the micro LEDs **100** are transferred to the second substrate **301** by releasing the vacuum applied to the porous member **1100** through the suction port.

[0130] According to the above process sequence, the transfer head **1000** can transfer the micro LEDs **100** formed on the first substrate **101** to the second substrate **301** and mount the micro LEDs **100**.

[0131] Hereinbelow, the spraying unit will be described.

[0132] The spraying unit is provided in the transfer chamber **11** and functions to spray the ionized gas G.

[0133] The spraying unit may include: a supply portion supplying gas; a nozzle spraying the gas; a pair of electrodes connected to a power source; a controller controlling the power source; and a booster connected to the electrodes.

[0134] Therefore, when positive and negative DC voltages are raised to a predetermined voltage in accordance with a signal from the controller and the voltages are alternately applied to the pair of electrodes at regular intervals, a corona discharge is generated at the ends of the pair of electrodes.

[0135] As described above, when the corona discharge occurs and the supply portion supplies gas to the pair of electrodes, the supplied gas is ionized, and the nozzle sprays the ionized gas G.

[0136] The ionized gas G spayed by the spraying unit functions to prevent the generation of an electrostatic force in at least one of the micro LEDs **100** formed on the first substrate **101**, the micro LEDs **100** mounted on the second substrate **301**, and the transfer head **1000**.

[0137] In detail, an electrostatic force caused by electrification may undesirably occur between the first substrate **101** and the transfer head **1000** or between the second substrate **301** and the transfer head **1000** due to friction or the like during the transfer process of the transfer head **1000**.

[0138] This undesirable electrostatic force has a great influence on the micro LEDs **100** having a size of 1 μm to 100 μm even if the electrostatic force is caused by small charge.

[0139] In other words, after the transfer head **1000** sucks the micro LEDs **100** from the first substrate **101**, if an electrostatic force is generated in the unloading process in which the micro LED **100***s* are mounted on the second substrate **301**, the micro LED **100***s* may stick to the transfer head **1000** and be unloaded to the second substrate **301** with a wrong position or unloading may not be performed at all.

[0140] In this situation, the ionized gas G sprayed by the spraying unit flows in the transfer chamber **11** in a form of gas G in which positive and negative ions are ionized.

[0141] The positive and negative ions are moved to a charged part in the first substrate **101**, the second substrate **301**, and the transfer head **1000** to convert the charged state to a neutral state. For example, when the first substrate **101** is electrified in which positive charges are accumulated on a region thereof, the negative charges of the ionized gas G moves to the region whereby the region is converted to the neutral state.

[0142] Therefore, even if at least one of the first substrate **101**, the second substrate **301**, and the transfer head **1000** is electrified by the ionized gas G sprayed by the spraying unit, it is possible to convert the electrified state to the neutral state and prevent the generation of an electrostatic force thereby.

[0143] In the case of the transfer head **1000** in which the micro LEDs **100** are not gripped by the electrostatic force (in the case of the present invention, the micro LEDs **100** are gripped by a suction force), the transfer of the micro LEDs **100** can be easily performed because the spraying unit prevents the generation of an electrostatic force.

[0144] In other words, if the electrostatic force is not generated because of the spraying unit, it is possible to prevent the above-mentioned positional error during the unloading of the micro LEDs **100** or the situation that the micro LEDs **100** stick to the transfer head **1000** and thus the unloading of the micro LEDs **100** is not performed at all.

[0145] As illustrated in FIG. **1**, the above-described spraying unit may be embodied as a spraying unit **51** for the transfer chamber provided at an upper portion of the transfer chamber **11**.

[0146] The ionized gas G sprayed through the nozzle flows from the upper portion to the lower portion inside the transfer chamber **11** such that the spraying unit **51** forms a downward flow.

[0147] The ionized gas G in the downward flow is filled into the transfer chamber **11** such that the atmosphere inside the transfer chamber **11** is replaced with the ionized gas G.

[0148] As the ionized gas G is filled into the transfer chamber **11** by the spraying unit **51**, the positive and negative ions flow in the transfer chamber **11** in the form of the ionized gas G.

[0149] As described above, since the spraying unit **51** replaces the atmosphere in the transfer chamber **11** with the ionized gas G, it is possible to prevent the generation of the electrostatic force on the first substrate **101**, the second substrate **301**, and the transfer head **1000**, thereby preventing the occurrence of errors and damage to the micro LEDs **100** during the transfer process.

[0150] Unlike the above, the spraying unit **51** may be provided at any position other than the upper portion of the transfer chamber **11**, for example, on a side or the lower portion of the transfer chamber **11**, etc., as long as the atmosphere in the transfer chamber **11** is replaced with the ionized gas G by the spraying unit **51**.

[0151] The first passage **14** and the second passage **16** may be provided with a spraying unit **55** for the first passage and a spraying unit **56** for the second passage, which have the same functions as the spraying unit described above.

[0152] When the first base **21** is moved along the X-axis from the loading chamber **13** to the transfer chamber **11** through the first passage **14**, the spraying unit **55** functions to spray the ionized gas onto an upper surface of the first substrate **101** seated on the first base **21**. Therefore, it is possible to prevent the generation of an electrostatic force on the first substrate **101** during transfer of the first substrate **101** through the first passage **14**.

[0153] When the second base **22** is moved along the X-axis from the transfer chamber **11** to the unloading chamber **15** through the second passage **16**, the spraying unit **56** functions to spray the ionized gas onto an upper surface of the second substrate **301** seated on the second base **22**. Therefore, it is possible to prevent the generation of an electrostatic force on the second substrate **301** during transfer of the second substrate **301** through the second passage **16**.

[0154] System **10'** for Transferring a Micro LED According to a Second Embodiment of the Present Invention

[0155] Hereinbelow, a system **10'** for transferring a micro LED according to a second embodiment of the present invention will be described.

[0156] FIG. **7** is a view illustrating a system for transferring a micro LED according to a second embodiment of the present invention.

[0157] The system **10'** for transferring a micro LED according to the second embodiment of the present invention differs from the system **10'** for transferring a micro LED according to the first embodiment of the present invention in the configuration of the spraying unit, but other configurations are the same. Therefore, a description of the components of the system **10'** for transferring a micro LED according to the second embodiment of the present invention can be substituted by the above description.

[0158] As illustrated in FIG. **7**, a spraying unit of the system **10'** for transferring a micro LED according to the second embodiment of the present invention includes: a spraying unit **52** for the first substrate spraying the ionized gas G on the upper surface of the first substrate **101**; a spraying unit **53** for the second substrate **102** spraying the ionized gas G on the upper surface of the second substrate **301**; and a spraying unit **54** for the transfer head spraying the ionized gas G on lower surfaces of the micro LEDs **100** gripped by the transfer head **1000**.

[0159] The spraying unit **52** is provided in the transfer chamber **11** to be positioned above the first substrate **101** and functions to spray the ionized gas G on the upper surface of the first substrate **101**. In this case, the spraying unit **52** ionizes the supplied gas and sprays the ionized gas G through a nozzle by the same operating principle as that of the above-described spraying unit.

[0160] The spraying unit **52** is disposed above the first substrate **101** disposed in the transfer chamber **11**, that is, above the first base **21** moved to the transfer chamber **11**, and provided to be movable in the X-axis and the Y-axis.

[0161] As described above, since the spraying unit **52** is provided to be movable in the X-axis and the Y-axis, it is possible to prevent the spraying unit **52** from interfering with the movement of the transfer head **1000**.

[0162] The spraying unit **53** is provided in the transfer chamber **11** to be positioned above the second substrate **301** and functions to spray the ionized gas G on the upper surface of the second substrate **301**. In this case, the spraying unit **53** ionizes the supplied gas and sprays the ionized gas G through a nozzle by the same operating principle as that of the above-described spraying unit.

[0163] The spraying unit **53** is disposed above the second substrate **301** disposed in the transfer chamber **11**, that is, above the second base **22** moved to the transfer chamber **11**, and provided to be movable in the X-axis and the Y-axis.

[0164] As described above, since the spraying unit **53** is provided to be movable in the X-axis and the Y-axis, it is possible to prevent the spraying unit **53** from interfering with the movement of the transfer head **1000**.

[0165] The spraying unit **54** is provided in the transfer chamber **11** to be positioned below the transfer head **1000** and functions to spray the ionized gas G on the lower surface of the transfer head **1000** or the lower surfaces of the micro LEDs **100** gripped by the transfer head **1000**. In this case, the spraying unit **54** ionizes the supplied gas and sprays the ionized gas G through a nozzle by the same operating principle as that of the above-described spraying unit.

[0166] The spraying unit **54** is disposed below the transfer head **1000** disposed in the transfer chamber **11** and provided to be movable in the X-axis and the Y-axis.

[0167] As described above, since the spraying unit **54** is provided to be movable in the X-axis and the Y-axis, it is possible to prevent the spraying unit **54** from interfering with the movement of the transfer head **1000**.

[0168] Compared with the system **10'** for transferring a micro LED according to the first embodiment of the present invention, the system **10'** for transferring a micro LED according to the second embodiment of the present invention is provided with the spraying unit **52**, the spraying unit **53**, and the spraying unit **54** whereby it is possible to prevent the generation of the electrostatic force with a small amount of gas.

[0169] In other words, the spraying unit **52**, the spraying unit **53**, and the spraying unit **54** spray the ionized gas G on the upper surface of the first substrate **101** (or on the upper surfaces of the micro LEDs **100** formed on the first substrate **101**), on the upper surface of the second substrate **301** (or on the upper surfaces of the micro LEDs **100** mounted on the second substrate **301**), and on the lower surface of the transfer head **1000** (or on the lower surfaces of the micro LEDs **100** gripped by the transfer head **1000**), respectively. Accordingly, the ionized gas G is sprayed only to the region where the electrification is generated whereby it is possible to not only prevent the generation of the electrostatic force but also reduce the amount of gas used.

[0170] In addition, since the spraying unit **52**, the spraying unit **53**, and the spraying unit **54** inject the ionized gas G intensively on the respective regions, it is possible to prevent the positive or negative ions from not reaching the charged regions (i.e., it is possible to minimize a region where the positive or negative ions can not reach). As a result, it is possible to effectively convert the charged region into a neutral state.

[0171] The transfer head **1000** provided in the system **10** for transferring a micro LED according to the first embodiment of the present invention and in the system **10'** for transferring a micro LED according to the second embodiment of the present invention may have various modifications.

[0172] Hereinbelow, first to thirteenth modifications of the transfer head **1000** will be described, wherein the transfer head **1000** being provided in the system **10** for transferring a micro LED according to the first embodiment of the present invention and in the system **10'** for transferring a micro LED according to the second embodiment of the present invention.

[0173] First Modification of the Transfer Head **1000**

[0174] Hereinbelow, a first modification of the transfer head **1000** will be described with reference to FIGS. **8** to **10**.

[0175] FIG. **8** is a view illustrating a first modification of the transfer head according to the present invention; FIG. **9** is an enlarged view of a portion 'A' of FIG. **8**; and FIG. **10** is a view illustrating a state in which the transfer head of FIG. **8** grips the micro LEDs.

[0176] As illustrated in FIGS. **8** to **10**, the first modification of the transfer head **1000** is provided with the anodic oxide film **1300**, which is provided in the transfer head **1000** of the system **10** for transferring a micro LED according to the first embodiment of the present invention and configured such that the porous member **1100** is embodied by the anodic oxide film **1300** having pores formed by anodizing a metal.

[0177] The anodic oxide film **1300** is a film formed by anodizing a metal that is a base material, and the pores **1303** are pores formed in a process of forming the anodic oxide film **1300** by anodizing the metal.

[0178] For example, in a case that the base metal is aluminum (Al) or an aluminum alloy, the anodization of the base material forms the anodic oxide film **1300** consisting of anodized aluminum (Al_2O_3) on a surface of the base material. The anodic oxide film **1300** formed as described above includes a barrier layer **1301** in which pores **1303** are not formed and a porous layer in which the pores **1303** are formed inside.

[0179] The barrier layer **1301** is positioned on top of the base material and the porous layer is positioned on top of the barrier layer **1301**.

[0180] After removing the base material on which the anodic oxide film **1300** having the barrier layer **1301** and the porous layer is formed, only anodic oxide film **1300** consisting of anodized aluminum (Al_2O_3) remains.

[0181] The anodic oxide film **1300** has the pores **1303** configured vertically and having a regular arrangement with a uniform diameter. Accordingly, after removing the barrier layer **1301**, the pores **1303** have a structure extending from top to bottom vertically, thereby facilitating the generation of the vacuum pressure in the vertical direction.

[0182] The inside of the anodic oxide film **1300** forms an air flow path vertically by the vertical pores **1303**.

[0183] An internal width of the pores **1303** has a size of several nanometers to several hundred nanometers. For example, when a size of the micro LED to be vacuum-sucked is 30 μm×30 μm and an internal width of the pores **1303** is several nanometers, it is possible to vacuum-suck the micro LEDs **100** by approximately tens of millions of pores **1303**.

[0184] When a size of the micro LED to be vacuum-sucked is 30 μm×30 μm and an internal width of the pores

1303 is several hundred nanometers, it is possible to vacuum-suck the micro LEDs **100** by approximately tens of thousands of pores **1303**.

[0185] The micro LED **100** is lightweight because the micro LED **100** is fundamentally configured with the first semiconductor layer **102**, the second semiconductor layer **104**, the active layer **103** provided between the first semiconductor layer **102** and the second semiconductor layer **104**, the first contact electrode **106**, and the second contact electrode **107**. Accordingly, it is possible to grip the micro LEDs **100** by tens of thousands to tens of millions of pores **1303** formed in the anodic oxide film **1300** by vacuum-suction.

[0186] The suction chamber **1200** is provided on the anodic oxide film **1300**.

[0187] The suction chamber **1200** is connected to a suction port providing vacuum pressure. The suction chamber **1200** functions to vacuum the multiple vertical pores of the anodic oxide film **1300** or release the vacuum according to the operation of the suction port.

[0188] When gripping the micro LEDs **100**, the vacuum applied to the suction chamber **1200** is transferred to the multiple pores **1303** of the anodic oxide film **1300** to provide a vacuum suction force for the micro LEDs **100**. When detaching the micro LEDs **100**, the vacuum applied to the suction chamber **1200** is released to remove the vacuum from the multiple pores **1303** of the anodic oxide film **1300** whereby the vacuum suction force to the micro LEDs **100** is removed.

[0189] The anodic oxide film **1300** includes a suction region **1310** gripping the micro LEDs **100** by vacuum-suction and a non-suction region **1330** not gripping the micro LEDs **100**.

[0190] The suction region **1310** is a region where vacuum of the suction chamber **1200** is transferred and grips the micro LEDs **100** by vacuum-suction. The non-suction region **1330** is a region where vacuum of the suction chamber **1200** is not transferred and thus does not grip the micro LEDs **100**.

[0191] Preferably, the suction region **1310** is a region where the pores **1303** extend from top to bottom vertically, and the non-suction region **1330** is a region where at least any one of upper and lower portions of the pores **1303** is closed.

[0192] The non-suction region **1330** may be embodied by forming a shielding portion on at least a part of a surface of the anodic oxide film **1300**. The shielding portion is formed to close openings of the pores **1303** exposed to at least a part of the surface of the anodic oxide film **1300**.

[0193] The shielding portion may be formed on at least a part of upper and lower surfaces of the anodic oxide film **1300**. The shielding portion is not limited in material, shape, and thickness as long as the shielding portion functions to close the openings of the pores **1303** exposed to the surface of the porous member **1100**. Preferably, the shielding portion may be further provided and formed of a photoresist (PR, including dry film PR) or a metal, and the barrier layer **1301** may be the shielding portion.

[0194] The non-suction region **1330** may be formed such that the barrier layer **1301** formed in the fabrication of the anodic oxide film **1300** closes any one of the upper and lower portions of the vertical pores **1303**. The suction region **1310** may be formed such that the barrier layer **1301** is removed by etching or the like so that the upper and lower portions of the vertical pores **1303** extend from top to bottom.

[0195] In addition, a thickness of the anodic oxide film **1300** in the suction region **1310** is smaller than a thickness of the anodic oxide film **1300** in the non-suction region **1330** because the pores **1303** extending from top to bottom are formed by removing a part of the barrier layer **1301**.

[0196] FIG. **8** illustrates that the barrier layer **1301** is provided at an upper portion of the anodic oxide film **1300** and the porous layer **1305** having the pores **1303** is provided at a lower portion thereof. However, the anodic oxide film **1300** illustrated in FIG. **8** may be inverted to form the non-suction region **1330** such that the barrier layer **1301** is provided at the lower portion of the anodic oxide film **1300**.

[0197] It has been described the non-suction region **1330** that any one of the upper and lower portions of the pores **1303** is closed by the barrier layer **1301**. However, the opposite surface, which is not closed by the barrier layer **1301**, may be configured such that an additional coating layer is provided to close both the upper and lower portions. In forming the non-suction region **1330**, the configuration in which both the upper and lower surfaces of the anodic oxide film **1300** are closed is advantageous in that it is possible to reduce the possibility that foreign substances remain in the pores **1303** of the non-suction region **1330** compared with the configuration in which at least one of the upper and lower surfaces of the anodic oxide film **1300** is closed.

[0198] Second Modification of the Transfer Head **1000**

[0199] Hereinbelow, a second modification of the transfer head **1000** will be described with reference to FIG. **11**.

[0200] FIG. **11** is a view illustrating a state in which a second modification of the transfer head grips the micro LEDs.

[0201] As illustrated in FIG. **11**, the second modification of the transfer head **1000** is configured such that a supporting portion **1307** is further provided on the non-suction region **1330** to reinforce the strength of the anodic oxide film **1300**.

[0202] For example, the supporting portion **1307** may be formed of a metal base material.

[0203] The metal base material used for the anodization is not removed and left on the barrier layer **1301** such that the metal base material may serve as the supporting portion **1307**.

[0204] Referring to FIG. **11**, the non-suction region **1330** is configured with the supporting portion **1307** formed of the metal, the barrier layer **1301**, and the porous layer **1305** having the pores **1303**. As the supporting portion **1307** formed of the metal and the barrier layer **1301** are removed, the suction region **1310** is formed in a manner that the upper and lower portions of the pores **1303** extend from top to bottom.

[0205] The supporting portion **1307** formed of the metal is provided in the non-suction region **1330** to secure the strength of the anodic oxide film **1300**.

[0206] As the strength of the anodic oxide film **1300** which has a relatively weak strength is increased due to the above-described configuration of the supporting portion **1307**, it is possible to configure the transfer head **1000** having the anodic oxide film **1300** to have a large area.

[0207] Third Modification of the Transfer Head **1000**

[0208] Hereinbelow, a third modification of the transfer head **1000** will be described with reference to FIG. **12**.

[0209] FIG. **12** is a view illustrating a state in which a third modification of the transfer head grips micro LEDs.

[0210] As illustrated in FIG. **12**, the third modification of the transfer head **1000** is configured such that a through-hole **1309** is further provided in the suction region **1310** of the anodic oxide film **1300** in addition to the pores **1303** which are formed spontaneously in the anodic oxide film **1300**.

[0211] The through-hole **1309** is configured to extend from top to bottom of the anodic oxide film **1300** longitudinally.

[0212] A diameter of the through-hole **1309** is configured to be larger than those of the pores **1303**.

[0213] Compared with the configuration in which the micro LEDs **100** are vacuum-sucked by only the pores **1303**, it is possible for the third modification to increase the grip surface area for the micro LEDs **100** due to the configuration in which the through-hole **1309** having a diameter larger than those of the pores **1303** is provided.

[0214] The through-hole **1309** may be formed by etching the anodic oxide film **1300** vertically after forming the anodic oxide film **1300** and the pores **1303**.

[0215] By using the etching method for forming the through-hole **1309**, it is possible to form the through-hole **1309** stably compared with simply forming the through-hole **1309** by reaming the pores **1303**.

[0216] In other words, when forming the through-hole **1309** by reaming the pores **1303**, side surfaces of the pores **1303** are collapsed, leading to damage to the through-hole **1309**, for example, a deformation of the through-hole **1309**.

[0217] However, by forming the through-hole **1309** by etching, the through-hole **1309** is easily formed without damaging the side surfaces of the pores **1303**, thereby preventing damage to the through-hole **1309**.

[0218] It is preferable that the through-hole **1309** is configured in the center of the suction region **1310** in order to prevent vacuum leakage in the suction region **1310**.

[0219] With respect to the entire the transfer head **1000**, the through-hole **1309** may have different sizes and numbers depending on each position of the suction region **1310**.

[0220] In the case the suction port is disposed at the center of the transfer head **1000**, the vacuum pressure is gradually decreased from the center to the edge of the transfer head **1000**, which may cause unevenness of the vacuum pressure among suction regions **1310**.

[0221] In this case, a suction region formed by the through-hole **1309** in the suction region **1310** disposed at the edge side of the transfer head **1000** may be configured to have a size larger than a suction region formed by the through-hole **1309** in the suction region **1310** disposed at the center side of the transfer head **1000**.

[0222] By varying the size of the suction region of the through-hole **1309** according to the position of the suction region **1310**, it is possible to eliminate unevenness of the vacuum pressure generated among the suction regions **1310** and to provide a uniform vacuum suction force.

[0223] Fourth Modification of the Transfer Head **1000**

[0224] Hereinbelow, a fourth modification of the transfer head **1000** will be described with reference to FIG. **13**.

[0225] FIG. **13** is a view illustrating a state in which a fourth modification of the transfer head grips the micro LEDs.

[0226] As illustrated in FIG. **13**, the fourth modification of the transfer head **1000** is configured such that a suction recess **1309'** is further provided in a lower portion of the suction region **1310** of the anodic oxide film **1300**.

[0227] The suction recess **1309'** have a horizontal area larger than that of the above-described pores **1303** or the through-hole **1309** of FIG. **12**, but smaller than that of the upper surface of the micro LED **100**.

[0228] Accordingly, it is possible to further increase the vacuum suction region for gripping the micro LEDs **100** and to provide a uniform vacuum suction region for gripping the micro LEDs **100** because of the suction recess **1309'**.

[0229] The suction recess **1309'** may be formed by etching a part of the anodic oxide film **1300** to a predetermined depth after forming the anodic oxide film **1300** and the pores **1303**.

[0230] Fifth Modification of the Transfer Head **1000**

[0231] Hereinbelow, a fifth modification of the transfer head **1000** will be described with reference to FIG. **14**.

[0232] FIG. **14** is a view illustrating a state in which a fifth modification of the transfer head grips the micro LEDs.

[0233] As illustrated in FIG. **14**, the fifth modification of the transfer head **1000** is configured such that a receiving recess **1311** is further provided in the lower portion of the suction region **1310** of the anodic oxide film **1300**.

[0234] The receiving recess **1311** has a horizontal area larger than that of the upper surface of the micro LED **100**.

[0235] As a result, the position of the micro LED **100** is restricted when the transfer head **1000** is moved as the micro LED **100** is inserted into the receiving recess **1311** and is seated.

[0236] The receiving recess **1311** may be formed by etching a part of the anodic oxide film **1300** to a predetermined depth after forming the anodic oxide film **1300** and the pores **1303**.

[0237] Sixth Modification of the Transfer Head **1000**

[0238] Hereinbelow, a sixth modification of the transfer head **1000** will be described with reference to FIGS. **15** and **16**.

[0239] FIGS. **15** and **16** are views illustrating a state in which a sixth modification of the transfer head grips the micro LEDs.

[0240] As illustrated in FIGS. **15** and **16**, the sixth modification of the transfer head **1000** is configured such that an escape recess **1313** is further provided in a lower portion of the non-suction region **1330** of the anodic oxide film **1300**.

[0241] When the transfer head **1000** descends to vacuum-suck the micro LED **100** at a predetermined position, column, or row, the escape recess **1313** functions to prevent interference of the micro LEDs **100** not to be gripped.

[0242] Due to the configuration of the escape recess **1313**, a protruding portion **1315** is provided in the lower portion of the suction region **1310**.

[0243] The protruding portion **1315** protrudes further downward in the vertical direction compared with the escape recess **1313**, and the micro LED **100** is gripped at a lower portion of the protruding portion **1315**. A horizontal area of the protruding portion **1315** is configured to be equal to or larger than the horizontal area of the suction region **1310**.

[0244] The horizontal area of the protruding portion **1315** may be configured to be larger than that of the upper surface of the micro LED **100**, and a width of the suction region **1310** is configured to be smaller than that of the upper surface of the micro LED **100** in order to prevent the vacuum leakage.

[0245] A horizontal area of the escape recess **1313** is configured to be larger than that of at least one micro LED **100**.

[0246] FIG. **15** illustrates that the escape recess **1313** has a horizontal width equal to a value obtained by summing twice the horizontal width of the two micro LEDs **100** and twice the horizontal pitch distance between the micro LEDs **100**. Thus, when descending the transfer head **1000** to vacuum-suck the micro LEDs **100** to be gripped, it is possible to prevent interference of the micro LEDs **100** not to be gripped.

[0247] As illustrated in FIGS. **15** and **16**, the micro LEDs **100** to be gripped on the first substrate **101** are the micro LEDs **100** at the 1st, 4th, 7th, and 10th positions with reference to the left side of the drawing. The transfer head **1000** having the configuration of the escape recess **1313** vacuum-sucks only the micro LEDs **100** corresponding to the 1st, 4th, 7th, and 10th positions without interference of the micro LEDs **100** not to be gripped.

[0248] Seventh Modification of the Transfer Head **1000**

[0249] Hereinbelow, a seventh modification of the transfer head **1000** will be described with reference to FIG. **17**.

[0250] FIG. **17** is a view illustrating a state in which a seventh modification of the transfer head grips the micro LEDs.

[0251] As illustrated in FIG. **17**, the seventh modification of the transfer head **1000** is configured such that the porous member **1100** of the transfer head **1000** of the system **10** for transferring a micro LED according to the first embodiment is configured to have two porous members including a first porous member **1500** and a second porous member **1600**.

[0252] The second porous member **1600** is provided on the first porous member **1500**. The first porous member **1500** functions to vacuum-suck the micro LEDs **100**. The second porous member **1600** is disposed between the suction chamber **1200** and the first porous member **1500** to transfer the vacuum pressure of the suction chamber **1200** to the first porous member **1500**.

[0253] The first and second porous members **1500** and **1600** may have different porosity characteristics. For example, the first and second porous members **1500** and **1600** have different characteristics in the arrangement and size of the pores, the material and the shape of the porous member.

[0254] With respect to the arrangement of the pores, one of the first and second porous members **1500** and **1600** may have a uniform arrangement of pores and the other may have a disordered arrangement of pores.

[0255] With respect to the size of the pores, any one of the first and second porous members **1500** and **1600** may have a larger pore size than the other. Here, the size of the pores may be the average size of the pores or may be the maximum size of the pores.

[0256] With respect to the material of the porous member, one of the first and second porous members may be formed of one of organic, inorganic (ceramic), metal, and hybrid type porous materials, and the other one may be formed of one of organic, inorganic (ceramic), metal, and or hybrid type porous material different from the first material.

[0257] In terms of the shape of the porous member, the first and second porous members **1500** and **1600** may have different shapes.

[0258] By varying the arrangement, size, material, and shape of the pores of the first and second porous members **1500** and **1600** as described above, the transfer head **1000** has various functions and each of the first and second porous members **1500** and **1600** performs complementary functions.

[0259] The number of the porous members is not limited to two as in the case of the first and second porous members. As long as the respective porous members have mutually complementary functions, providing two or more porous members also falls into the seventh modification of the transfer head **1000**.

[0260] Eighth Modification of the Transfer Head **1000**

[0261] Hereinbelow, an eighth modification of the transfer head **1000** will be described with reference to FIG. **18**.

[0262] FIG. **18** is a view illustrating a state in which an eighth modification of the transfer head grips the micro LEDs.

[0263] As illustrated in FIG. **18**, the first porous member **1500** of the eighth modification of the transfer head **1000** is provided with the anodic oxide film **1300** having the pores formed by anodizing a metal.

[0264] The first porous member **1500** may be employed in the first to sixth modifications of the transfer head **1000**.

[0265] The second porous member **1600** may be composed of a porous scaffold functioning to support the first porous member **1500**.

[0266] A material of the second porous member **1600** is not limited as long as the second porous member **1600** functions to support the first porous member **1500**. The second porous member **1600** may have the above-mentioned configuration of the porous member **1100** of the transfer head **1000** of the system **10** for transferring a micro LED according to the first embodiment of the present invention.

[0267] The second porous member **1600** may be composed of a rigid porous scaffold capable of preventing sagging at the center portion of the first porous member **1500**. For example, the second porous member **1600** may be formed of a porous ceramic material.

[0268] Alternatively, the first porous member **1500** may be employed in first to sixth modifications of the transfer head **1000**, and the second porous member **1600** may be composed of a porous buffer to buffer the contact between the first porous member **1500** and the micro LEDs **100**.

[0269] A material of the second porous member **1600** is not limited as long as the second porous member **1600** functions to buffer the first porous member **1500**. The second porous member **1600** may have the above-mentioned configuration of the porous member **1100** of the transfer head **1000** of the system **10** for transferring a micro LED according to the first embodiment of the present invention.

[0270] The second porous member **1600** may be composed of a soft porous buffer that helps to protect the micro LEDs **100** from damage, which may occur when the micro LEDs **100** and the first porous member **1500** are brought into contact with each other to grip the micro LED **100***s* by the vacuum-suction. For example, the second porous member **1600** may be composed of a porous elastic material such as a sponge or the like.

[0271] Ninth Modification of the Transfer Head **1000**

[0272] Hereinbelow, a ninth modification of the transfer head **1000** will be described with reference to FIG. **19**.

[0273] FIG. **19** is a view illustrating a state in which a ninth modification of the transfer head grips the micro LEDs.

[0274] As illustrated in FIG. **19**, the ninth modification of the transfer head **1000** is configured such that the above-described porous member **1100** of the transfer head **1000** of the system **10** for transferring a micro LED according to the first embodiment is configured to have three porous members including a first porous member **1700**, a second porous member **1800**, and a third porous member **1900**.

[0275] The second porous member **1800** is provided on the first porous member **1700**, and the third porous member **1900** is provided on the second porous member **1800**. The first porous member **1700** functions to vacuum-suck the micro LEDs **100**. At least one of the second porous member **1800** and the third porous member **1900** may be composed of a rigid porous scaffold, and the remaining one of the second porous member **1800** and the third porous member **1900** may be composed of a soft porous buffer.

[0276] With the above structure, it is possible to vacuum-suck the micro LEDs, prevent the sagging at the center portion of the first porous member **1700**, and prevent damage to the micro LEDs **100**.

[0277] Tenth Modification of the Transfer Head **1000**

[0278] Hereinbelow, a tenth modification of the transfer head **1000** will be described with reference to FIGS. **20** and **21**.

[0279] FIG. **20** is a view illustrating a state in which a tenth modification of the transfer head grips the micro LEDs; and FIG. **21** is a view illustrating various embodiments of a dam of the transfer head of FIG. **20**.

[0280] As illustrated in FIG. **20**, the tenth modification of the transfer head **1000** is configured such that a dam **2000** is provided at a lower portion of the porous member **1100** of the transfer head **1000** of the system **10** for transferring a micro LED according to the first embodiment.

[0281] A material of the dam **2000** may be formed of a photoresist (PR, including dry film PR) or a metal. The dam **2000** may be formed of any material that can be formed on a surface of the porous member **1100** with a predetermined height.

[0282] A cross-sectional shape of a protruding portion of the dam **2000** may be any protruding shape such as a quadrangle, a circle, and a triangle.

[0283] The cross-sectional shape of the protruding portion of the dam **2000** may be configured in consideration of the shape of the micro LEDs **100**.

[0284] For example, in the case the micro LEDs **100** have a structure in which an upper portion thereof is wider than a lower portion thereof, it is advantageous in terms of prevention of interference between the dam **2000** and the micro LEDs **100** that the protruding portion of the dam **2000** has a structure in which a lower portion thereof has a narrower cross section than an upper portion thereof.

[0285] Referring to FIG. **20**, the protruding portion of the dam **2000** has a cross section tapered downward.

[0286] When descending the transfer head **1000** to the suction position to grip the micro LEDs **100** positioned on the first substrate **101** by vacuum-suction, an error in a driving means of the transfer head **1000** may cause the contact between the porous member **1100** and the micro LEDs **100**, leading to damage to the micro LEDs **100**.

[0287] In order to prevent damage to the micro LEDs **100**, it is preferable that the lower surface of the porous member **1100** and the upper surfaces of the micro LEDs **100** are spaced apart from each other at a position where the transfer head **1000** sucks the micro LEDs **100**. However, when there is a gap between the lower surface of the porous member **1100** and the micro LEDs **100**, a larger vacuum pressure is required compared with the case where the micro LEDs **100** and the porous member **1100** are in contact with each other.

[0288] However, the configuration of the dam **2000** of the tenth modification of the transfer head **1000** reduces the amount of air flowing into the suction region **1110** from the peripheral area. Thus, the porous member **1100** of the tenth modification can vacuum-suck the micro LEDs **100** by a smaller vacuum pressure compared with the configuration in which the dam **2000** is not provided.

[0289] There is a case that a length of the protruding portion of the dam **2000** is configured to be longer than the height of the micro LEDs **100**. In this case, when descending the transfer head **1000** to the lowermost position, the dam **2000** may come into contact with the first substrate **101**, but the lower surface of the porous member **1100** may be not in contact with the upper surfaces of the micro LEDs **100**.

[0290] According to the configuration in which the dam **2000** come into contact with the first substrate **101** and the lower surface of the porous member **1100** is spaced from the upper surfaces of the micro LEDs **100**, the dam **2000** more reliably blocks the inflow of air from the peripheral area to the suction region **1110** as compared with the configuration in which the porous member **1100** and the micro LEDs **100** are spaced apart from each other. Thus, the porous member **1100** having the dam **2000** can vacuum-suck the micro LEDs **100** easily.

[0291] In addition, even when air flow causes the adjacent micro LEDs **100** to move finely, it is possible to physically restrict the position of the micro LEDs **100** due to the dam **2000**.

[0292] A shielding portion **3000** is provided on an upper surface of the porous member **1100** to configure a non-suction region. A region **4000** communicating with the suction chamber **1200** is provided between adjacent shielding portions **3000** to configure the suction region **1110**.

[0293] The shielding portion is not limited in material, shape, and thickness as long as the shielding portion functions to close the pores exposed to the surface of the porous member **1100**. Preferably, the shielding portion may be further provided and formed of a photoresist (PR, including dry film PR) or a metal. In the case the porous member **1100** is formed of an anodic oxide film, the shielding portion may be a barrier layer or a metal base material.

[0294] FIG. **21** is a bottom view of the porous member **1100** provided with the dam **2000**.

[0295] As illustrated in FIG. **21**, the dam **2000** is formed entirely except an opening **2100** which becomes the suction region **1110**.

[0296] The opening **2100** of the dam **2000** may be configured at the same pitch distance as the arrangement of the micro LEDs **100** on the first substrate **101**.

[0297] Openings **2100** of the dam **2000** may be arranged in an m by n matrix as illustrated in FIG. **21**.

[0298] When pitch distances of the micro LEDs **100** on the first substrate **101** are P(n) in the column direction and P(m) in the row direction, pitch distances of the opening **2100** of the dam **2000** are P(n) in a column direction and P(m) in a row direction. In this case, the opening **2100** of the dam **2000** is in one-to-one correspondence with the micro LED **100** to be gripped.

[0299] In the case of the present invention, since the micro LED **100** has a circular cross-section, the opening **2100** is also formed in a circular shape as illustrated in FIG. **21**. However, the shape of the opening **2100** may vary depending on the cross-sectional shape of the micro LED **100**. For example, when the micro LED **100** has a rectangular cross-section, the opening **2100** may have a rectangular cross-section corresponding to the cross-sectional shape of the micro LED **100**.

[0300] Eleventh Modification of the Transfer Head **1000**

[0301] Hereinbelow, an eleventh modification of the transfer head **1000** will be described with reference to FIG. **22**.

[0302] FIG. **22** is a view illustrating a state in which an eleventh modification of the transfer head grips the micro LEDs.

[0303] As illustrated in FIG. **22**, the eleventh modification of the transfer head **1000** is configured such that the porous member **1100** of the transfer head **1000** of the system **10** for transferring a micro LED according to the first embodiment is embodied by the anodic oxide film **1300** having the pores formed by anodizing a metal.

[0304] Referring to FIG. **22**, the dam **2000** is formed on the lower surface of the anodic oxide film **1300**.

[0305] The anodic oxide film **1300** includes a portion in which a surface of a barrier layer **3001** provided on the anodic oxide film **1300** is removed such that the suction region **1110** is formed and a portion in which the surface of the barrier layer **3001** is not removed such that the non-suction region **1130** is formed.

[0306] In this case, the barrier layer **3001** functions as the shielding portion **3000** illustrated in FIG. **20**, and a region where the barrier layer **3001** is not provided functions as the region **4000** communicating with the suction chamber **1200** illustrated in FIG. **20**.

[0307] Twelfth and Thirteenth Modifications of the Transfer Head **1000**

[0308] Hereinbelow, twelfth and thirteenth modifications of the transfer head **1000** will be described with reference to FIGS. **23** and **24**.

[0309] FIG. **23** is a view illustrating a state in which a twelfth modification of the transfer head grips the micro LEDs; and FIG. **24** is a view illustrating a state in which a thirteenth modification of the transfer head grips the micro LEDs.

[0310] As illustrated in FIGS. **23** and **24**, the dam **2000** is provided only around the micro LEDs **100** to be gripped in the suction region **1110**.

[0311] As illustrated in FIGS. **23** and **24**, the micro LEDs **100** to be gripped on the first substrate **101** are the micro LEDs **100** at the 1st, 4th, 7th, and 10th positions with reference to the left side of the drawing. The dam **2000** functions to block the inflow of air from the peripheral area to each suction region **1110** when the transfer head **1000** grips the micro LEDs **100** at the 1st, 4th, 7th, and 10th positions by vacuum-suction.

[0312] Here, the dam **2000** provided on the lower surface of the anodic oxide film **1300** may have the shape of the dam **2000** of FIG. **21**.

[0313] As described above, the present invention has been described with reference to the preferred embodiments. However, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

1. A system having a transfer head for transferring a micro LED, the system comprising:
- a first substrate provided in a transfer chamber and on which a micro LED is formed;
- a second substrate provided in the transfer chamber and on which the micro LED is mounted;
- a transfer head provided between the first substrate and the second substrate in the transfer chamber and transferring the micro LED; and
- a spraying unit provided in the transfer chamber spraying ionized gas.

2. The system of claim **1**, wherein the spraying unit is configured as a spraying unit for a transfer chamber to replace the atmosphere in the transfer chamber with the ionized gas.

3. The system of claim **1**, wherein the spraying unit is configured as a spraying unit for the first substrate to spray the ionized gas on an upper surface of the first substrate.

4. The system of claim **1**, wherein the spraying unit is configured as a spraying unit for the second substrate to spray the ionized gas on an upper surface of the second substrate.

5. The system of claim **1**, wherein the spraying unit is configured as a spraying unit for the transfer head to spray the ionized gas on a lower surface of the micro LED gripped by the transfer head.

* * * * *

专利名称(译)	具有用于转移微型LED的转移头的系统		
公开(公告)号	US20190305178A1	公开(公告)日	2019-10-03
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[标]申请(专利权)人(译)	普因特工程有限公司		
申请(专利权)人(译)	POINT ENGINEERING CO. , LTD.		
当前申请(专利权)人(译)	POINT ENGINEERING CO. , LTD.		
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摘要(译)

具有转移头的系统技术领域本发明涉及一种具有转移头的系统，该转移头用于将微型发光二极管（micro LED）从第一衬底转移到第二衬底。更具体地，本发明涉及一种具有用于转印微型LED的转印头的系统，该系统被构造成使得转印头不使用静电力并防止产生可能引起问题的静电力。另外，本发明涉及一种具有用于转印微型LED的转印头的系统，该系统采用利用抽吸力的抽吸结构通过多孔构件来转印微型LED，从而解决了相关技术的问题。