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(54) Ink-jet printhead and method for manufacturing the same

Tintenstrahldruckkopf und dazugehöriges Herstellungsverfahren

Tête d'impression à jet d'encre et sa méthode de fabrication

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Description

[0001] The present invention relates to an ink-jet printhead and a method for manufacturing the same, and more particularly, to an ink-jet printhead in which an ink passage is formed in the same plane as an ink chamber to improve ejection performance, a metallic nozzle plate is disposed on a substrate to improve linearity of ink droplets ejected through a nozzle, and heat generated by a heater is effectively dissipated to increase a driving frequency of the printhead, and a method for manufacturing the same.

[0002] In general, inkjet printheads are devices for printing a predetermined color image by ejecting droplets of ink at desired positions on a recording sheet. Inkjet printheads are generally categorized into two types according to an ink ejection mechanism. One is a thermal inkjet printhead in which a source of heat is employed to form bubbles in ink to eject the ink due to the expansive force of the bubbles. The other is a piezoelectric inkjet printhead in which ink is ejected by a pressure applied to the ink due to deformation of a piezoelectric element.

[0003] The ink droplet ejection mechanism of the thermal inkjet printhead will be explained in further detail. When a current pulse is supplied to a heater which comprises a heating resistor, the heater generates heat such that ink near to the heater is instantaneously heated to approximately 300°C. As the ink boils to generate bubbles, the generated bubbles expand to exert a pressure on the ink filled in an ink chamber. Therefore, the ink around a nozzle is ejected in the form of droplets to the outside of the ink chamber.

[0004] The thermal inkjet printhead is classified into a top-shooting type, a side-shooting type, and a back-shooting type, according to a bubble growing direction and a droplet ejection direction. In a top-shooting type printhead, bubbles grow in the same direction in which ink droplets are ejected. In a side-shooting type of printhead, bubbles grow in a direction perpendicular to a direction in which ink droplets are ejected. In a back-shooting type of printhead, bubbles grow in a direction opposite to a direction in which ink droplets are ejected.

[0005] The thermal inkjet printhead generally needs to meet the following conditions. First, a manufacturing process must be simple, a manufacturing cost must be low, and mass production must be feasible. Second, cross-talk between adjacent nozzles must be avoided to produce a high-quality image, and a distance between the adjacent nozzles must be as narrow as possible. That is, a plurality of nozzles should be densely disposed to increase dots per inch (DPI). Third, a refill cycle after ink ejection must be as short as possible to permit high-speed printing. That is, an operating frequency must be high by fast-cooling the heated ink and the heater.

[0006] FIGS. 1 through 3 illustrate the structure of a conventional back-shooting thermal ink-jet printhead.

[0007] FIG. 1 is a perspective view illustrating the structure of an ink-jet printhead disclosed in U.S. Patent No. 5,502,471. Referring to FIG. 1, an ink-jet printhead 24 has a structure in which a substrate 11 having a nozzle 10 through which ink droplets are ejected and an ink chamber 16 filled with ink to be ejected, a cover plate 3 having a through hole 2 connecting the ink chamber 16 and an ink reservoir 12, and the ink reservoir 12 which supplies ink to the ink chamber 16, are sequentially stacked. Here, a heater 42 has a ring shape and is disposed around the nozzle 10 of the substrate 11.

[0008] In the above structure, if a pulse current is applied to the heater 42 and heat is generated in the heater 42, ink in the ink chamber 16 boils and bubbles are generated. The bubbles expand continuously and apply pressure to ink in the ink chamber 16. As a result, ink is ejected in droplets through the nozzle 10. Next, ink is drawn into the ink chamber 16 from the ink reservoir 12 through the through hole 2 formed in the cover plate 3, and the ink chamber 16 is refilled with ink.

[0009] However, in the ink-jet printhead 24, since the height of the ink chamber 16 is almost the same as the thickness of the substrate 11, unless a very thin substrate is used, the size of the ink chamber 16 increases. Thus, pressure generated by bubbles for ejecting ink is dispersed by the ink, resulting in degradation of an ejection property. Meanwhile, if a thin substrate is used to reduce the size of the ink chamber 16, it is difficult to process the substrate 11. In other words, the height of the ink chamber 16 in a typical conventional ink-jet printhead is about 10-30 μm. In order to form an ink chamber having this height, a silicon substrate having a thickness of 10-30 μm should be used. However, it is impossible to process a silicon substrate having such a thickness using semiconductor processes.

[0010] Meanwhile, in order to manufacture an ink-jet printhead having the above structure, the substrate 11, the cover plate 3, and the ink reservoir 12 should be bonded to one another. Thus, a process of manufacturing the ink-jet printhead becomes complicated, and an ink passage, which has a large effect on the ejection property, cannot be made very elaborate.

[0011] FIG. 2 is a cross-sectional view illustrating the structure of an ink-jet printhead disclosed in U.S. Patent No. 5,841,452. Referring to FIG. 2, a hemispherical ink chamber 15 is formed on a substrate 30 formed of silicon, a manifold 26 which supplies ink to the ink chamber 15 is formed under the substrate 30, and an ink channel 13 which connects the ink chamber 15 and the manifold 26 has a cylindrical shape and is formed between the ink chamber 15 and the manifold 26, perpendicular to the surface of the substrate 30. A nozzle plate 20 having a nozzle 21 through which ink droplets 18 are ejected is positioned on the surface of the substrate 30 and forms an upper wall of the ink chamber 15. A ring-shaped heater 22 which is adjacent to and surrounds the nozzle 21 is formed in the nozzle plate 20, and an electric wire (not shown) for applying an electric current is connected to the heater 22.

[0012] In the above structure, if a pulse current is applied to the ring-shaped heater 22 in a state in which the ink chamber 15 is filled with ink supplied from the manifold 26 through the ink channel 13, ink under the heater 22 boils by heat generated in the heater 22, and bubbles are generated in the ink. As a result, pressure is applied to the ink in the ink chamber 15, and ink in the vicinity of the nozzle 21 is ejected as the ink droplets 18 through the nozzle 21. Next, ink is drawn into the ink chamber 15 through the ink channel 13, and the ink chamber 15 is refilled with ink.

[0013] In this ink-jet printhead, since only part of the substrate 30 is etched to form the ink chamber 15, the size of the ink chamber 15 can be reduced. In addition, since the printhead is manufactured by a batch process without a bonding process, a process of manufacturing the ink-jet printhead is simple.

[0014] However, since the ink channel 13 is positioned in the same line as the nozzle 21, ink flows back toward the ink channel 13 when bubbles are generated, thereby lowering the ejection property. In addition, since the substrate 30 exposed by the nozzle 21 is etched to form the ink chamber 15, the size of the ink chamber can be reduced, but the ink chamber 15 cannot be formed with various different shapes. Thus, it is difficult to form the ink chamber to have an optimum shape.

[0015] FIG. 3 is a cross-sectional view illustrating the structure of an ink-jet printhead disclosed in U.S. Patent No. 6,382,782. Referring to FIG. 3, the ink-jet printhead has a structure in which a nozzle plate 50 having a nozzle 51, an insulating layer 60 having an ink chamber 61 and an ink channel 62, and a silicon substrate 70 having a manifold 55 for supplying ink to the ink chamber 61, are sequentially stacked.

[0016] In this ink-jet printhead, since the ink chamber 61 is formed using the insulating layer 60 stacked on the substrate 70, the ink chamber 61 may have a variety of shapes, and backflow of ink can be reduced.

[0017] However, when manufacturing this ink-jet printhead, a method of depositing the thick insulating layer 60 on the silicon substrate 70, etching the insulating layer 60, and forming the ink chamber 61 is generally used. This method has the following problems. First, it is difficult to stack the thick insulating layer 60 on the substrate 70 using existing semiconductor processes. Second, it is difficult to etch the thick insulating layer 60. Thus, there is a limitation in the height of the ink chamber 61. As shown in FIG. 3, the ink chamber 61 and the nozzle 51 have a combined height of only about 6 μm. However, with such a shallow ink chamber, it is impossible for an ink-jet printhead to have a relatively large drop size.

[0018] US 2003/0085957 A1 discloses an ink-jet printhead comprising a field oxide layer and nozzle layers formed over a silicon substrate. The field oxide layer is etched to form an elongate ink chamber and the silicon substrate is etched to form an ink manifold. The nozzle layers comprise a oxide layers, a heater and a conductor. This document disclosed an ink-jet head according to the preamble of claim 1.

[0019] US 6019457 discloses several nozzle arrangements for ink-jet printheads. Some of these structures include a thermal diffuser, or thermal shunt, formed as part of a layer of metal contacts.

[0020] According to an aspect of the present invention, there is provided an ink-jet printhead comprising: a substrate, an ink chamber to be filled with ink to be ejected being formed on a surface of the substrate, a manifold which supplies ink to the ink chamber being formed on a rear surface of the substrate, and an ink passage which connects the ink chamber and the manifold being formed parallel to the surface of the substrate and in the same plane as the ink chamber; a nozzle plate, which includes a plurality of passivation layers stacked on the substrate and formed of an insulating material, through which a nozzle connected to the ink chamber is formed; and a heater and a conductor, which are disposed between the passivation layers of the nozzle plate, the heater being positioned on the ink chamber and heating ink in the ink chamber, and the conductor applying a current to the heater, wherein the ink-jet print printhead is characterized in that the nozzle plate further includes a heat dissipating layer formed on the passivation layers, the heat dissipating layer being formed of a metallic material having good thermal conductivity.

[0021] The ink passage preferably includes at least one ink channel connected to the ink chamber, and an ink feed hole which connects the ink channel to the manifold.

[0022] The passivation layers may include a first passivation layer, a second passivation layer, and a third passivation layer, which are sequentially stacked on the substrate, the heater is disposed between the first passivation layer and the second passivation layer, and the conductor is disposed between the second passivation layer and the third passivation layer.

[0023] A lower portion of the nozzle is preferably formed in the plurality of the passivation layers, and an upper portion of the nozzle is preferably formed in the heat dissipating layer.

[0024] The upper portion of the nozzle formed in the heat dissipating layer may have a tapered shape such that a diameter thereof becomes smaller in the direction of an outlet.

[0025] The heat dissipating layer may be formed of at least one metallic layer, and each of the metallic layers may be formed of at least one material selected from the group consisting of Ni, Cu, Al, and Au. The heat dissipating layer may be formed to a thickness of about 10-100 μm by electroplating.

[0026] A seed layer for electroplating the heat dissipating layer may be formed on the passivation layers. The seed layer may be formed of at least one metallic layer, and each of the metallic layers may be formed of at least one material selected from the group consisting of Cu, Cr, Ti, Au, and Ni.

[0027] According to another aspect of the present invention, there is provided a method for manufacturing an ink-jet printhead, the method comprising: forming a sacrificial layer having a predetermined depth on a surface of a substrate; sequentially stacking a plurality of passivation layers on the substrate on which the sacrificial layer is formed and forming a heater and a conductor connected to the heater between the passivation layers; forming a heat dissipating layer of metal on the passivation layers and forming a nozzle through which ink is ejected through the heat dissipating layer and the passivation layers to expose the sacrificial layer; forming a manifold for supplying ink on a rear surface of the substrate; removing the sacrificial layer to form an ink chamber and an ink passage, the ink passage being formed parallel to the surface of the substrate and in the same plane as the ink chamber; and connecting the manifold and the ink passage.

[0028] Forming the sacrificial layer may comprise etching the surface of the substrate to form a groove having a predetermined depth; oxidizing the surface of the substrate in which the groove is formed to form an oxide layer; and filling the groove with a predetermined material and planarizing the surface of the substrate. Filling groove with the predetermined material may be performed by epitaxially growing poly silicon in the groove.

[0029] Forming the sacrificial layer may comprise forming a trench exposing an insulating layer in a predetermined shape in an upper silicon substrate of a SOI substrate; and filling the trench with a predetermined material. The predetermined material may be silicon oxide.

[0030] Forming the passivation layers may comprise forming a first passivation layer on a surface of the substrate on which the sacrificial layer is formed; forming the heater on the first passivation layer; forming a second passivation layer on the first passivation layer and the heater; forming the conductor on the second passivation layer; and forming a third passivation layer on the second passivation layer and the conductor.

[0031] The heat dissipating layer may be formed of at least one metallic layer, and each of the metallic layers may be formed by electroplating at least one material selected from the group consisting of Ni, Cu, Al, and Au. The heat dissipating layer may be formed to a thickness of 10-100 μm.

[0032] Forming the heat dissipating layer and the nozzle may comprise etching the passivation layers formed on the sacrificial layer to form a lower nozzle; forming a lower plating mold inside the lower nozzle; forming an upper plating mold having a predetermined shape for forming the upper nozzle on the lower plating mold; forming the heat dissipating layer on the passivation layers by electroplating; and removing the upper and lower plating molds to form the nozzle comprising the upper nozzle and the lower nozzle. The lower plating mold and the upper plating mold may be formed of a photoresist or photosensitive polymer.

[0033] Forming the heat dissipating layer and the nozzle may comprise etching the passivation layers formed on the sacrificial layer to form a lower nozzle; forming a plating mold having a predetermined shape for forming an upper nozzle vertically from the inside of the lower nozzle; forming the heat dissipating layer on the passivation layers by electroplating; and removing the plating mold and forming the nozzle comprising the upper nozzle and the lower nozzle. The plating mold may be formed of a photoresist or a photosensitive polymer.

[0034] The lower nozzle may be formed by dry etching the passivation layers by reactive ion etching (RIE).

[0035] A seed layer for electroplating the heat dissipating layer may be formed on the passivation layers. The seed layer may be formed of at least one metallic layer, and each of the metallic layers may be formed by depositing at least one metallic material selected from the group consisting of Cu, Cr, Ti, Au, and Ni.

[0036] After forming the heat dissipating layer, forming the heat dissipating layer and the nozzle may further comprise planarizing the top surface of the heat dissipating layer by a chemical mechanical polishing (CMP) process.

[0037] The present invention thus provides an ink-jet printhead having an improved structure in which an ink passage is formed in the same plane as an ink chamber to improve ejection performance, a metallic nozzle plate is disposed on a substrate to improve linearity of ink droplets ejected through a nozzle, and heat generated by a heater is effectively dissipated to increase a driving frequency of the printhead, and a method for manufacturing the same.

[0038] The above and other aspects and advantages of the present invention will become more apparent by describing in detail exemplary embodiments thereof with reference to the attached drawings in which:

FIG. 1 is a perspective view illustrating an example of a conventional ink-jet printhead;

FIG. 2 is a perspective view illustrating another example of a conventional ink-jet printhead;

FIG. 3 is a perspective view illustrating still another example of a conventional ink-jet printhead;

FIG. 4 is a plan view schematically illustrating an ink-jet printhead according to an embodiment of the present invention;

FIG. 5 is an enlarged plan view illustrating a portion A of FIG. 4;

FIG. 6 is a cross-sectional view of the ink-jet printhead taken along line VI-VI' of FIG. 5;

FIG. 7 is a partial perspective view of a substrate on which an ink chamber and an ink passage are formed;

FIGS. 8 through 19 are cross-sectional views illustrating a method for manufacturing an ink-jet printhead according to an embodiment of the present invention; and

FIGS. 20 through 22 are cross-sectional views illustrating a method for manufacturing an ink-jet printhead according to another embodiment of the present invention.

[0039] Hereinafter, exemplary embodiments of the present invention will be described in detail with reference to the accompanying drawings. In the drawings, whenever the same element reappears in subsequent drawings, it is denoted by the same reference numeral. Also, the sizes or thicknesses of elements may be exaggerated for clarity. It will be understood that when a layer is referred to as being on another layer or on a substrate, it can be directly on the other layer or the substrate, or intervening layers may also be present.

[0040] FIG. 4 is a plan view schematically illustrating an ink-jet printhead according to an embodiment of the present invention. Referring to FIG. 4, the ink-jet printhead includes ink ejecting portions 103 disposed in two rows and bonding pads 101 which are electrically connected to each ink ejecting portion 103. In alternative embodiments, the ink ejecting portions 103 may be disposed in one row, or in three or more rows to improve printing resolution.

[0041] FIG. 5 is an enlarged plan view of a portion A of FIG. 4, FIG. 6 is a cross-sectional view illustrating a vertical structure of the ink-jet printhead taken along line VI-VI' of FIG. 5, and FIG. 7 is a partial perspective view of a substrate illustrating an ink chamber and an ink passage, which are formed on the surface of the substrate.

[0042] Referring to FIGS. 5, 6, and 7, an ink chamber 106 to be filled with ink is formed on the surface of a substrate 100 to a predetermined depth, and a manifold 102 which supplies ink to the ink chamber 106 is formed on a rear surface of the substrate 100.

[0043] Here, since each of the surface and the rear surface of the substrate 100 is etched to form the ink chamber 106 and the manifold 102, the ink chamber 106 and the manifold 102 may have a variety of shapes. Here, the ink chamber 106 may be formed to a depth of about 10-80 μm. The manifold 102 formed under the ink chamber 106 is connected to an ink reservoir (not shown).

[0044] An ink passage 105 which connects the ink chamber 106 and the manifold 102 is formed on the surface of the substrate 100. Here, like the ink chamber 106, the surface of the substrate 100 is etched to form the ink passage 105. Thus, the ink passage 105 may have a variety of shapes. The ink passage 105 is formed parallel to the surface of the substrate 100, in the same plane as the ink chamber 106. The ink passage 105 comprises an ink channel 105a and an ink feed hole 105b. The ink channel 105a is connected to the ink chamber 106, and the ink feed hole 105b is connected to the manifold 102. Meanwhile, a plurality of ink channels 105a may be formed in consideration of an ejection property.

[0045] A nozzle plate 120 is disposed on the substrate 100 on which the ink chamber 106, the ink passage 105, and the manifold 102 are formed. The nozzle plate 120 forms an upper wall of the ink chamber 106 and the ink passage 105. A nozzle 104 through which ink is ejected from the ink chamber 106 is vertically formed through the nozzle plate 120.

[0046] The nozzle plate 120 is formed of a plurality of material layers stacked on the substrate 100. The plurality of material layers includes first, second, and third passivation layers 121, 122, and 126, and a heat dissipation layer 128 formed of metal. A heater 108 is disposed between the first passivation layer 121 and the second passivation layer 122, and a conductor (112 of FIG. 5) is disposed between the second passivation layer 122 and the third passivation layer 126.

[0047] The first passivation layer 121 is a lowermost material layer of the plurality of material layers which are components of the nozzle plate 120, and is formed on the surface of the substrate 100. The first passivation layer 121 is formed to provide insulation between the heater 108 and the substrate 100 and to protect the heater 122. The first passivation layer 121 may be formed of silicon oxide or silicon nitride.

[0048] The heater 108 which heats ink in the ink chamber 106 is disposed on the first passivation layer 121 formed on the ink chamber 106. In alternative embodiments, a plurality of heaters 108 may be formed and may have a variety of positions and shapes, which are different from those shown in FIGS. 5, 6, and 7. The heater 108 may be formed in a ring shape around the nozzle 104. The heater 108 is formed of a resistive heating material, such as impurity-doped poly silicon, tantalum-aluminum alloy, tantalum nitride, titanium nitride, or tungsten silicide.

[0049] The second passivation layer 122 is formed on the first passivation layer 121 and the heater 108. The second passivation layer 122 is formed to protect the heater 108 and may be formed of silicon nitride or silicon oxide, like the first passivation layer 121.

[0050] Meanwhile, although not shown in FIG. 6, a conductor (112 of FIG. 5) which is electrically connected to the heater 108 and applies a pulse current to the heater 108 is formed on the second passivation layer 122. One end of the conductor (112 of FIG. 5) is connected to the heater 108 via a contact hole formed in the second passivation layer 122, and the other end thereof is electrically connected to a bonding pad (101 of FIG. 4). The conductor (112 of FIG. 5) may be formed of metal with good conductivity, for example, aluminum (Al), aluminum alloy, gold (Au), or silver (Ag).

[0051] The third passivation layer 126 is formed on the conductor (112 of FIG. 5) and the second passivation layer 122. The third passivation layer 126 may be formed of tetraethylorthosilicate (TEOS) oxide or silicon oxide.

[0052] The heat dissipating layer 128, formed on the third passivation layer 126, is the uppermost material layer of the plurality of material layers which are components of the nozzle plate 120. The heat dissipating layer 128 may be formed of a metallic material with good thermal conductivity, such as Ni, Cu, Al, or Au. In addition, the heat dissipating layer 128 may be formed of a plurality of metallic layers. The heat dissipating layer 128 may be formed to a larger thickness of about 10 - 100 μm by electroplating the above-described metallic material. To this end, a seed layer 127 for electroplating of the above-described metallic material may be formed on the top surface of the third passivation layer 126 and at both sides of the surface of the substrate 100. The seed layer 127 may be formed of a metallic material with good electrical conductivity, such as Cu, Cr, Ti, Au, or Ni. In addition, the seed layer 127 may be formed of a plurality of metallic layers.

[0053] The heat dissipating layer 128 dissipates heat generated by and remaining around the heater 108. In other words, heat generated by and remaining around the heater 108 after ink is ejected is dissipated to the substrate 100 and outside via the heat dissipating layer 128. Thus, heat is dissipated after ink is ejected and the temperature around the nozzle 104 falls rapidly so that printing can be performed stably at a high driving frequency.

[0054] As described above, since the heat dissipating layer 128 may be formed to a larger thickness, the nozzle 104 can be formed to have a sufficient length. Thus, a stable high-speed operation can be performed, and the linearity of ink droplets ejected through the nozzle 104 is improved. That is, the ink droplets can be ejected in a direction exactly perpendicular to the substrate 100.

[0055] Meanwhile, the nozzle 104 comprises a lower nozzle 104a and an upper nozzle 104b. The lower nozzle 104a has a cylindrical shape and is formed in the first, second, and third passaivation layers 121, 122, and 126. The upper nozzle 104b has a tapered shape such that a diameter thereof becomes smaller in the direction of an outlet in the heat dissipating layer 128. Since the upper nozzle 104 has a tapered shape, a meniscus at the surface of ink in the nozzle 104 is more quickly stabilized after ink is ejected.

[0056] An operation of ejecting ink from the ink-jet printhead having the above structure will now be described.

[0057] First, if the pulse current is applied to the heater 108 via the conductor 112 in a state in which the ink chamber 106 and the nozzle 104 are filled with ink, heat is generated by the heater 108 and transferred to the ink in the ink chamber 106 through the first passivation layer 121 formed under the heater 108. As a result, the ink boils, and a bubble is generated. The bubble expands due to a continuous supply of heat, causing ink to protrude from the nozzle 104.

[0058] Next, when the applied current is cut off, the bubble contracts and collapses, causing ink that has protruded from the nozzle 104 to be ejected in droplets. Meanwhile, since heat generated by and remaining around the heater 108 after ink is ejected is dissipated to the substrate 100 and outside via the heat dissipating layer 128, the temperature around the heater 108 goes down.

[0059] Next, the ink chamber 106 is refilled with ink supplied from the manifold 102 through the ink channel 105a and the ink feed hole 105b. When ink refilling is completed and the ink-jet printhead returns to its initial state, the above-described cycle is repeated.

[0060] In the ink-jet printhead according to the embodiment of the present invention, since the ink passage 105 is formed parallel to the surface of the substrate 100 in the same plane as the ink chamber 106, backflow of ink can be reduced. Since the ink chamber 106 and the ink passage 105 are formed using an etching method, they may have a variety of shapes. Thus, the ink chamber 106 and the ink passage 105 can be formed to have optimum shapes. In addition, since the metal heat dissipating layer 128 is formed by electroplating, it may be formed as a single body with the other elements of the ink-jet printhead and formed to a larger thickness, and heat can be effectively dissipated.

[0061] A method of manufacturing an ink-jet printhead according to an embodiment of the present invention will now be described.

[0062] FIGS. 8 through 19 are cross-sectional views illustrating a method for manufacturing an ink-jet printhead according to an embodiment of the present invention.

[0063] FIG. 8 illustrates a state in which a groove is formed on the surface of the substrate 100, and the substrate 100 is oxidized to form silicon oxide layers 130 and 140 on the front and rear surfaces of the substrate 100.

[0064] First, in the present embodiment, a silicon wafer is processed to a thickness of about 300-700 μm and is used as the substrate 100. Silicon wafers are widely used to manufacture semiconductor devices, and thus are good for mass production of a printhead. While FIG. 8 illustrates only a part of a silicon wafer, several tens to hundreds of chips corresponding to ink-jet printheads maybe contained in one wafer.

[0065] An etching mask for defining a portion to be etched is formed on a top surface of the silicon substrate 100. A photoresist is coated on the top surface of the substrate 100 to a predetermined thickness and is patterned, thereby forming the etch mask.

[0066] Subsequently, the substrate 100 exposed by the etch mask is etched, thereby forming a groove having a predetermined shape. The substrate 100 may be etched by dry etching such as reactive ion etching (RIE). The groove is a portion in which an ink chamber (106 of FIG. 6) and an ink passage (105 of FIG. 6) are to be formed. Preferably, the depth of the groove is about 10-80 μm. Meanwhile, the groove may have a variety of shapes depending on the shape in which the surface of the substrate 100 is etched. Thus, the ink chamber and the ink passage can be formed to have desired shapes. After the groove is formed, the etch mask is removed from the substrate 100.

[0067] Subsequently, the substrate 100 on which the grove is formed is oxidized to form the silicon oxide layers 130 and 140 on the front and rear surfaces of the substrate 100.

[0068] FIG. 9 illustrates a state in which a sacrificial layer 250 is formed in the groove formed on the substrate 100 and the surface of the substrate 100 is planarized.

[0069] Specifically, poly silicon is epitaxially grown in the groove formed on the surface of the oxidized substrate 100, thereby forming the sacrificial layer 250. Next, the sacrificial layer 250 and the surface of the substrate 100 are planarized by a chemical mechanical polishing (CMP) process. Here, the protruding silicon oxide layer 140 is removed.

[0070] FIG. 10 illustrates a state in which the first passivation layer 121, the heater 108, the second passivation layer 122, the conductor (112 of FIG. 5), and the third passivation layer 126 are sequentially stacked on the entire surface of the structure shown in FIG. 9.

[0071] Specifically, the first passivation layer 121 is formed on the surface of the planarized substrate 100. The first passivation layer 121 may be formed by depositing silicon oxide or silicon nitride.

[0072] Next, the heater 108 is formed on the first passivation layer 121. The heater 108 is formed by depositing a resistive heating material, such as impurity-doped poly silicon, tantalum-aluminum alloy, tantalum nitride, or tungsten silicide, on the entire surface of the first passivation layer 121 to a predetermined thickness and patterning the deposited material in a predetermined shape. Specifically, impurity-doped poly silicon may be formed to a thickness of about 0.7-1 μm by depositing poly silicon together with impurities, for example, a source gas of phosphorous (P), by low pressure chemical vapor deposition (LP CVD). When the heater 108 is formed of tantalum-aluminum alloy, tantalum nitride, or tungsten silicide, the heater 108 may be formed to a thickness of about 0.1-0.3 μm by depositing tantalum-aluminum alloy, tantalum nitride, or tungsten silicide by sputtering or chemical vapor deposition (CVD). The deposition thickness of the resistive heating material may be varied so as to have proper resistance in consideration of the width and length of the heater 108. Subsequently, the resistive heating material deposited on the entire surface of the first passivation layer 121 is patterned by a photolithographic process using a photomask and a photoresist and an etch process using a photoresist pattern as an etch mask.

[0073] Next, the second passivation layer 122 formed of silicon oxide or silicon nitride may be formed to a thickness of about 0.2-1 μm by depositing silicon oxide or silicon nitride on the entire surface of the first passivation layer 121 on which the heater 108 is formed. Subsequently, the second passivation layer 122 is etched to form a contact hole (not shown) through which the heater 108 is exposed to be connected to the conductor (112 of FIG. 5).

[0074] Subsequently, the conductor (112 of FIG. 5) is formed by depositing metal having good conductivity, such as aluminum (Al), aluminum alloy, gold (Au), or silver (Ag), on the entire surface of the second passivation layer 122 to a thickness of about 0.5-2 μm through sputtering and patterning the deposited metal. Then, the conductor (112 of FIG. 5) is connected to the heater 108 via the contact hole (not shown).

[0075] Next, the third passivation layer 126 is formed on top surfaces of the second passivation layer 122 and the conductor (112 of FIG. 5). The third passivation layer 126 is a material layer that provides insulation between the conductor (112 of FIG. 5) and a heat dissipating layer (128 of FIG. 6) that will be formed later. The third passivation layer 126 may be formed to a thickness of about 0.7-3 μm by depositing TEOS oxide using plasma enhanced chemical vapor deposition (PE CVD).

[0076] FIG. 11 illustrates a state in which the lower nozzle 104a is formed. The lower nozzle 104a may be formed by sequentially etching the third passivation layer 126, the second passivation layer 122, and the first passivation layer 121 through RIE such that part of the sacrificial layer 250 formed on the surface of the substrate 100 and both sides of the surface of the substrate 100 is exposed.

[0077] FIG. 12 illustrates a state in which a lower plating mold 350 is formed in the lower nozzle 104a and the seed layer 127 is formed on the lower plating mold 350. Specifically, the lower plating mold 350 may be formed by coating a photoresist on the entire surface of the structure shown in FIG. 11 to a predetermined thickness, patterning a coated photoresist, and leaving only the photoresist inside the lower nozzle 104a. Meanwhile, the lower plating mold 350 may be formed of a photoresist or a photosensitive polymer.

[0078] Subsequently, the seed layer 127 for electroplating is formed on the entire surface of the structure shown in FIG. 12. For electroplating, the seed layer 127 may be formed to a thickness of about 500-3000 A by depositing metal having good conductivity, such as Cu, Cr, Ti, Au, or Ni, by sputtering. Alternatively, the seed layer 127 may be formed of a plurality of metallic layers.

[0079] FIG. 13 illustrates a state in which an upper plating mold 450 for forming an upper nozzle (104b of FIG. 6) is formed. The upper plating mold 450 may be formed by coating a photoresist on the entire surface of the seed layer 127, patterning the coated photoresist, and leaving only photoresist where the upper nozzle (104b of FIG. 6) is to be formed. Meanwhile, the upper plating mold 450 may be formed of a photoresist or photosensitive polymer. The upper plating mold 450 has a tapered shape such that a diameter thereof becomes smaller as the upper plating mold 450 extends upwards. Alternatively, the upper nozzle (104b of FIG. 6) may have a cylindrical shape. In this case, the upper plating mold 450 may have the pillar shape.

[0080] Meanwhile, the lower plating mold 350 and the upper plating mold 450 may be formed by the following steps. Referring to FIG. 19, before forming the lower plating mold 350, a seed layer 127' for electroplating is formed on the entire surface of the structure shown in FIG. 11. Subsequently, the lower plating mold 350 and the upper plating mold 450 are sequentially formed. Alternatively, the lower and upper plating molds 350 and 450 may be formed of a single body.

[0081] FIG. 14 illustrates a state in which the heat dissipating layer 128 formed of a metallic material having a predetermined thickness is formed on a top surface of the seed layer 127. The heat dissipating layer 128 may be formed to a thickness of about 10-100 μm by electroplating metal having good thermal conductivity, such as Ni, Cu, Al, or Au, on the surface of the seed layer 127. Alternatively, the heat dissipating layer 128 may be formed of a plurality of metallic layers. The thickness of the heat dissipating layer 128 may be determined in consideration of a cross-sectional area and shape of the upper nozzle and a heat dissipating capability to the substrate 100 and the outside.

[0082] The surface of the heat dissipating layer 128 after electroplating is completed, is uneven due to material layers formed under the heat dissipating layer 128. Thus, the surface of the heat dissipating layer 128 can be planarized by CMP.

[0083] Subsequently, the upper plating mold 450, the seed layer 127 formed under the upper plating mold 450, and the lower plating mold 350 are sequentially removed. The upper and lower plating molds 450 and 350 may be removed using a general method of removing a photoresist. The seed layer 127 may be etched by wet etching using an etchant capable of selectively etching the seed layer 127 in consideration of etch selectivity of the metallic material used to form the heat dissipating layer 128 to the metallic material used to form the seed layer 127. For example, when the seed layer 127 is formed of copper (Cu), an acetic acid based etchant may be used, and when the seed layer 127 is formed of titanium (Ti), a HF based etchant may be used. Then, as shown in FIG. 15, the lower nozzle 104a and the upper nozzle 104b are connected to each other, thereby forming a complete nozzle 104 and completing the nozzle plate 120 formed of a stack of a plurality of material layers. In this case, a partial surface of the sacrificial layer 250 that occupies a space in which the ink chamber (106 of FIG. 6) and the ink passage (105 of FIG. 6) are to be formed, is exposed through the nozzle 104.

[0084] FIG. 16 illustrates a state in which the manifold 102 is formed on a rear surface of the substrate 100. Specifically, the silicon oxide layer 130 formed on the rear surface of the silicon substrate 100 is patterned, thereby forming an etch mask which defines an area to be patterned. Next, the silicon substrate 100 exposed by the etch mask is wet etched using tetramethyl ammonium hydroxide (TMAH) or potassium hydroxide (KOH) as an etchant, thereby forming the manifold 102 having an inclined side, as shown in FIG. 16. Meanwhile, the manifold 102 may be formed by anisotropically dry etching the rear surface of the substrate 100.

[0085] FIG. 17 illustrates a state in which the ink chamber 106 and the ink passage 105 are formed on the surface of the substrate 100. The ink chamber 106 and the ink passage 105 may be formed by isotropically etching the sacrificial layer (250 of FIG. 16). Specifically, the sacrificial layer (250 of FIG. 16) exposed through the nozzle 104 is dry etched using an etchant, such as an XeF_2 gas or a BrF_3 gas, for a predetermined amount of time. In this case, since the sacrificial layer (250 of FIG. 16) is etched isotropically, it is etched at a uniform speed in all directions from a portion exposed through the nozzle 104. However, further etching of the silicon oxide layer 140 which serves as an etch stopper is suppressed. As shown in FIG. 17, the ink chamber 106 and the ink passage 105 are formed parallel to the surface of the substrate 100 in the same plane. Here, the depths of the ink chamber 106 and the ink passage 105 formed on the surface of the substrate 100 are about 10-80 μm. The ink passage 105 includes an ink channel 105a connected to the ink chamber 106 and an ink feed hole 105b connected to the manifold 102.

[0086] FIG. 18 illustrates a state in which the ink passage 105 and the manifold 102, which are formed on the substrate 100, are connected to each other. Specifically, the silicon oxide layer 140 between the ink passage 105 formed on the front surface of the substrate 100 and the manifold 102 formed on the rear surface of the substrate 100 is removed by etching, thereby connecting the ink passage 105 to the manifold 102. The ink-jet printhead according to the embodiment of the present invention is now complete.

[0087] FIGS. 20 through 22 are cross-sectional views illustrating a method for manufacturing an ink-jet printhead according to another embodiment of the present invention. This method is the same as the method of the previous embodiment, except for the step of forming the sacrificial layer, and thus, only the step of forming the sacrificial layer will be described.

[0088] First, as shown in FIG. 20, a silicon-on-insulator (SOI) substrate 300, in which an insulating layer 320 is interposed between two silicon substrates 310 and 330, is used as a substrate. Here, the thickness of the upper silicon substrate 330 is about 10-80 μm, and the thickness of the lower silicon substrate 310 is about 300-700 μm.

[0089] Next, as shown in FIG. 21, the surface of the upper silicon substrate 330 is etched, thereby forming a trench 340 having a predetermined shape so that the insulating layer 320 is exposed. The trench 340 is formed to surround portions in which the ink chamber (106 of FIG. 6) and the ink passage (105 of FIG. 6) are to be formed. The trench 340 is formed to a width of several μm so that it can easily be filled with a predetermined material.

[0090] Next, as shown in FIG. 22, the trench 340 is filled with a silicon oxide 370, and then, the surface of the upper silicon substrate 330 is planarized. By doing so, portions that are surrounded by the silicon oxide 370 become sacrificial layers 250' for forming the ink chamber (106 of FIG. 6) and the ink passage (105 of FIG. 6). Thus, the sacrificial layer 250' is formed of silicon, unlike in the previous embodiment in which it was formed of poly silicon.

[0091] Subsequent steps are the same as the above-described steps shown in FIGS. 10 through 18.

[0092] As described above, the ink-jet printhead and the method for manufacturing the same according to the present invention have the following effects. First, an ink passage is formed parallel to the surface of a substrate in the same plane as the ink chamber such that ejection failure caused by backflow of ink is prevented and the performance of the printhead is improved. Second, since a heat dissipating layer is formed to a large thickness, a nozzle having a sufficient length can be obtained. Thus, the linearity of ink droplets ejected through the nozzle is improved. Third, heat generated by and remaining around a heater is efficiently dissipated to the substrate and outside. Thus, the area near the nozzle can be rapidly cooled enabling a driving frequency to be increased.

[0093] While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the scope of the present invention as defined by the following claims. For example, materials used in forming each element of an ink-jet printhead according to the present invention may be varied, methods for depositing and forming each element may be modified, and the order in which steps of a method for manufacturing the ink-jet printhead are performed may be changed, all within the scope of the present invention as defined by the appended claims.

Claims

1. An ink-jet printhead comprising:

a substrate (100), an ink chamber (106) to be filled with ink to be ejected being formed on a surface of the substrate (100), a manifold (102) which supplies ink to the ink chamber (106) being formed on a rear surface of the substrate (100), and an ink passage (105) which connects the ink chamber (106) and the manifold (102) being formed parallel to the surface of the substrate (100) and in the same plane as the ink chamber (106);

a nozzle plate (120), which includes a plurality of passivation layers (121, 122, 126) stacked on the substrate (100) and formed of an insulating material, through which a nozzle (104) connected to the ink chamber (106) is formed; and

a heater (108) and a conductor (112), which are disposed between the passivation layers (121, 122, 126) of the nozzle plate (120), the heater (108) being positioned on the ink chamber (106) and heating ink in the ink chamber (106), and the conductor (112) applying a current to the heater (108),

wherein the ink-jet print printhead is **characterized in that** the nozzle plate (120) further includes a heat dissipating layer (128) formed on the passivation layers (121, 122, 126), the heat dissipating layer (128) being formed of a metallic material having good thermal conductivity.

2. The ink-jet printhead of claim 1, wherein the ink passage (105) includes at least one ink channel (105a) connected to the ink chamber (106), and an ink feed hole (105b) which connects the ink channel (105a) to the manifold (102).

3. The ink-jet printhead of any one of the preceding claims, wherein the passivation layers include a first passivation layer (121), a second passivation layer (122), and a third passivation layer (126), which are sequentially stacked on the substrate (100), the heater (108) is disposed between the first passivation layer (121) and the second passivation layer (122), and the conductor (112) is disposed between the second passivation layer (122) and the third passivation layer (126).

4. The ink-jet printhead of any one of the preceding claims, wherein a lower portion of the nozzle (104a) is formed in the plurality of the passivation layers (121, 122, 126), and an upper portion of the nozzle (104b) is formed in the heat dissipating layer (128).

5. The ink-jet printhead of claim 4, wherein the upper portion of the nozzle (104b) formed in the heat dissipating layer (128) has a tapered shape such that a diameter thereof becomes smaller in the direction of an outlet.

6. The ink-jet printhead of any one of the preceding claims, wherein the heat dissipating layer (128) is formed of at least one metallic layer, and each of the metallic layers is formed of at least one material selected from the group consisting of Ni, Cu, Al, and Au.

7. The ink-jet printhead of any one of the preceding claims, wherein the heat dissipating layer (128) is formed to a thickness of about 10-100 μm by electroplating.

8. The ink-jet printhead of any one of the preceding claims, wherein a seed layer (127) for electroplating the heat dissipating layer is formed on the passivation layers.

9. The ink-jet printhead of claim 8, wherein the seed layer (127) is formed of at least one metallic layer, and each of the metallic layers is formed of at least one material selected from the group consisting of Cu, Cr, Ti, Au, and Ni.

10. A method for manufacturing an ink-jet printhead, the method comprising:

forming a sacrificial layer (250) having a predetermined depth on a surface of a substrate (100);
sequentially stacking a plurality of passivation layers (121, 122, 126) on the substrate (100) on which the sacrificial layer (250) is formed and forming a heater (108) and a conductor (112) connected to the heater between the passivation layers (121, 122, 126);
forming a heat dissipating layer of metal (128) on the passivation layers (121, 122, 126) and forming a nozzle (104) through which ink is ejected through the heat dissipating layer (128) and the passivation layers (121, 122, 126) to expose the sacrificial layer (250);
forming a manifold (102) for supplying ink on a rear surface of the substrate (100);
removing the sacrificial layer (250) to form an ink chamber (106) and an ink passage (105), the ink passage (105) being formed parallel to the surface of the substrate (100) and in the same plane as the ink chamber (106); and
connecting the manifold (102) and the ink passage (105).

11. The method of claim 10, wherein forming the sacrificial layer (250) comprises:

etching the surface of the substrate (100) to form a groove having a predetermined depth;
oxidizing the surface of the substrate (100) in which the groove is formed to form an oxide layer (140); and
filling the groove with a predetermined material (250) and planarizing the surface of the substrate (100).

12. The method of claim 11, wherein filling groove with the predetermined material (250) is performed by epitaxially growing poly silicon in the groove.

13. The method of claim 10, wherein forming the sacrificial layer (250') comprises:

forming a trench (340) exposing an insulating layer (320) in a predetermined shape in an upper silicon substrate (330) of a silicon-on-insulator substrate (300); and
filling the trench (340) with a predetermined material (370).

14. The method of claim 13, wherein the predetermined material (370) is silicon oxide.

15. The method of any one of claims 10 to 14, wherein forming the passivation layers (121, 122, 126) comprises:

forming a first passivation layer (121) on a surface of the substrate (100) on which the sacrificial layer (250) is formed;
forming the heater (108) on the first passivation layer (121);
forming a second passivation layer (122) on the first passivation layer (121) and the heater (108);
forming the conductor (112) on the second passivation layer (122); and
forming a third passivation layer (126) on the second passivation layer (122) and the conductor (112).

16. The method of any one of claims 10 to 15, wherein the heat dissipating layer (128) is formed of at least one metallic layer, and each of the metallic layers is formed by electroplating at least one material selected from the group consisting of Ni, Cu, Al, and Au.

17. The method of any one of claims 10 to 16, wherein the heat dissipating layer (128) is formed to a thickness of 10-100 μm.

18. The method of any one of claims 10 to 17, wherein forming the heat dissipating layer (128) and the nozzle (104) comprises:

etching the passivation layers (121, 122, 126) formed on the sacrificial layer (250) to form a lower nozzle (104a);
forming a lower plating mold (350) inside the lower nozzle (104a);
forming an upper plating mold (450) having a predetermined shape for forming the upper nozzle (104b) on the lower plating mold (350);
forming the heat dissipating layer (128) on the passivation layers (121, 122, 126) by electroplating; and
removing the upper and lower plating molds (350, 450) to form the nozzle (104) comprising the upper nozzle (1 04b) and the lower nozzle (104a).

19. The method of any one of claims 10 to 17, wherein the forming the heat dissipating layer (128) and the nozzle (104) comprises:

etching the passivation layers (121, 122, 126) formed on the sacrificial layer (250) to form a lower nozzle (104a);
forming a plating mold (450) having a predetermined shape for forming an upper nozzle vertically from the inside of the lower nozzle;
forming the heat dissipating layer (128) on the passivation layers (121, 122, 126) by electroplating; and
removing the plating mold (450) and forming the nozzle (104) comprising the upper nozzle (104b) and the lower nozzle (104a).

20. The method of claim 18 or 19, wherein the plating mold or plating molds (350, 450) is/are formed of a photoresist or a photosensitive polymer.

21. The method of any one of claims 18 to 20, wherein the lower nozzle (104a) is formed by dry etching the passivation layers (121, 122, 126) by reactive ion etching.

22. The method of any one of claims 18 to 21, wherein forming the heat dissipating layer (128) and the nozzle (104) further comprises forming a seed layer (127) for electroplating the heat dissipating layer (128) on the passivation layers (121, 122, 126).

23. The method of claim 22, wherein the seed layer (127) is formed of at least one metallic layer, and each of the metallic layers is formed by depositing at least one metallic material selected from the group consisting of Cu, Cr, Ti, Au, and Ni.

24. The method of any one of claims 18 to 23, wherein after forming the heat dissipating layer (128), forming the heat dissipating layer (128) and the nozzle (104) further comprises planarizing the top surface of the heat dissipating layer (128) by a chemical mechanical polishing process.

Patentansprüche

1. Tintenstrahldruckkopf umfassend:

ein Substrat (100), eine auf einer Oberfläche des Substrats (100) ausgebildete Tintenkammer (106) zum Befüllen mit auszustoßender Tinte, einen auf einer Rückseite des Substrats (100) ausgebildeten Verteiler (102), der Tinte zur Tintenkammer (106) zuführt, und einen parallel zur Oberfläche des Substrats (100) und in derselben Ebene wie die Tintenkammer (106) ausgebildeten Tintendurchgang (105), der die Tintenkammer (106) und den Verteiler (102) verbindet,
eine Düsenplatte (120), die eine Mehrzahl von Passivierungsschichten (121, 122, 126) auf dem Substrat (100) aufgeschichtet und aus einem Isoliermaterial gebildet aufweist, durch das hindurch eine Düse (104) verbunden mit der Tintenkammer (106) ausgebildet ist, und
eine Erwärmungseinrichtung (108) und einen Leiter (112), die zwischen den Passivierungsschichten (121, 122, 126) der Düsenplatte (120) angeordnet sind, wobei die Erwärmungseinrichtung (108) auf der Tintenkammer (106) positioniert ist und Tinte in der Tintenkammer (106) erwärmt und der Leiter (112) einen Strom an die Erwärmungseinrichtung (108) anlegt,
wobei der Tintenstrahldruckkopf **dadurch gekennzeichnet ist, dass** die Düsenplatte (120) ferner eine Wärmeableitschicht (128) aufweist, die auf den Passivierungsschichten (121, 122, 126) ausgebildet ist, wobei die Wärmeableitschicht (128) aus einem metallischen Material mit einer guten Wärmeleitfähigkeit gebildet ist.

2. Tintenstrahldruckkopf nach Anspruch 1, wobei der Tintendurchgang (105) mindestens einen mit der Tintenkammer (106) verbundenen Tintenkanal (105a) und eine Tintenzufuhröffnung (105b) aufweist, die den Tintenkanal (105a) mit dem Verteiler (102) verbindet.

3. Tintenstrahldruckkopf nach einem der vorhergehenden Ansprüche, wobei die Passivierungsschichten eine erste Passivierungsschicht (121), eine zweite Passivierungsschicht (122) und eine dritte Passivierungsschicht (126) beinhalten, die sequentiell auf dem Substrat (100) aufgeschichtet sind, wobei die Erwärmungseinrichtung (108) zwischen der ersten Passivierungsschicht (121) und der zweiten Passivierungsschicht (122) angeordnet ist und der Leiter (112) zwischen der zweiten Passivierungsschicht (122) und der dritten Passivierungsschicht (126) angeordnet ist.

4. Tintenstrahldruckkopf nach einem der vorhergehenden Ansprüche, wobei ein unterer Teil der Düse (104a) in der Mehrzahl von Passivierungsschichten (121, 122, 126) ausgebildet ist und ein oberer Teil der Düse (104b) in der Wärmeableitschicht (128) ausgebildet ist.

5. Tintenstrahldruckkopf nach Anspruch 4, wobei der in der Wärmeableitschicht (128) ausgebildete obere Teil der Düse (104b) eine verjüngte Form derart aufweist, dass sein Durchmesser in Richtung zu einem Auslass kleiner wird.

6. Tintenstrahldruckkopf nach einem der vorhergehenden Ansprüche, wobei die Wärmeableitschicht (128) aus mindestens einer metallischen Schicht gebildet ist und jede der metallischen Schichten aus mindestens einem Material ausgewählt aus der Gruppe bestehend aus Ni, Cu, Al und Au gebildet ist.

7. Tintenstrahldruckkopf nach einem der vorhergehenden Ansprüche, wobei die Wärmeableitschicht (128) durch Elektroplattieren auf eine Dicke von ungefähr 10 bis 100 μm ausgebildet ist.

8. Tintenstrahldruckkopf nach einem der vorhergehenden Ansprüche, wobei eine Keimschicht (127) für das Elektroplattieren der Wärmeableitschicht auf den Passivierungsschichten ausgebildet ist.

9. Tintenstrahldruckkopf nach Anspruch 8, wobei die

Keimschicht (127) aus mindestens einer metallischen Schicht gebildet ist und jede der metallischen Schichten aus mindestens einem Material ausgewählt aus der Gruppe bestehend aus Cu, Cr, Ti, Au und Ni gebildet ist.

10. Verfahren zur Herstellung eines Tintenstrahldruckkopfs, wobei das Verfahren umfasst:

Ausbilden einer Opferschicht (250) mit einer bestimmten Tiefe auf einer Oberfläche eines Substrats (100),
sequentielles Aufschichten einer Mehrzahl von Passivierungsschichten (121, 122, 126) auf dem Substrat (100), auf dem die Opferschicht (250) ausgebildet ist, und Ausbilden einer Erwärmungseinrichtung (108) und eines mit der Erwärmungseinrichtung verbundenen Leiters (112) zwischen den Passivierungsschichten (121, 122, 126),
Ausbilden einer Wärmeableitschicht aus Metall (128) auf den Passivierungsschichten (121, 122, 126) und Ausbilden einer Düse (104), durch die Tinte ausgestoßen wird, durch die Wärmeableitschicht (128) und die Passivierungsschichten (121, 122, 126) hindurch, so dass die Opferschicht (250) freigelegt wird,
Ausbilden eines Verteilers (102) zum Zuführen von Tinte auf einer Rückseite des Substrats (100),
Entfernen der Opferschicht (250) zum Ausbilden einer Tintenkammer (106) und eines Tintendurchgangs (105), wobei der Tintendurchgang (105) parallel zur Oberfläche des Substrats (100) und in derselben Ebene wie die Tintenkammer (106) ausgebildet wird, und
Verbinden des Verteilers (102) mit dem Tintendurchgang (105).

11. Verfahren nach Anspruch 10, wobei das Ausbilden der Opferschicht (250) umfasst:

Ätzen der Oberfläche des Substrats (100), so dass eine Vertiefung mit einer vorgegebenen Tiefe ausgebildet wird,
Oxidieren der Oberfläche des Substrats (100), in der die Vertiefung ausgebildet ist, so dass eine Oxidschicht (140) ausgebildet wird, und
Füllen der Vertiefung mit einem vorgegebenen Material (250) und Planarisieren der Oberfläche des Substrats (100).

12. Verfahren nach Anspruch 11, wobei das Füllen der Vertiefung mit dem vorgegebenen Material (250) durch epitaktisches Aufwachsen von Polysilicium in der Vertiefung durchgeführt wird.

13. Verfahren nach Anspruch 10, wobei das Ausbilden der Opferschicht (250') umfasst:

Ausbilden eines Grabens (340), der eine Isolierschicht (320) freilegt, in einer vorgegebenen Form in einem oberen Siliciumsubstrat (330) eines Silicium-auf-Isolator-Substrats (300) und Füllen des Grabens (340) mit einem vorgegebenen Material (370).

14. Verfahren nach Anspruch 13, wobei das vorgegebene Material (370) Siliciumoxid ist.

15. Verfahren nach einem der Ansprüche 10 bis 14, wobei das Ausbilden der Passivierungsschichten (121, 122, 126) umfasst:

Ausbilden einer ersten Passivierungsschicht (121) auf einer Oberfläche des Substrats (100), auf der die Opferschicht (250) ausgebildet ist,
Ausbilden der Erwärmungseinrichtung (108) auf der ersten Passivierungsschicht (121),
Ausbilden einer zweiten Passivierungsschicht (122) auf der ersten Passivierungsschicht (121) und der Erwärmungseinrichtung (108),
Ausbilden des Leiters (112) auf der zweiten Passivierungsschicht (122) und
Ausbilden einer dritten Passivierungsschicht (126) auf der zweiten Passivierungsschicht (122) und dem Leiter (112).

16. Verfahren nach einem der Ansprüche 10 bis 15, wobei die Wärmeableitschicht (128) aus mindestens einer metallischen Schicht gebildet wird und jede der metallischen Schichten durch Elektroplattieren mindestens eines Materials ausgewählt aus der Gruppe bestehend aus Ni, Cu, Al und Au gebildet wird.

17. Verfahren nach einem der Ansprüche 10 bis 16, wobei die Wärmeableitschicht (128) auf eine Dicke von 10 bis 100 μm ausgebildet wird.

18. Verfahren nach einem der Ansprüche 10 bis 17, wobei das Ausbilden der Wärmeableitschicht (128) und der Düse (104) umfasst:

Ätzen der auf der Opferschicht (250) ausgebildeten Passivierungsschichten (121, 122, 126) zum Ausbilden einer unteren Düse (1 04a),
Ausbilden einer unteren Plattierungsform (350) im Inneren der unteren Düse (104a),
Ausbilden einer oberen Plattierungsform (450) mit einer vorgegebenen Form zum Ausbilden einer oberen Düse (104b) auf der unteren Plattierungsform (350),
Ausbilden der Wärmeableitschicht (128) auf den Passivierungsschichten (121, 122, 126) durch Elektroplattieren und
Entfernen der oberen und unteren Plattierungs-

form (350, 450) zum Ausbilden der Düse (104), die die obere Düse (104a) und die untere Düse (104b) umfasst.

19. Verfahren nach einem der Ansprüche 10 bis 17, wobei das Ausbilden der Wärmeableitschicht (128) und der Düse (104) umfasst:

Ätzen der auf der Opferschicht (250) ausgebildeten Passivierungsschichten (121, 122, 126) zum Ausbilden einer unteren Düse (104a),
Ausbilden einer Plattierungsform (450) mit einer vorgegebenen Form zum Ausbilden einer oberen Düse vertikal aus dem Inneren der unteren Düse,
Ausbilden der Wärmeableitschicht (128) auf den Passivierungsschichten (121, 122, 126) durch Elektroplattieren und
Entfernen der Plattierungsform (450) und Ausbilden der Düse (104), die die obere Düse (1 04b) und die untere Düse (104a) umfasst.

20. Verfahren nach Anspruch 18 oder 19, wobei die Plattierungsform oder Plattierungsformen (350, 450) aus einem Photoresist oder einem photosensitiven Polymer gebildet wird/werden.

21. Verfahren nach einem der Ansprüche 18 bis 20, wobei die untere Düse (104a) durch Trockenätzen der Passivierungsschichten (121, 122, 126) durch reaktives Ionenätzen gebildet wird.

22. Verfahren nach einem der Ansprüche 18 bis 21, wobei das Ausbilden der Wärmeableitschicht (128) und der Düse (104) ferner Ausbilden einer Keimschicht (127) für das Elektroplattieren der Wärmeableitschicht (128) auf den Passivierungsschichten (121, 122, 126) umfasst.

23. Verfahren nach Anspruch 22, wobei die Keimschicht (127) aus mindestens einer metallischen Schicht gebildet wird und jede der metallischen Schichten durch Abscheiden mindestens eines metallischen Materials ausgewählt aus der Gruppe bestehend aus Cu, Cr, Ti, Au und Ni gebildet wird.

24. Verfahren nach einem der Ansprüche 18 bis 23, wobei das Ausbilden der Wärmeableitschicht (128) und der Düse (104) nach Ausbilden der Wärmeableitschicht (128) ferner Planarisieren der Oberseite der Wärmeableitschicht (128) durch einen chemisch-mechanischen Polierprozess umfasst.

Revendications

1. Tête d'impression à jet d'encre comprenant :

un substrat (100), une chambre d'encrage (106) à remplir d'encre devant être éjectée, formée sur une surface du substrat (100), un collecteur (102) qui fournit de l'encre à la chambre d'encrage (106), formé sur une surface arrière du substrat (100), et un conduit d'encre (105) qui relie la chambre d'encrage (106) et le collecteur (102), formé parallèlement à la surface du substrat (100) et dans le même plan que la chambre d'encrage (106) ;
une plaque à buse (120), qui comprend une pluralité de couches de passivation (121, 122, 126) empilées sur le substrat (100) et formées d'un matériau isolant, à travers laquelle une buse (104) reliée à la chambre d'encrage (106) est formée ; et
un dispositif de chauffage (108) et un conducteur (112), qui sont disposés entre les couches de passivation (121, 122, 126) de la plaque à buse (120), le dispositif de chauffage (108) étant positionné sur la chambre d'encrage (106) et chauffant l'encre dans la chambre d'encrage (106), et le conducteur (112) appliquant un courant au dispositif de chauffage (108),
dans laquelle la tête d'impression à jet d'encre est **caractérisée en ce que** la plaque à buse (120) comprend en outre une couche de dissipation thermique (128) formée sur les couches de passivation (121, 122, 126), la couche de dissipation thermique (128) étant formée d'un matériau métallique ayant une bonne conductibilité thermique.

2. Tête d'impression à jet d'encre selon la revendication 1, dans laquelle le conduit d'encre (105) comprend au moins un canal d'encre (105a) relié à la chambre d'encrage (106) et un orifice d'alimentation d'encre (105b) qui relie le canal d'encre (105a) au collecteur (102).

3. Tête d'impression à jet d'encre selon l'une quelconque des revendications précédentes, dans laquelle les couches de passivation comprennent une première couche de passivation (121), une deuxième couche de passivation (122) et une troisième couche de passivation (126), qui sont empilées de manière séquentielle sur le substrat (100), dans laquelle le dispositif de chauffage (108) est disposé entre la première couche de passivation (121) et la deuxième couche de passivation (122), et dans laquelle le conducteur (112) est disposé entre la deuxième couche de passivation (122) et la troisième couche de passivation (126).

4. Tête d'impression à jet d'encre selon l'une quelconque des revendications précédentes, dans laquelle une partie inférieure de la buse (104a) est formée dans la pluralité des couches de passivation (121, 122, 126), et dans laquelle une partie supérieure de la buse (104b) est formée dans la couche de dissipation thermique (128).

5. Tête d'impression à jet d'encre selon la revendication 4, dans laquelle la partie supérieure de la buse (104b) formée dans la couche de dissipation thermique (128) a une forme effilée de telle sorte que le diamètre de celle-ci devienne plus petit dans la direction d'une sortie.

6. Tête d'impression à jet d'encre selon l'une quelconque des revendications précédentes, dans laquelle la couche de dissipation thermique (128) est formée d'au moins une couche métallique, et dans laquelle chacune des couches métalliques est formée d'au moins un matériau sélectionné parmi le groupe se composant de Ni, Cu, Al et Au.

7. Tête d'impression à jet d'encre selon l'une quelconque des revendications précédentes, dans laquelle la couche de dissipation thermique (128) est formée par galvanoplastie avec une épaisseur d'environ 10 à 100 μm.

8. Tête d'impression à jet d'encre selon l'une quelconque des revendications précédentes, dans laquelle une couche d'ensemencement (127) destinée à galvaniser la couche de dissipation thermique est formée sur les couches de passivation.

9. Tête d'impression à jet d'encre selon la revendication 8, dans laquelle la couche d'ensemencement (127) est formée d'au moins une couche métallique, et dans laquelle chacune des couches métalliques est formée d'au moins un matériau sélectionné parmi le groupe se composant de Cu, Cr, Ti, Au et Ni.

10. Procédé de fabrication d'une tête d'impression à jet d'encre, le procédé comprenant :

la formation sur une surface du substrat (100) d'une couche sacrificielle (250) ayant une profondeur prédéterminée ;
l'empilement de manière séquentielle d'une pluralité de couches de passivation (121, 122, 126) sur le substrat (100) sur lequel la couche sacrificielle (250) est formée, et la formation d'un dispositif de chauffage (108) et d'un conducteur (112) relié au dispositif de chauffage entre les couches de passivation (121, 122, 126) ;
la formation d'une couche de dissipation thermique en métal (128) sur les couches de passivation (121, 122, 126) et la formation d'une buse (104) par laquelle l'encre est éjectée à travers la couche de dissipation thermique (128) et les couches de passivation (121, 122, 126) pour exposer la couche sacrificielle (250) ;
la formation d'un collecteur (102) destiné à fournir de l'encre sur une surface arrière du substrat (100) ;
le retrait de la couche sacrificielle (250) pour former une chambre d'encrage (106) et un conduit d'encre (105), le conduit d'encre (105) étant formé parallèlement à la surface du substrat (100) et dans le même plan que la chambre d'encrage (106) ; et
la liaison du collecteur (102) au conduit d'encre (105).

11. Procédé selon la revendication 10, dans lequel la formation de la couche sacrificielle (250) comprend :

le gravage de la surface du substrat (100) pour former une rainure ayant une profondeur prédéterminée ;
l'oxydation de la surface du substrat (100) dans laquelle la rainure est formée pour former une couche d'oxyde (140) ; et
le remplissage de la rainure avec un matériau prédéterminé (250) et la planarisation de la surface du substrat (100).

12. Procédé selon la revendication 11, dans lequel le remplissage de la rainure avec le matériau prédéterminé (250) est effectué en faisant croître par épitaxie du polysilicium dans la rainure.

13. Procédé selon la revendication 10, dans lequel la formation de la couche sacrificielle (250') comprend :

la formation d'une tranchée (340) exposant une couche isolante (320) dans une forme prédéterminée dans un substrat supérieur en silicium (330) d'un substrat en silicium sur isolant (300) ; et
le remplissage de la tranchée (340) avec un matériau prédéterminé (370).

14. Procédé selon la revendication 13, dans lequel le matériau prédéterminé (370) est de l'oxyde de silicium.

15. Procédé selon l'une quelconque des revendications 10 à 14, dans lequel la formation des couches de passivation (121, 122, 126) comprend :

la formation d'une première couche de passivation (121) sur la surface du substrat (100) sur laquelle la couche sacrificielle (250) est formée ;
la formation du dispositif de chauffage (108) sur la première couche de passivation (121) ;
la formation d'une deuxième couche de passivation (122) sur la première couche de passivation (121) et le dispositif de chauffage (108) ;

la formation du conducteur (112) sur la deuxième couche de passivation (122) ; et
la formation d'une troisième couche de passivation (126) sur la deuxième couche de passivation (122) et le conducteur (112).

16. Procédé selon l'une quelconque des revendications 10 à 15, dans lequel la couche de dissipation thermique (128) est formée d'au moins une couche métallique, et dans lequel chacune des couches métalliques est formée en galvanisant au moins un matériau sélectionné parmi le groupe se composant de Ni, Cu, Al et Au.

17. Procédé selon l'une quelconque des revendications 10 à 16, dans lequel la couche de dissipation thermique (128) est formée avec une épaisseur de 10 à 100 μm.

18. Procédé selon l'une quelconque des revendications 10 à 17, dans lequel la formation de la couche de dissipation thermique (128) et de la buse (104) comprend :

Le gravage des couches de passivation (121, 122, 126) formées sur la couche sacrificielle (250) pour former une buse inférieure (104a) ;
la formation d'un moule de placage inférieur (350) à l'intérieur de la buse inférieure (104a) ;
la formation d'un moule de placage supérieur (450) ayant une forme prédéterminée destiné à former la buse supérieure (104b) sur le moule de placage inférieur (350) ;
la formation de la couche de dissipation thermique (128) sur les couches de passivation (121, 122, 126) par galvanoplastie ; et
le retrait des moules de placage supérieur et inférieur (350, 450) pour former la buse (104) comprenant la buse supérieure (104b) et la buse inférieure (104a).

19. Procédé selon l'une quelconque des revendications 10 à 17, dans lequel la formation de la couche de dissipation thermique (128) et de la buse (104) comprend :

le gravage des couches de passivation (121, 122, 126) formées sur la couche sacrificielle (250) pour former une buse inférieure (104a) ;
la formation d'un moule de placage (450) ayant une forme prédéterminée destiné à former une buse supérieure verticalement à partir de l'intérieur de la buse inférieure ;
la formation de la couche de dissipation thermique (128) sur les couches de passivation (121, 122, 126) par galvanoplastie ; et
le retrait du moule de placage (450) et la formation de la buse (104) comprenant la buse supérieure (104b) et la buse inférieure (104a).

20. Procédé selon la revendication 18 ou 19, dans lequel le ou les moules de placage (350, 450) est/sont formé(s) d'un polymère photorésistant ou photosensible.

21. Procédé selon l'une quelconque des revendications 18 à 20, dans lequel la buse inférieure (104a) est formée par gravure sèche des couches de passivation (121, 122, 126) par gravage ionique réactif.

22. Procédé selon l'une quelconque des revendications 18 à 21, dans lequel la formation de la couche de dissipation thermique (128) et de la buse (104) comprend en outre la formation d'une couche d'ensemencement (127) destinée à galvaniser la couche de dissipation thermique (128) sur les couches de passivation (121, 122, 126).

23. Procédé selon la revendication 22, dans lequel la couche d'ensemencement (127) est formée d'au moins une couche métallique, et dans lequel chacune des couches métalliques est formée en déposant au moins un matériau métallique sélectionné parmi le groupe se composant de Cu, Cr, Ti, Au et Ni.

24. Procédé selon l'une quelconque des revendications 18 à 23, comprenant en outre, après la formation de la couche de dissipation thermique (128), la formation de la couche de dissipation thermique (128) et de la buse (104), la planarisation de la surface supérieure de la couche de dissipation thermique (128) grâce à un procédé de polissage chimico-mécanique.

FIG. 1 (PRIOR ART)

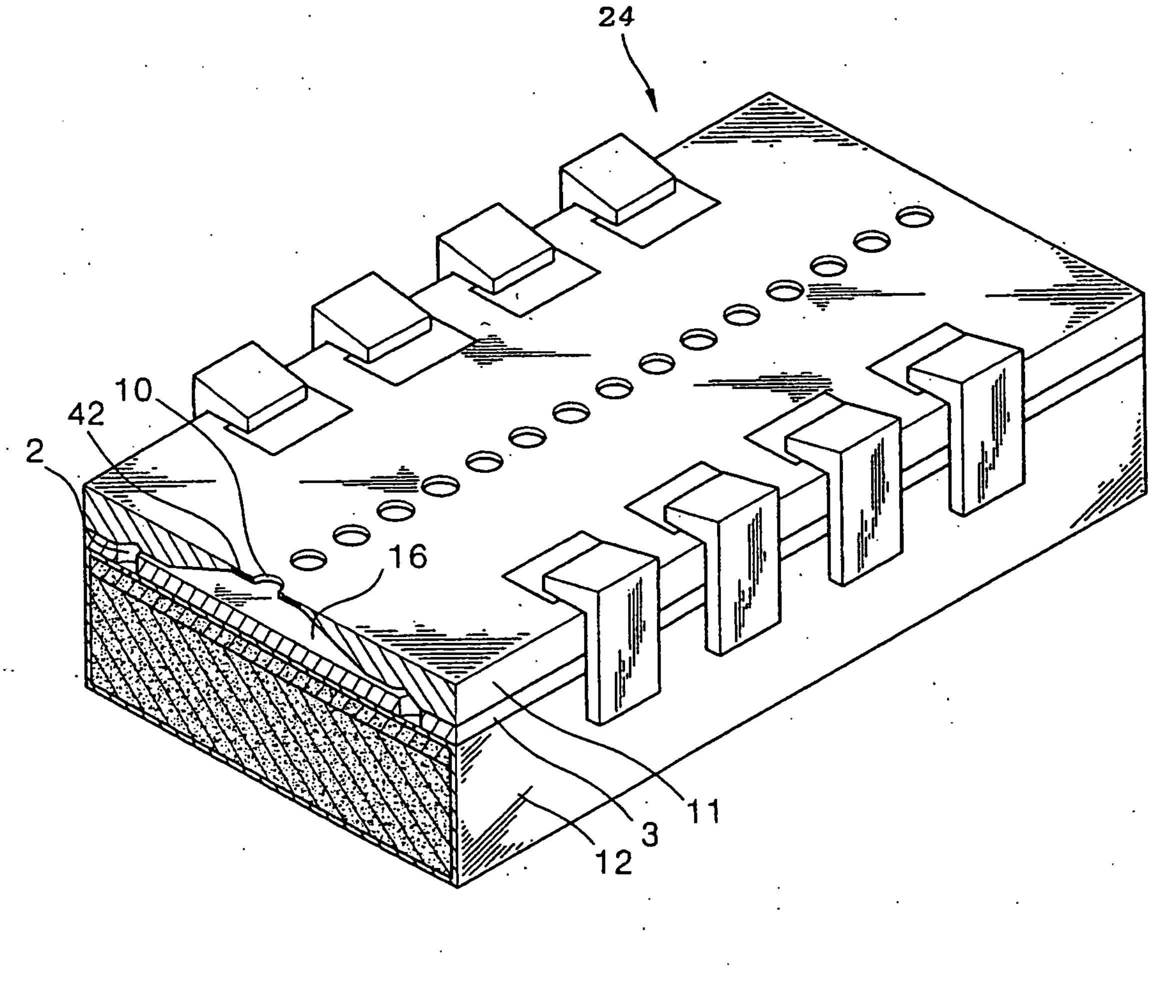


FIG. 2 (PRIOR ART)

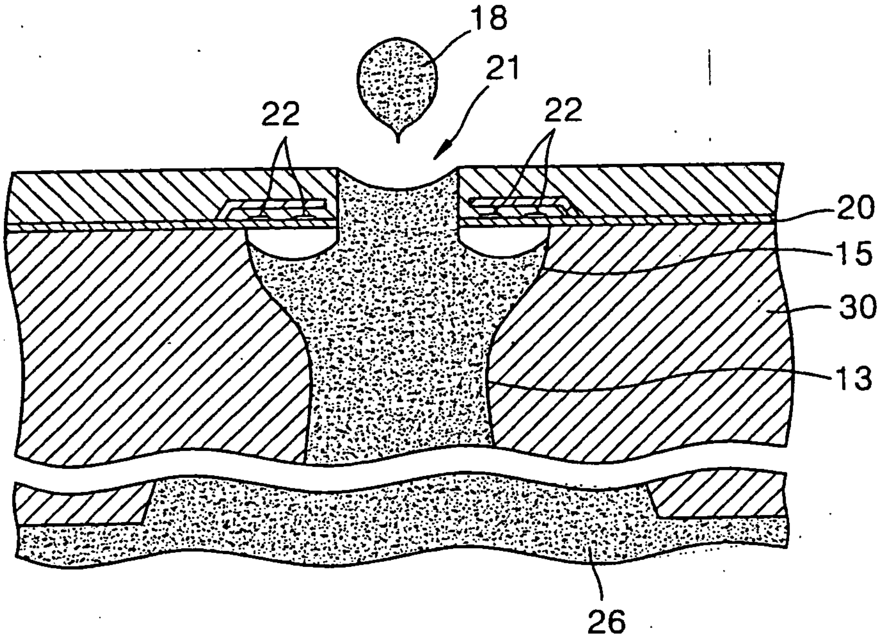


FIG. 3 (PRIOR ART)

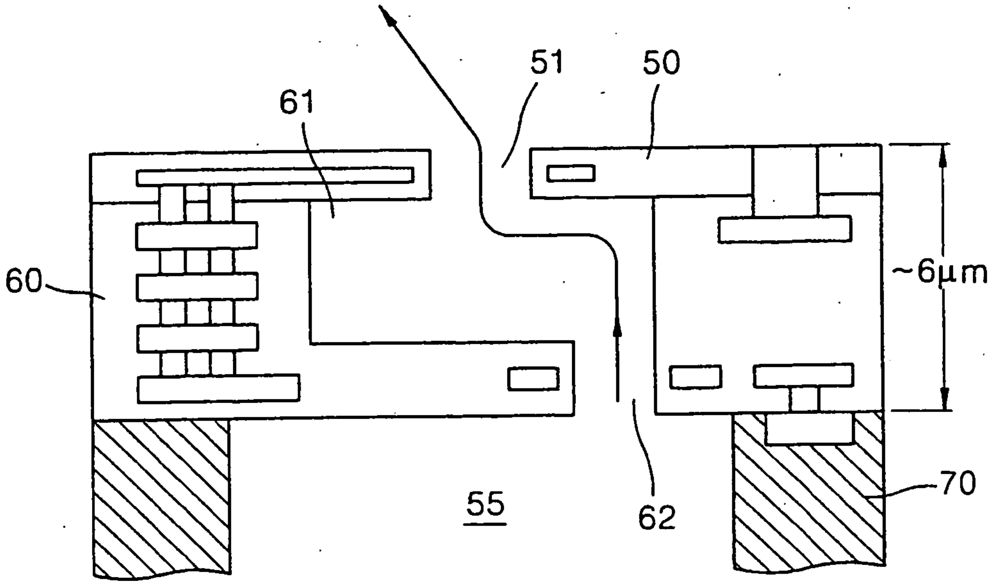


FIG. 4

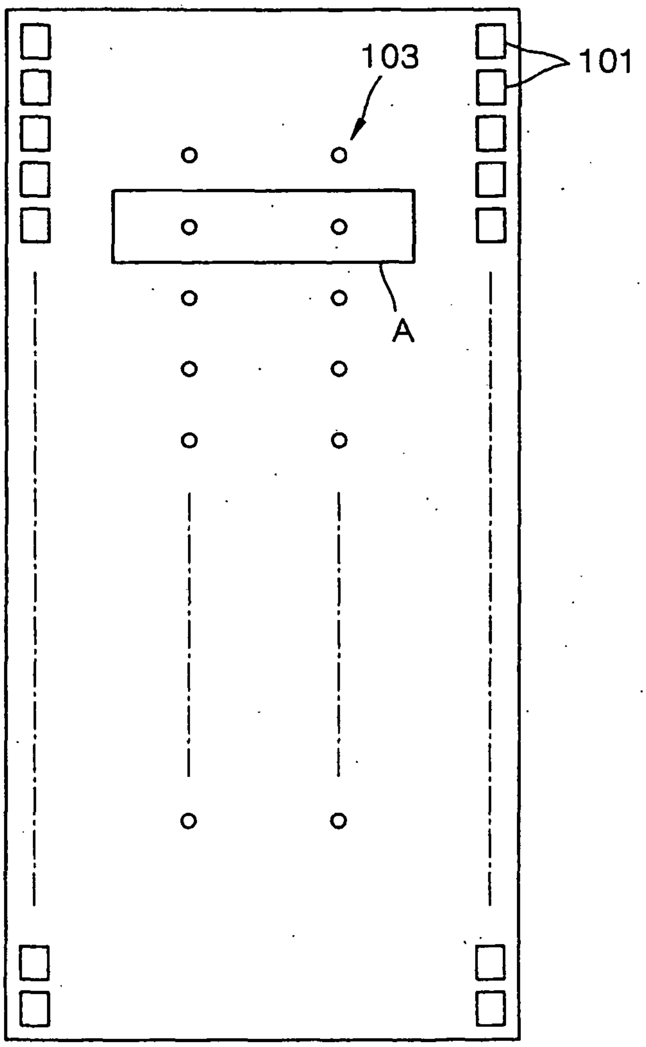


FIG. 5

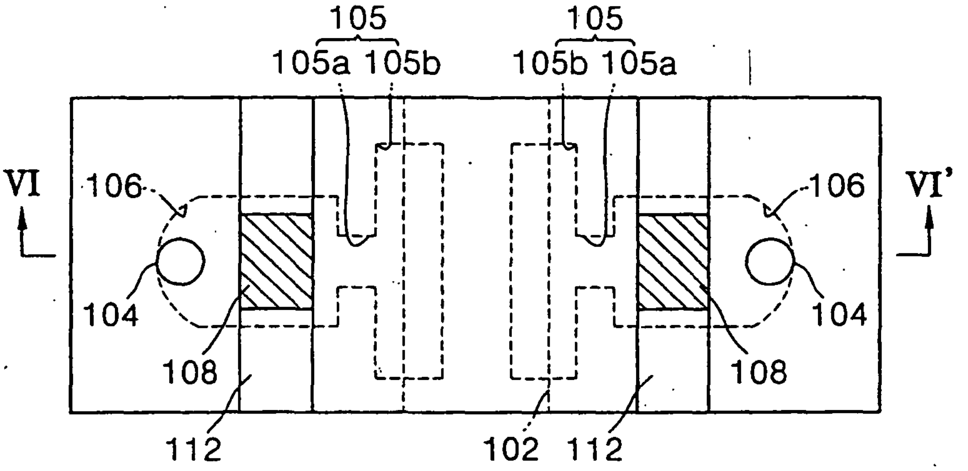
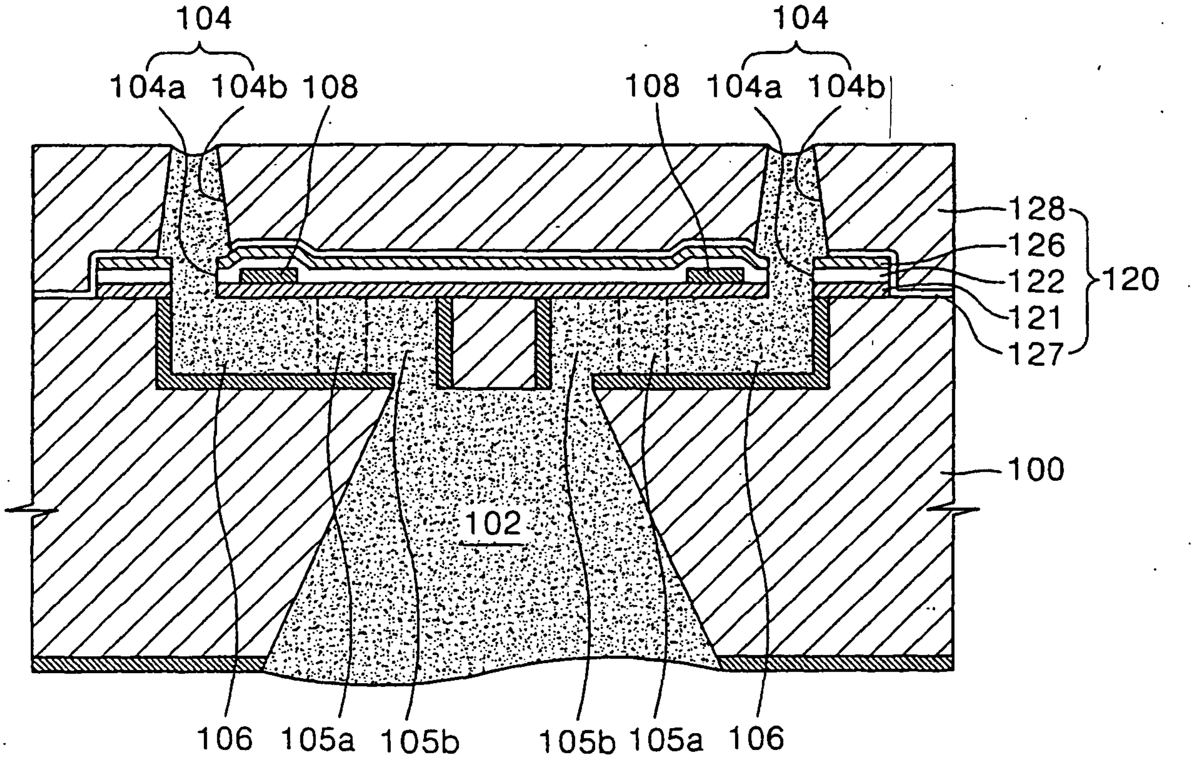

105
105a 105b
105
105b 105a
VI
106
106
VI'
104
104
108
108
112
102
112

FIG. 6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128
126
122
120
121
127
100
102
106 105a 105b
105b 105a 106

FIG. 7

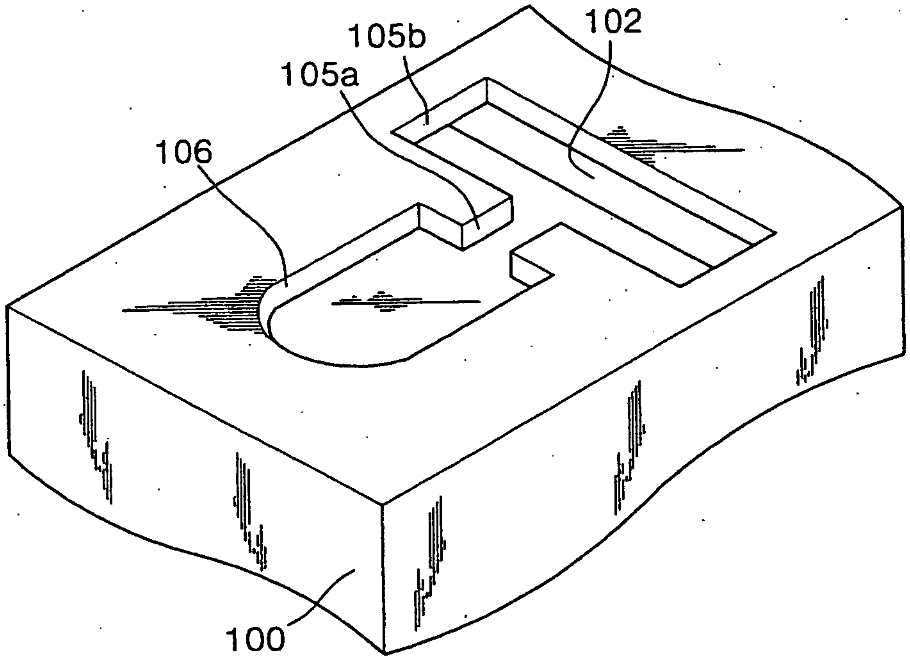


FIG. 8

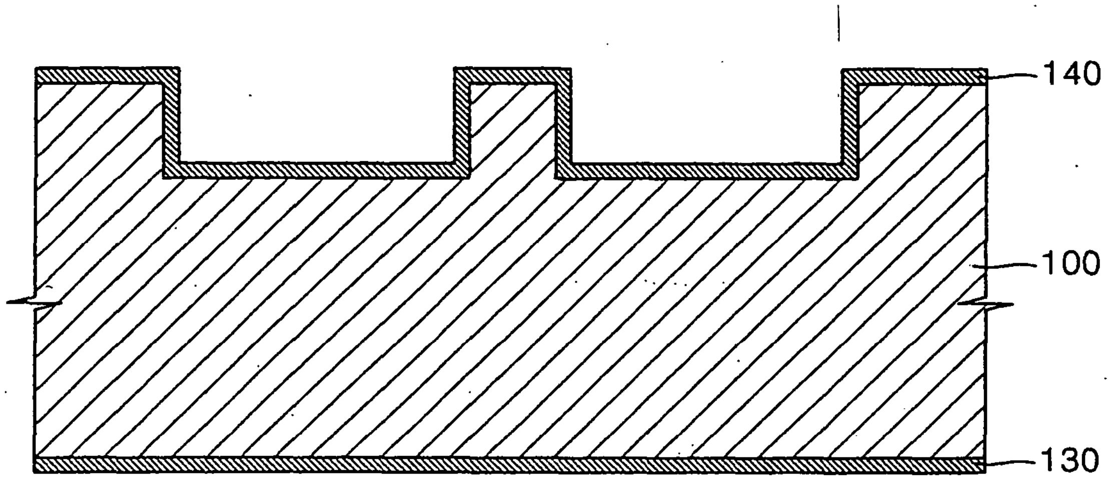


FIG. 9

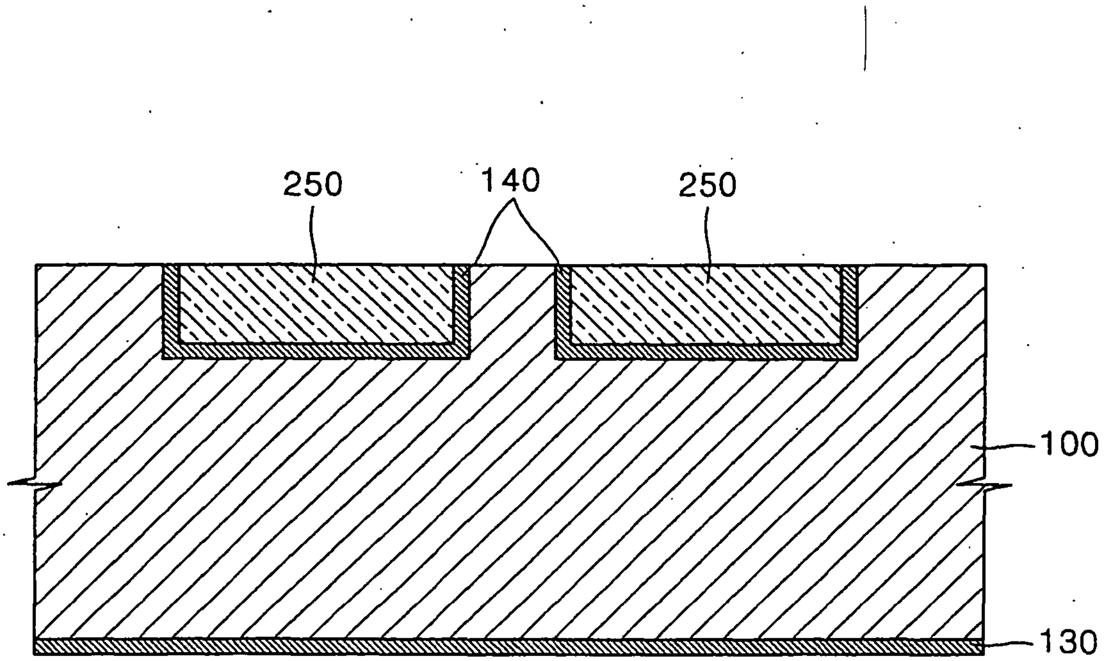
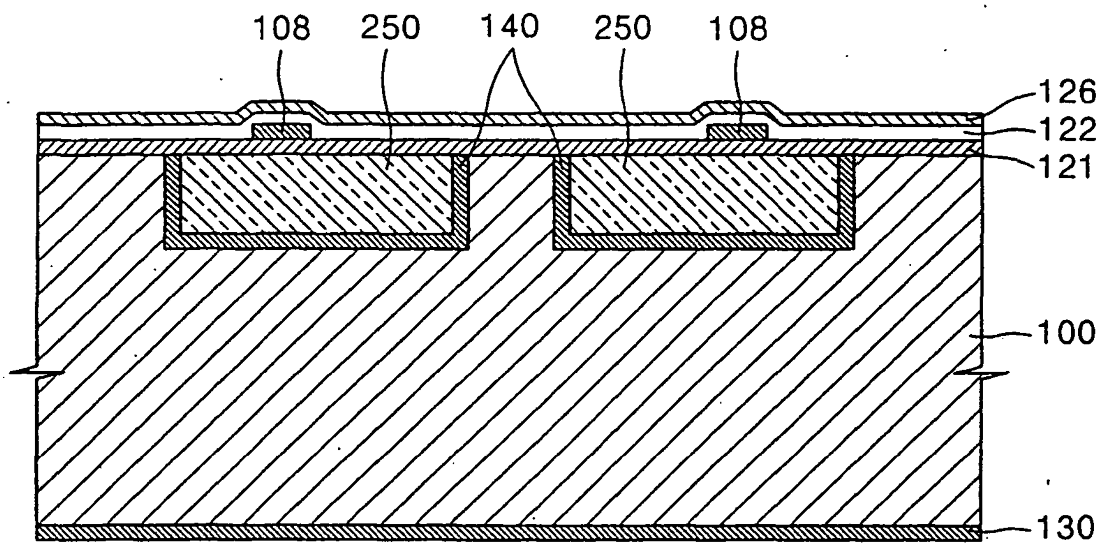


FIG. 10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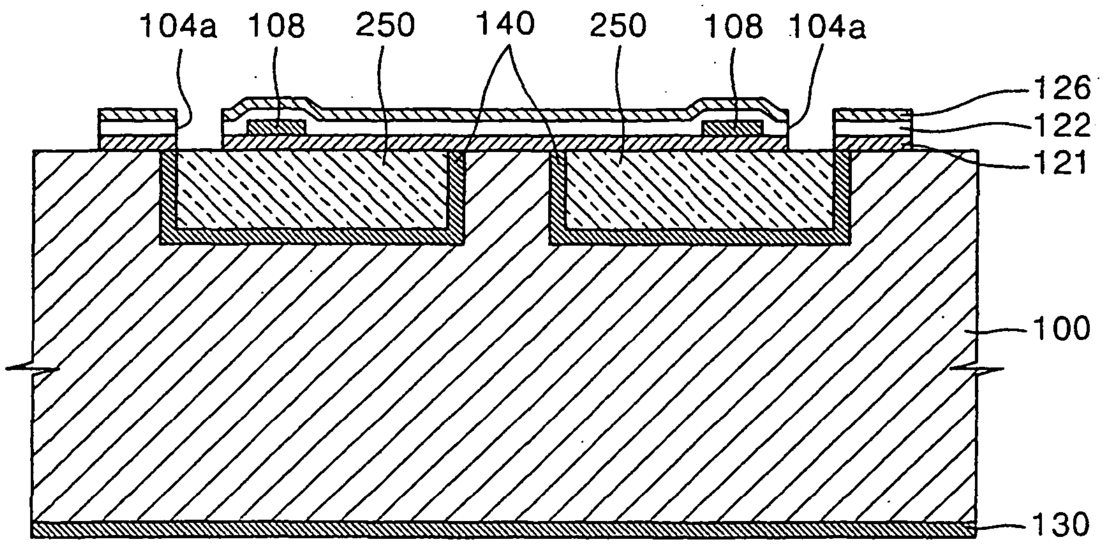
140
250
108
126
122
121
100
130

FIG. 11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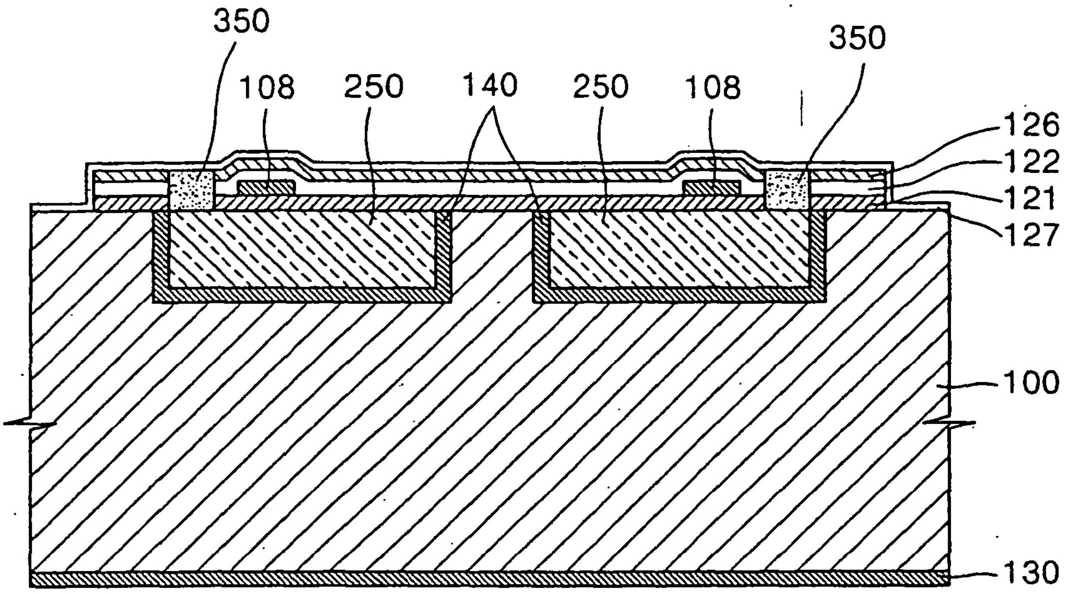
104a
126
122
121
100
130

FIG. 12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121
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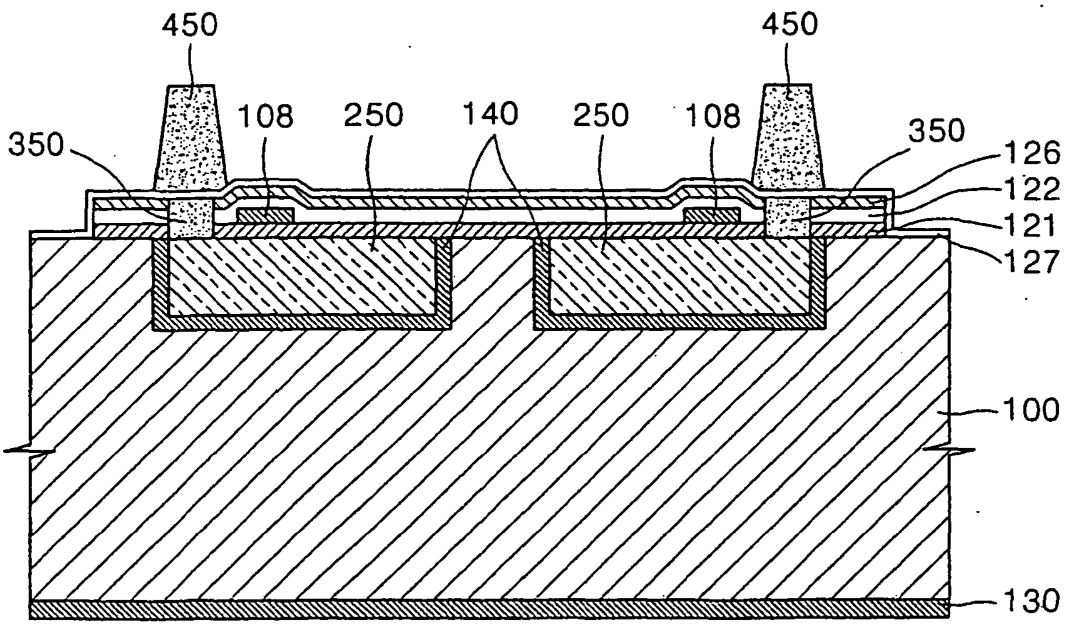
130

FIG. 13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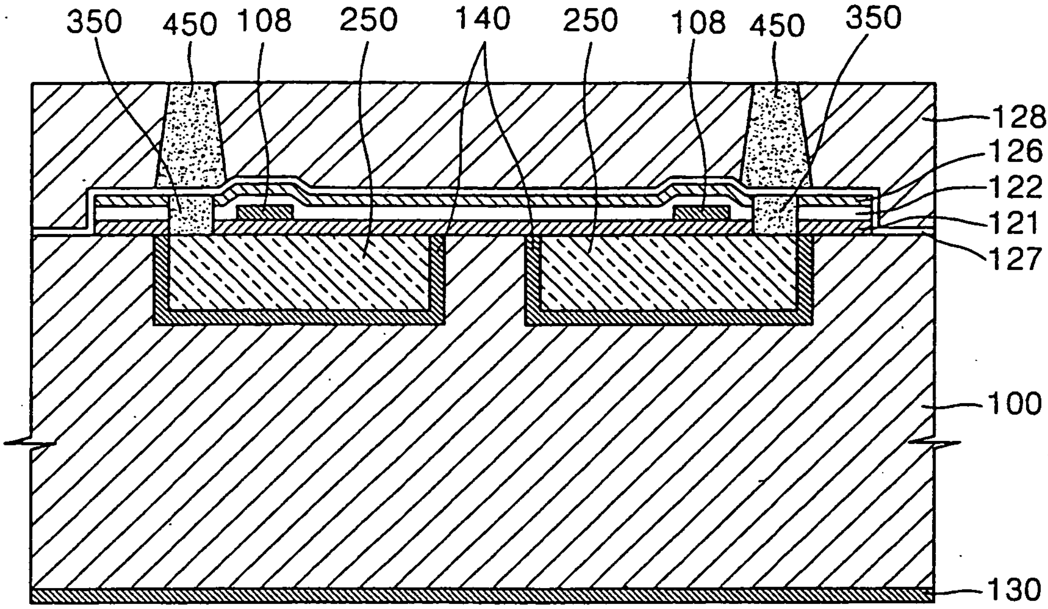
121
127
100
130

FIG. 14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450
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121
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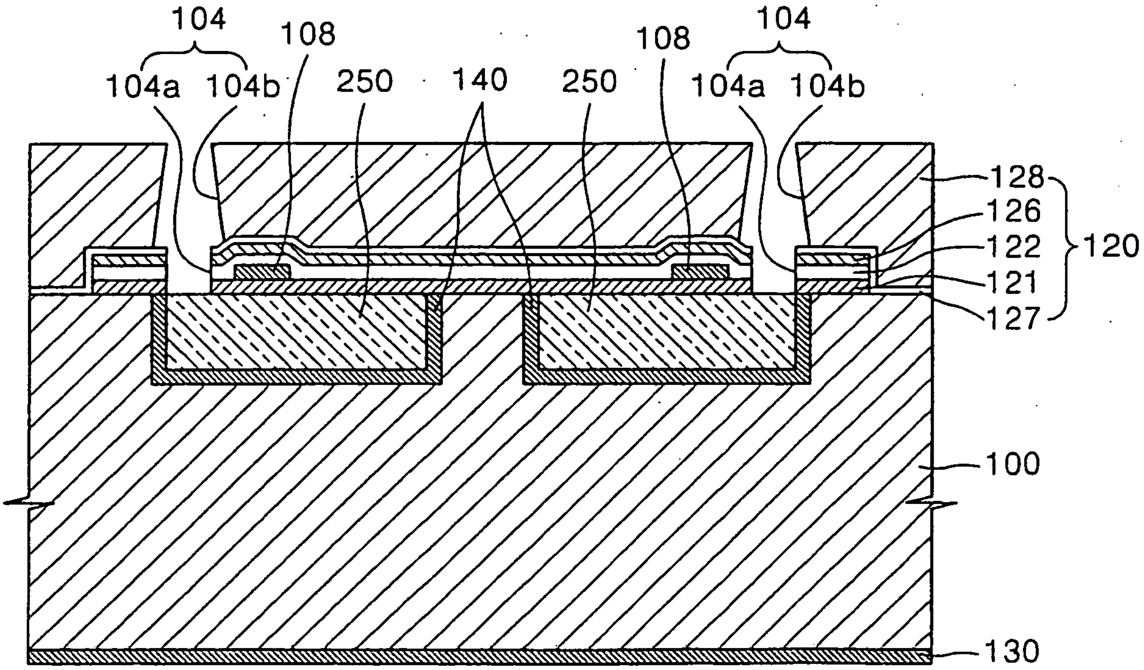
100
130

FIG. 15


104
104a
104b
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140
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108
104
104a
104b
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122
121
127
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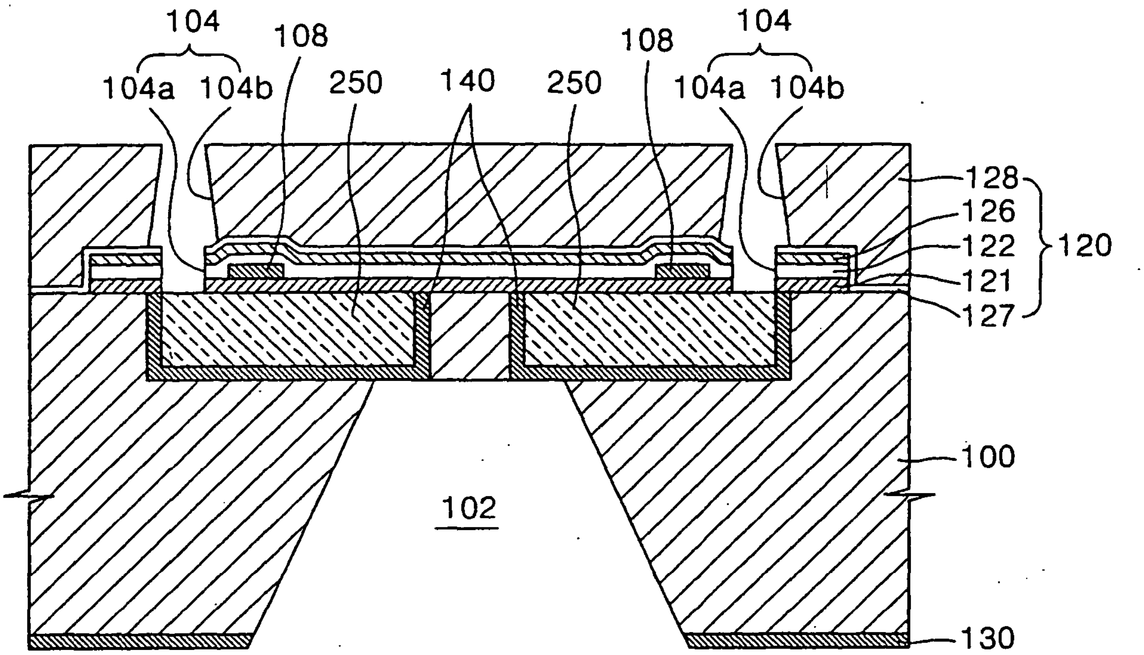
100
130

FIG. 16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104
104a
104b
128
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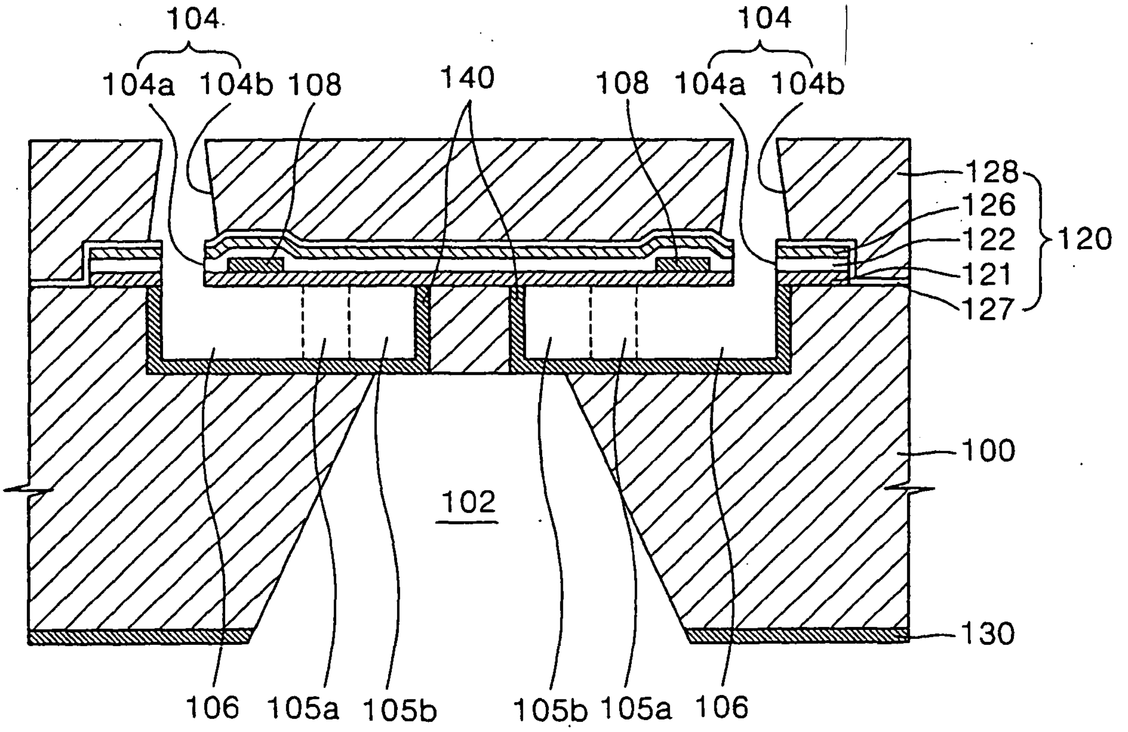
130

FIG. 17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104a
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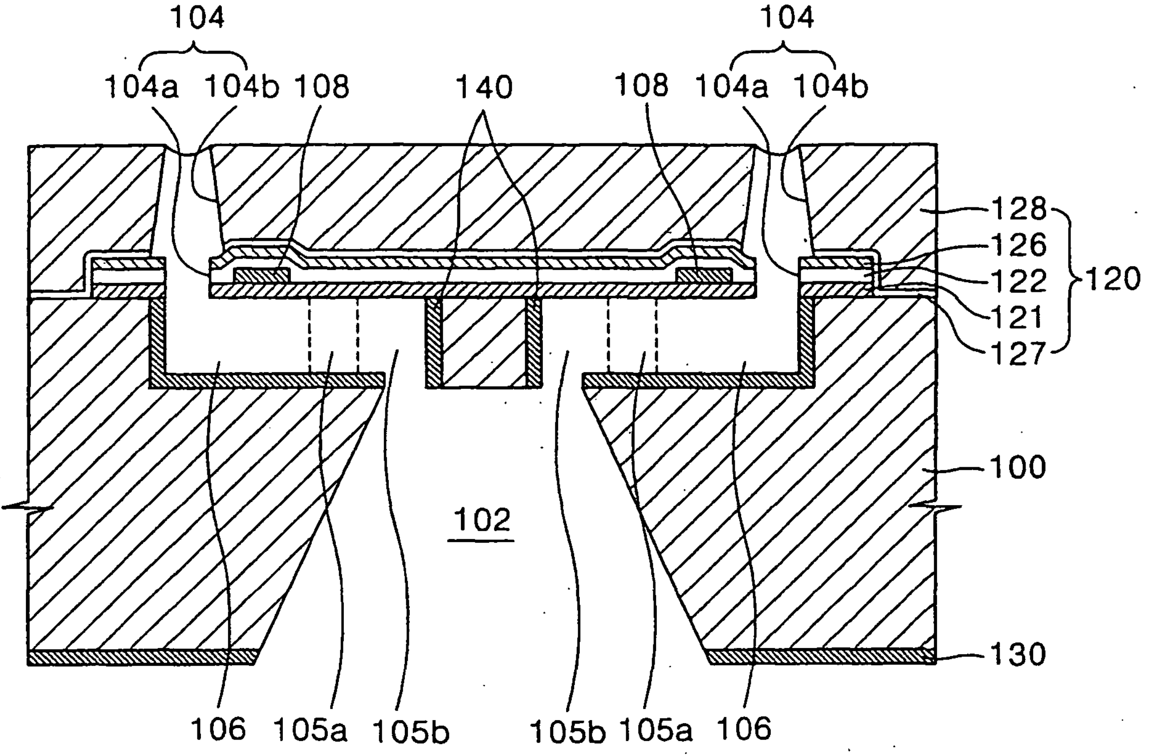
106
105a
105b
105b
105a
106

FIG. 18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105b
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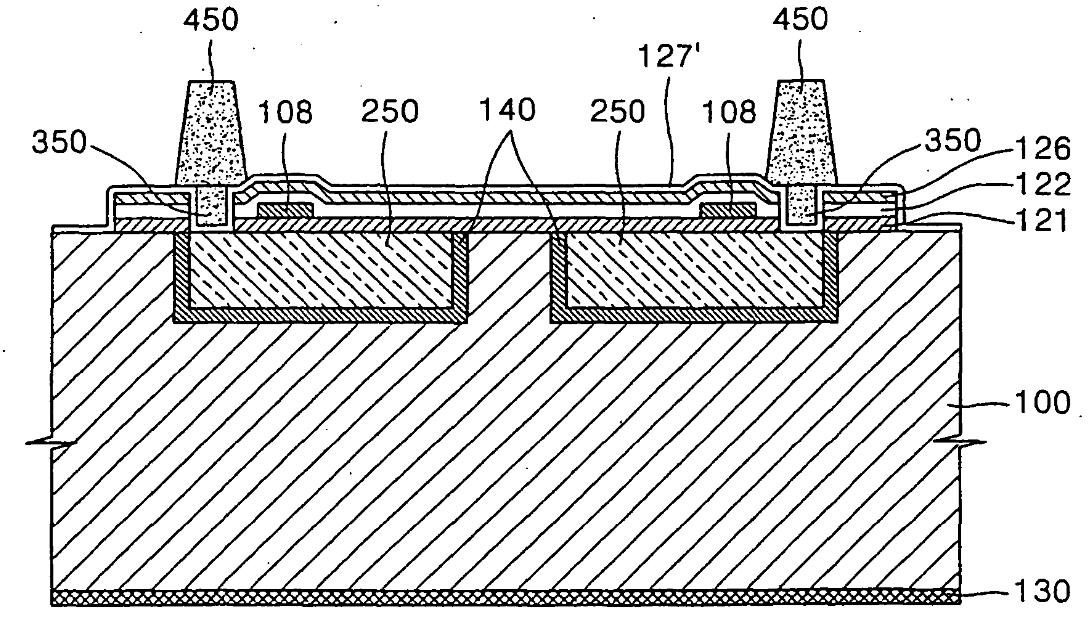
FIG. 19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140
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350
126
122
121
100
130

FIG. 20

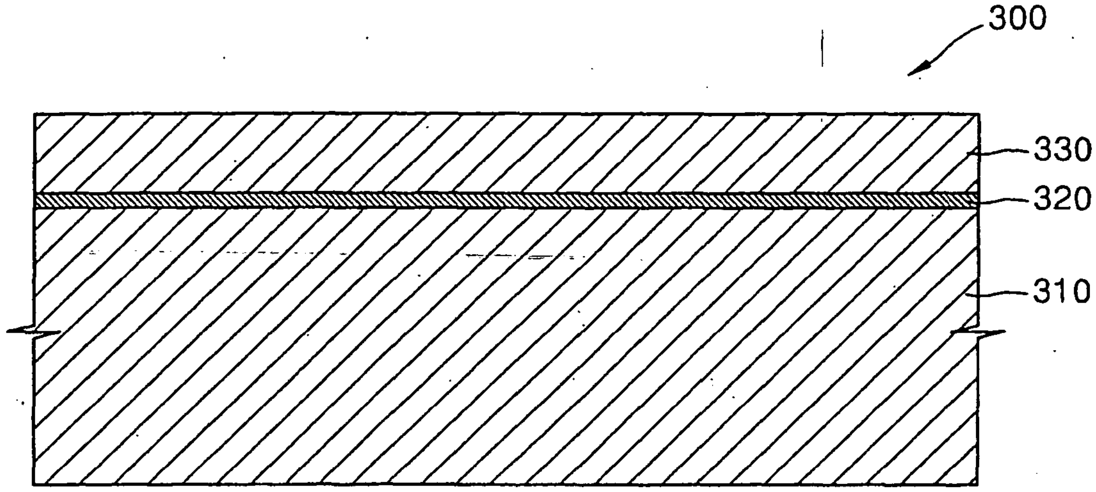


FIG. 21

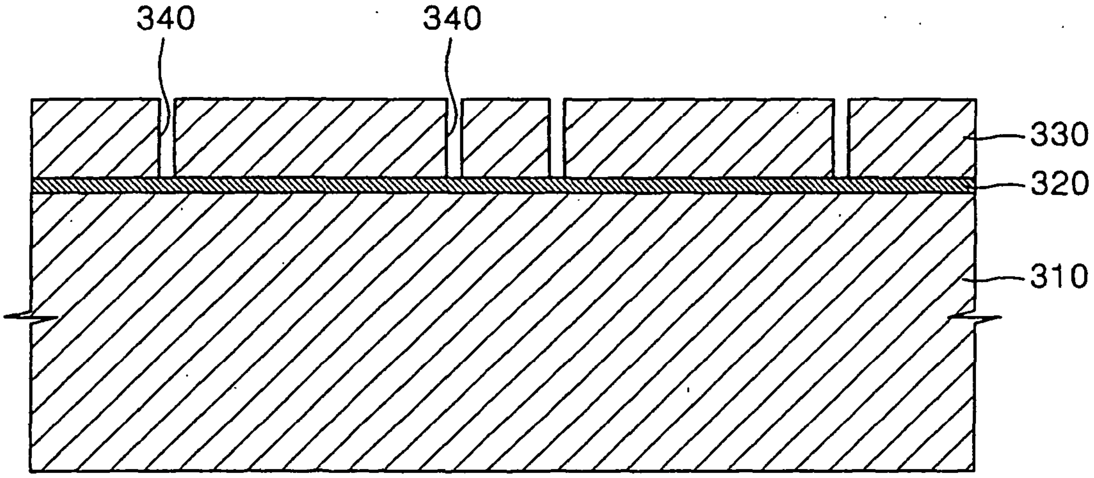
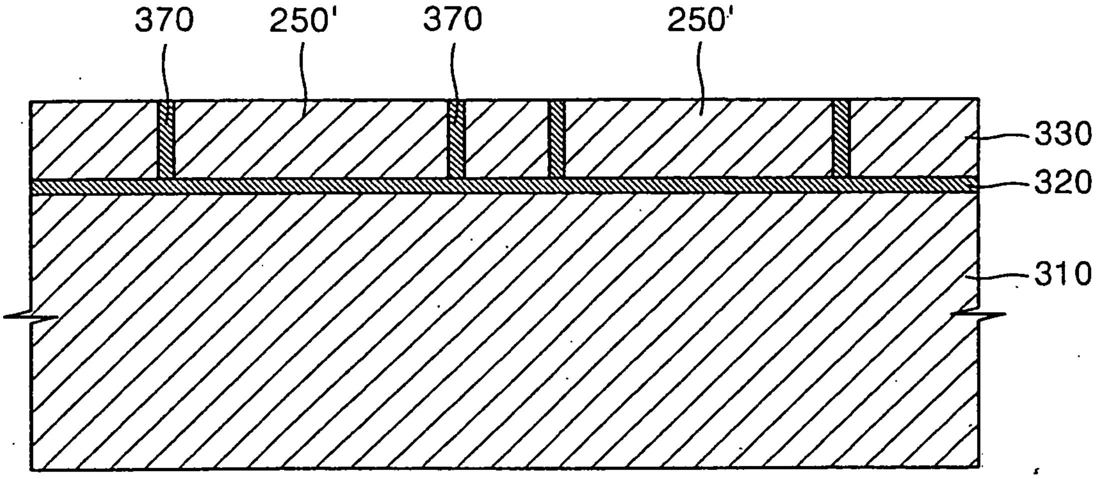


FIG. 22



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