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(54) **INTERPOSER AND PACKAGE ON PACKAGE STRUCTURE**

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H05K 3/28 (2006.01)

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(58) **Field of Classification Search**
CPC H05K 1/141; H05K 2201/042; H05K 1/0206; H05K 2201/04; H05K 1/144; H05K 1/145; H05K 7/205; H05K 3/3447; H05K 2203/1572; H05K 2201/10303; H05K 3/368
USPC 361/707, 721, 711, 709, 720, 719, 704; 165/80.3; 174/252
See application file for complete search history.

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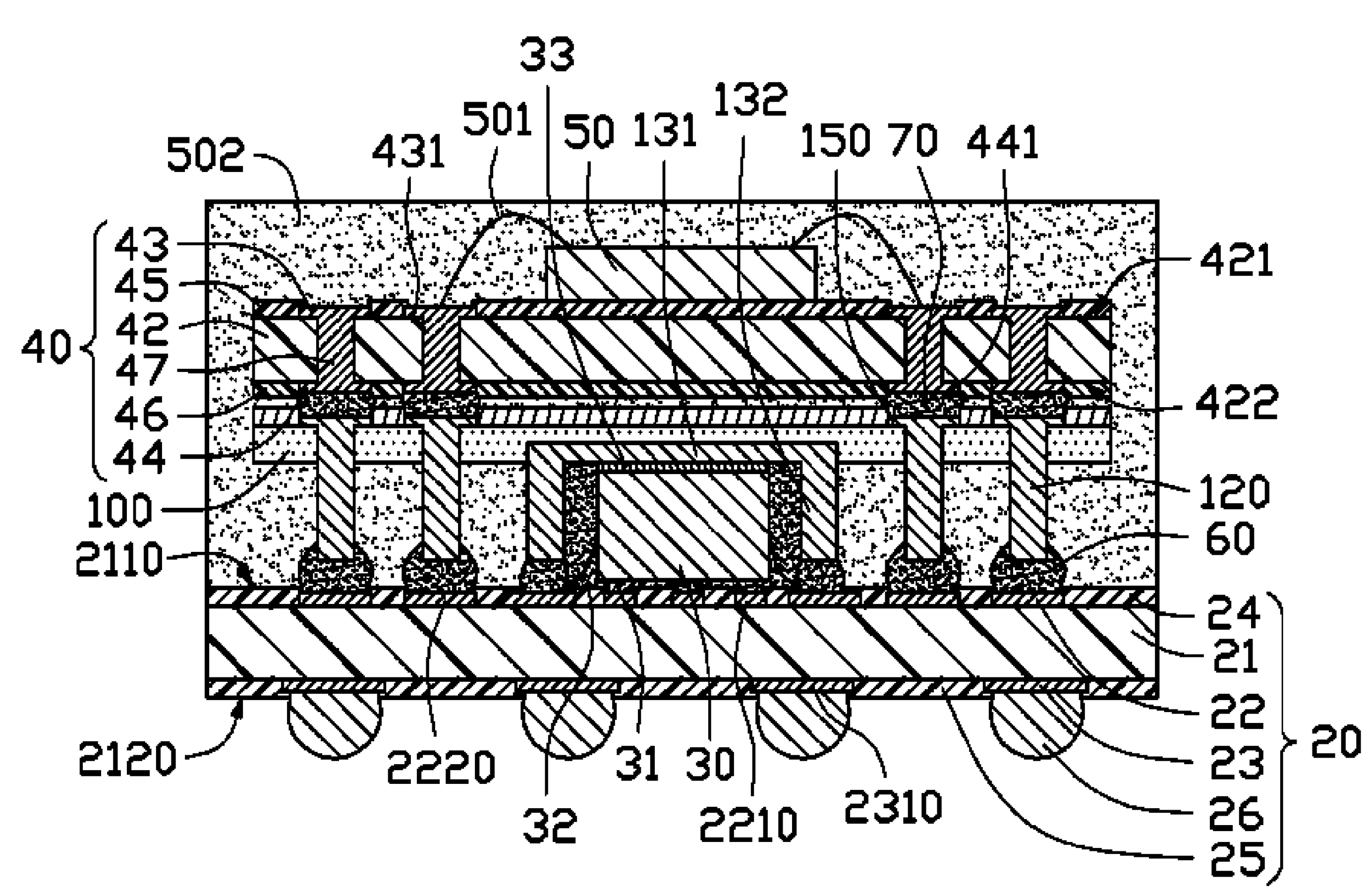
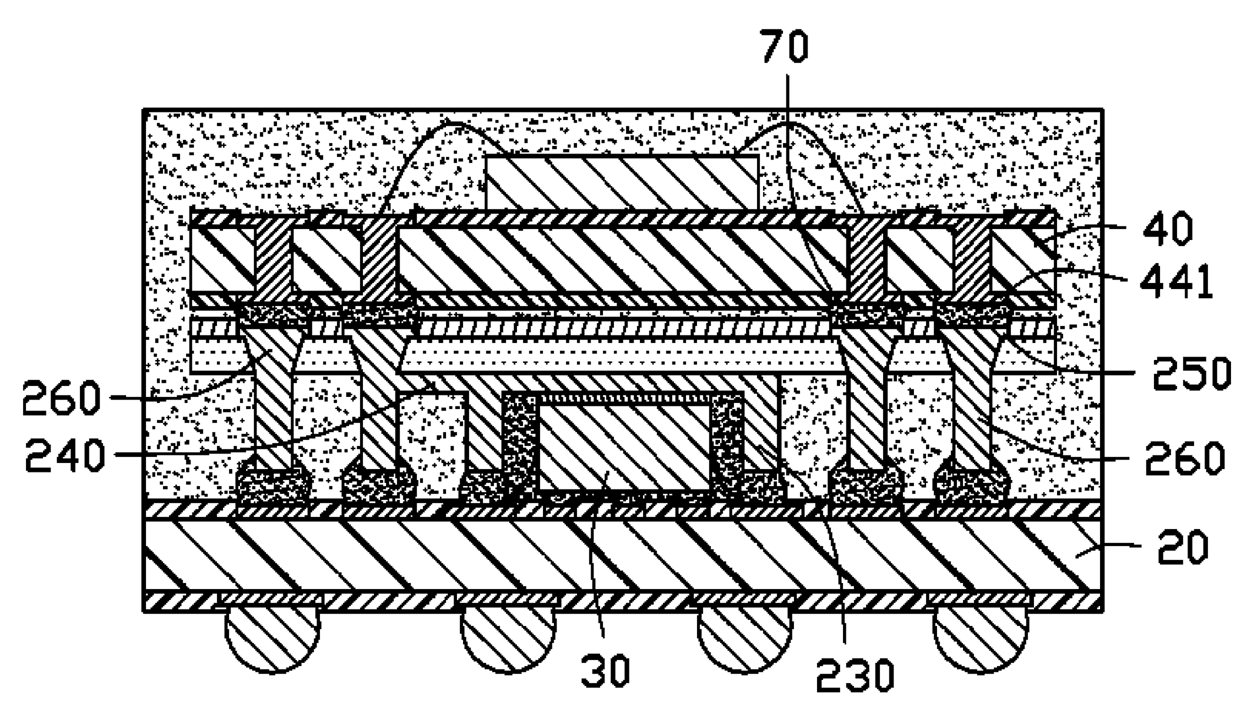
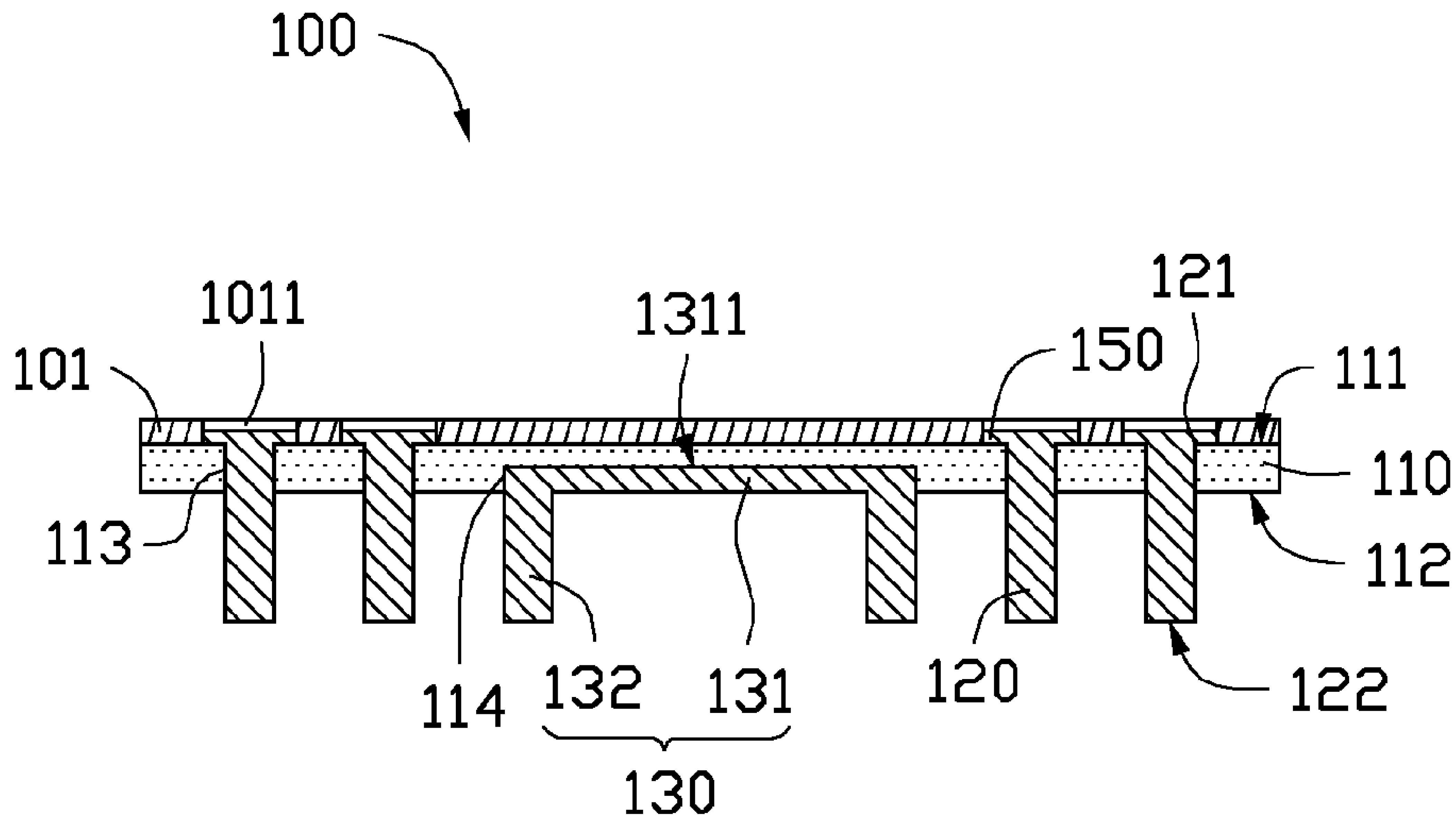
(57) **ABSTRACT**

A heat-dissipating interposer includes an insulating base, a plurality of conductive pillars and a thermal conducting frame. The insulating base includes a first surface and an opposite second surface. The conductive pillars are arranged on the insulating base. The conductive pillars protrude from the second surface. The height of the conductive pillars relative to the second surface is greater than the thickness of the insulating base. The thermal conducting frame is placed on the second surface and receives a heat-generating component. The interposer can be used in a package on package structure.

13 Claims, 7 Drawing Sheets



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130

FIG. 1

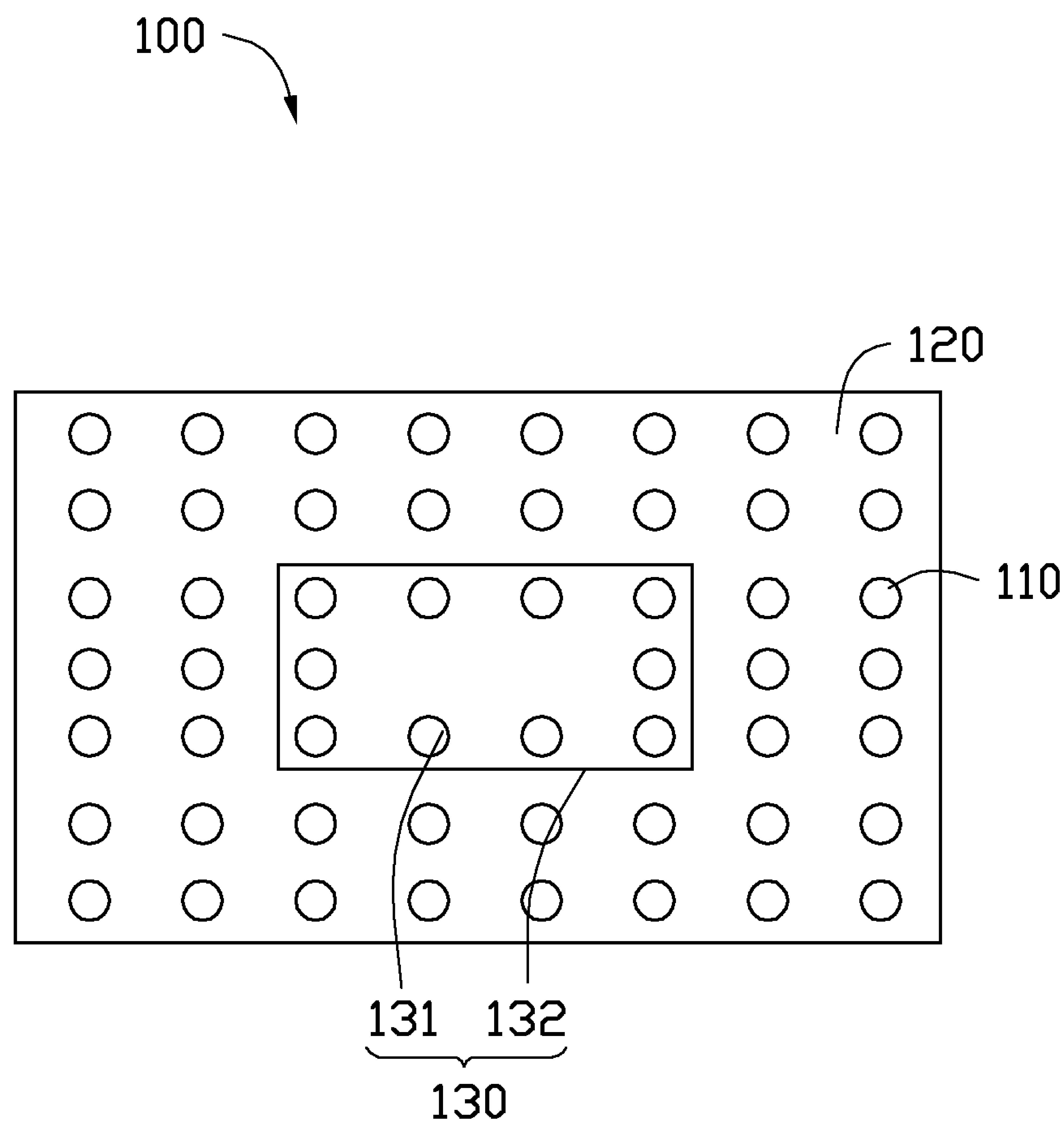


FIG. 2

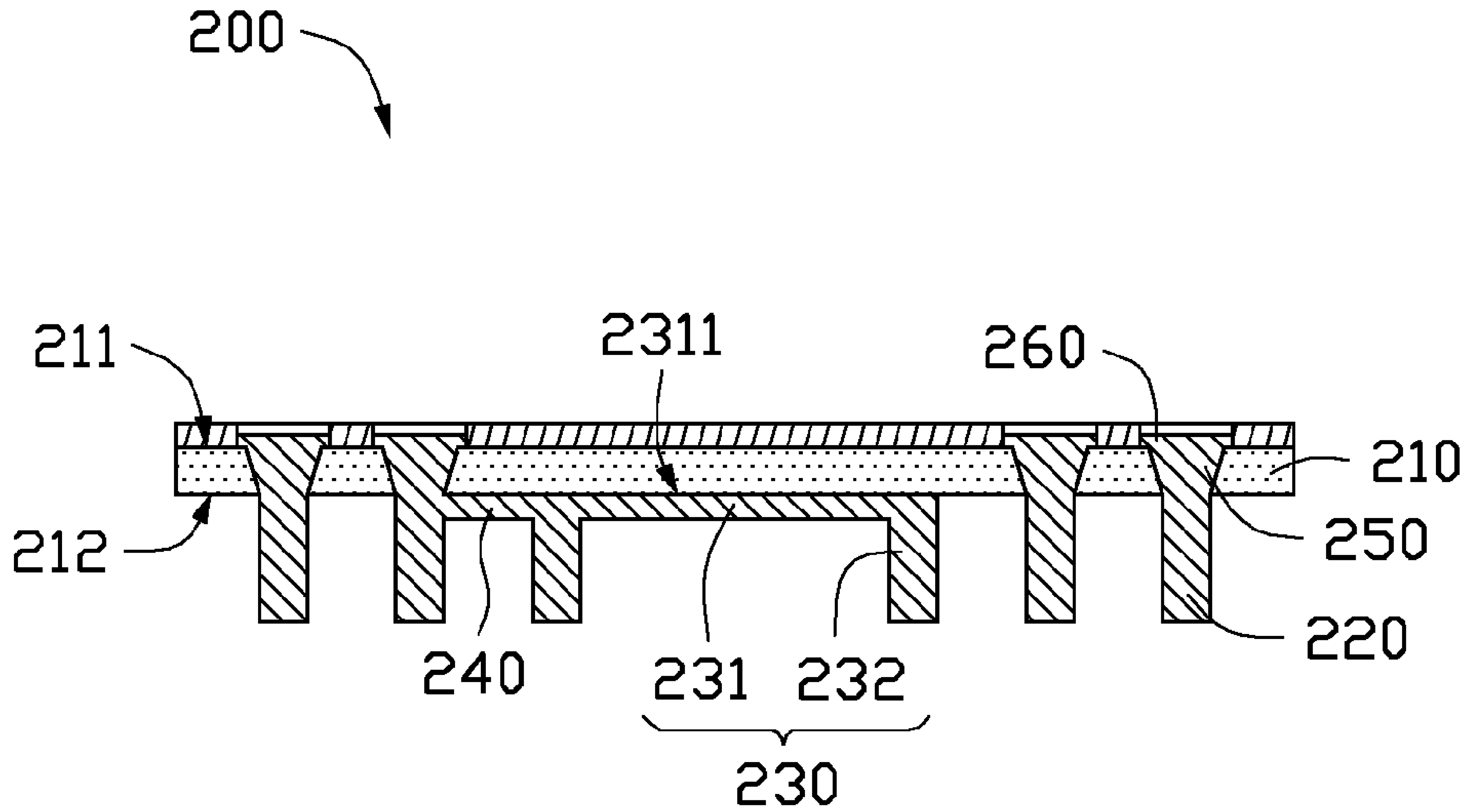


FIG. 3

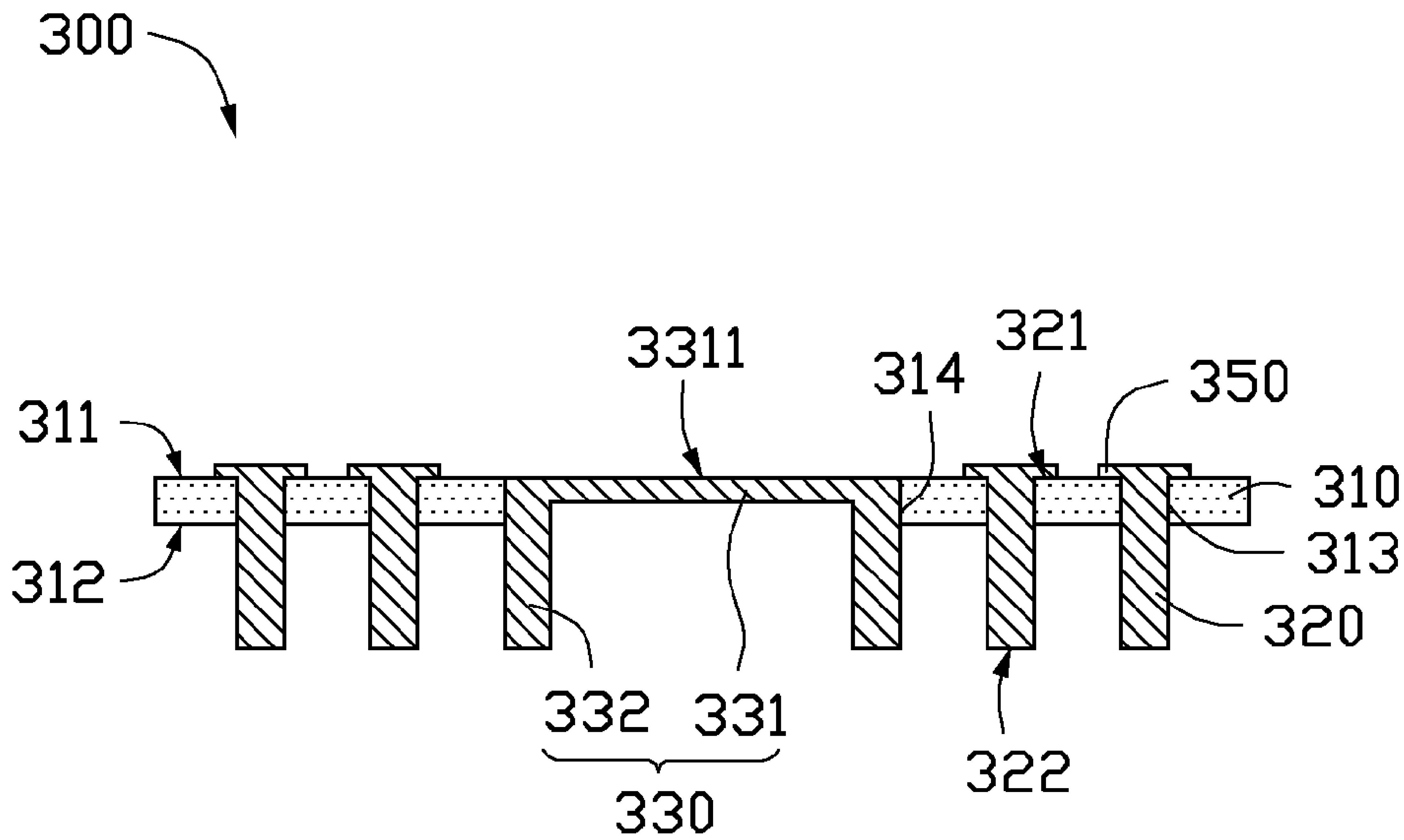
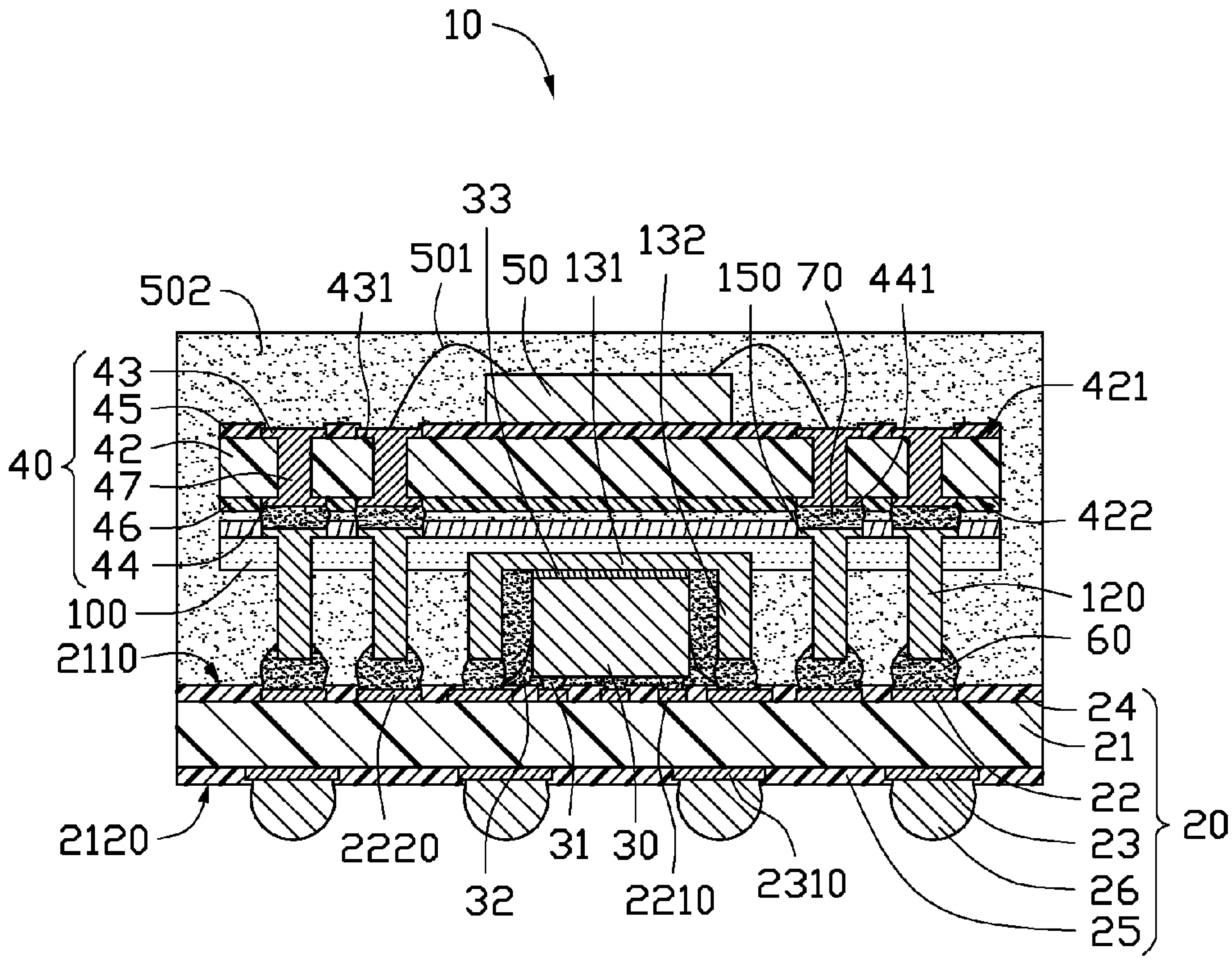


FIG. 4


10
33
502
431
501
50
131
132
150
70
441
421
43
45
42
40
47
46
44
422
100
120
2110
60
24
21
22
23
20
26
25
2120
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30
32
2210
2310

FIG. 5

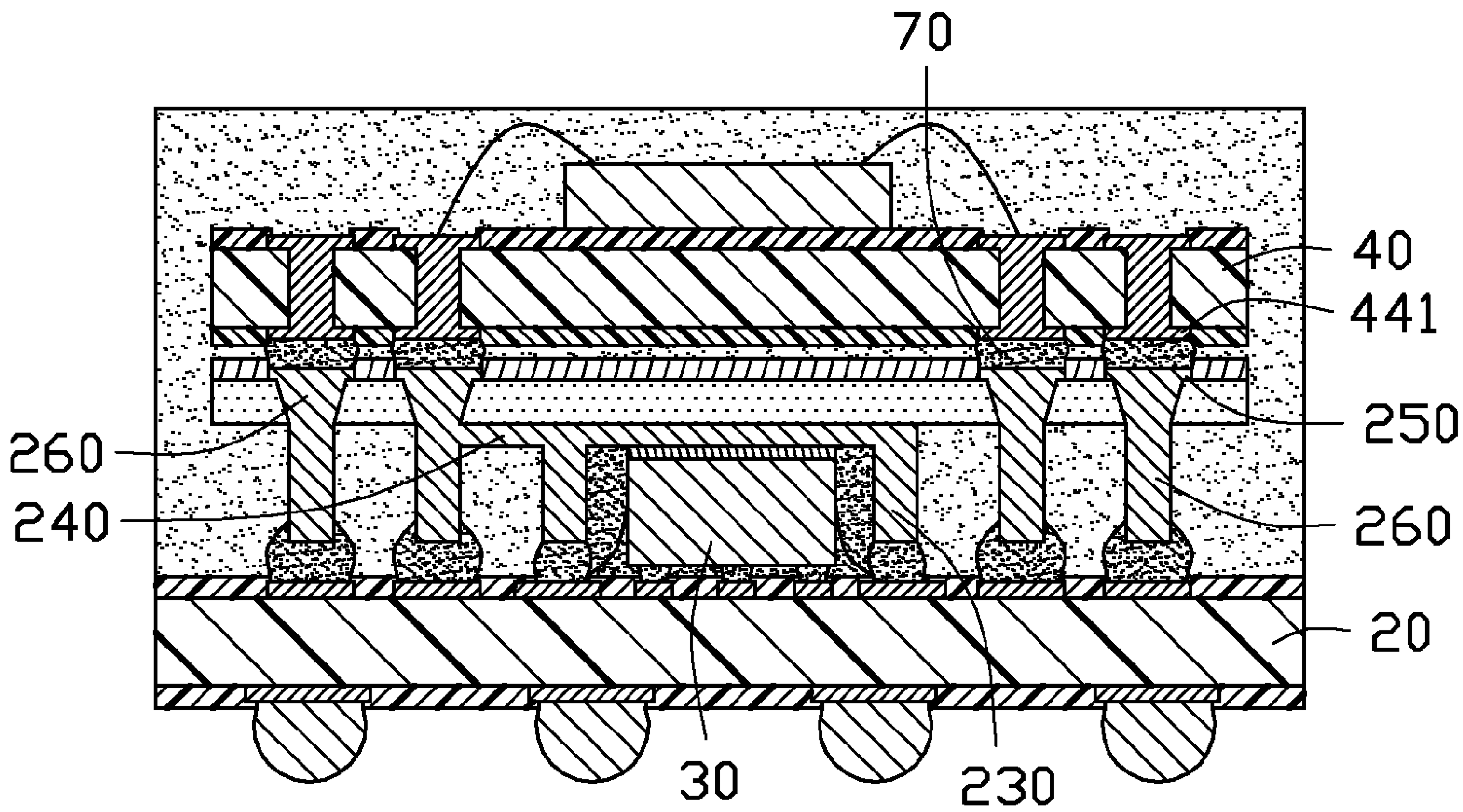

FIG. 6

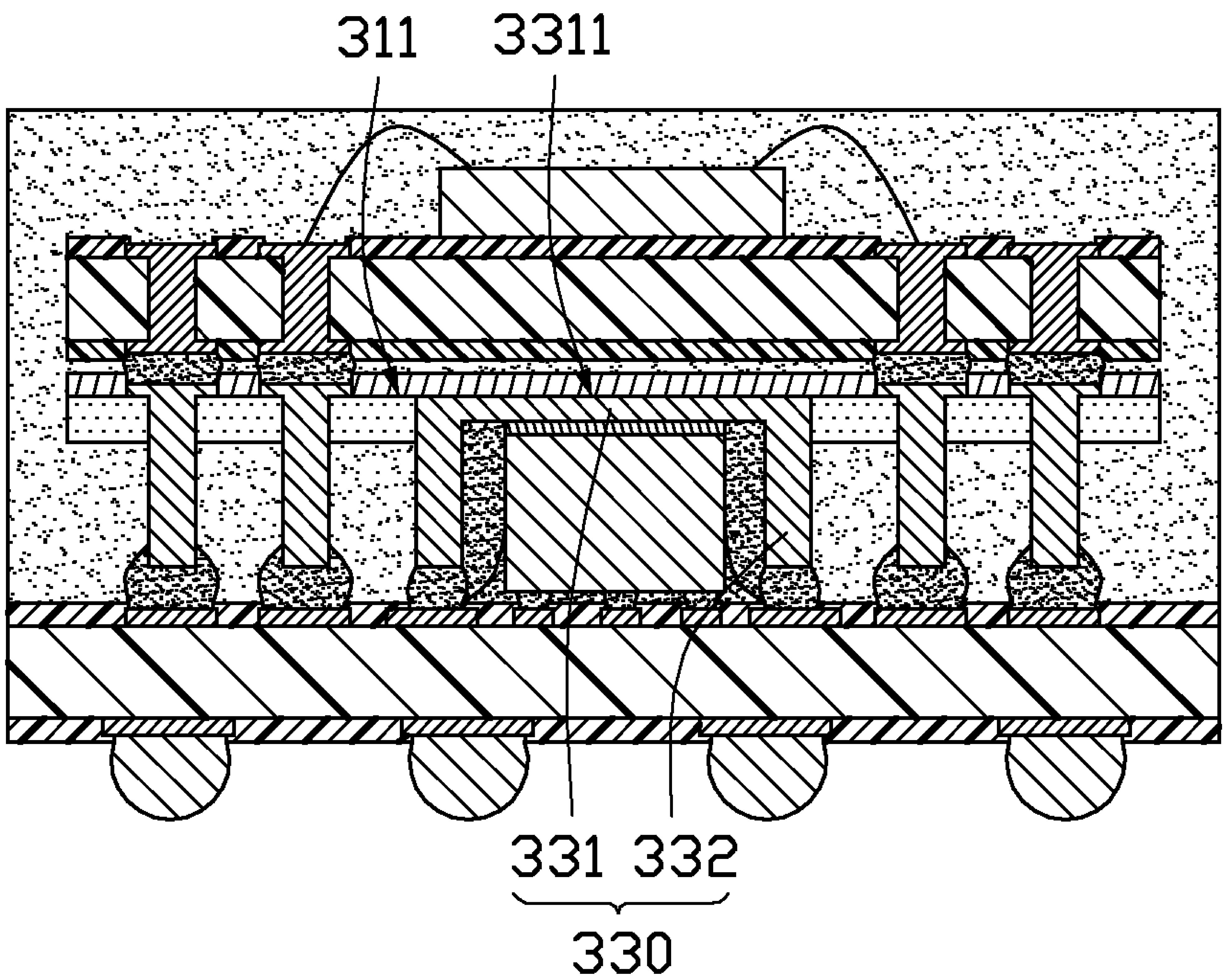

FIG. 7

INTERPOSER AND PACKAGE ON PACKAGE STRUCTURE

BACKGROUND

1. Technical Field

The present disclosure relates to packaging structures for semiconductor devices, particularly to an interposer and a package on package (POP) structure including the interposer.

2. Description of Related Art

In order for a POP structure to attain a high density integrated layout and a small area installation, two electric elements are electrically connected by a plurality of solder balls. The diameter of the solder ball may be in the range from 200 um to 300 um which is quite large. It is difficult to reduce the volume of the POP structure due to the large diameters of the solder ball and the large size of contact pad corresponding to the solder ball. The structural strength and integrity of the connection between the solder ball and the contact pad is not optimal due to the large diameter of the solder ball. So, the reliability of POP structure is not good. In addition, the bottom one of the two electric elements is usually provided between two circuit boards. Heat created by the bottom electric elements is hard to dissipate due to undesirable insulation given by the two circuit boards.

What is needed, therefore, is a POP structure that can overcome the described limitations.

BRIEF DESCRIPTION OF THE DRAWINGS

Many aspects of the present embodiments can be better understood with reference to the following drawings. The components in the drawings are not necessarily drawn to scale, the emphasis instead being placed upon clearly illustrating the principles of the present embodiments. Moreover, in the drawings, like reference numerals designate corresponding parts throughout the several views.

FIG. **1** is a schematic, cross-sectional view of an interposer according to a first embodiment.

FIG. **2** is a bottom view of the interposer of FIG. **1**.

FIG. **3** is a schematic, cross-sectional view of an interposer according to a second embodiment.

FIG. **4** is a schematic, cross-sectional view of an interposer according to a third embodiment.

FIGS. **5-7** are schematic, cross-sectional views of a POP structure.

DETAILED DESCRIPTION

An interposer and a POP structure will be described with reference to the drawings.

FIGS. **1-2** show an interposer **100** according to a first embodiment. The interposer **100** includes an insulating base **110**, a plurality of electric conductive pillars **120**, and a thermal conductive frame **130**.

The insulating base **110** includes a first surface **111** and a second surface **112** opposite to the first surface **111**. A plurality of through holes **113** is defined in the insulating base **110**. The through holes **113** are separated from each other. A groove **114** is defined in the first surface **112** to the inside of the insulating base **110**.

The electric conductive pillars **120** are aligned with and arranged in the through holes **113**. An electric conductive pillar **120** includes a first end face **121** and a second end face **122** opposite to the first end face **121**. A height of each electric conductive pillar **120** is greater than the thickness of the insulating base **110** in this embodiment. The first end face **121** and the first surface **111** are coplanar. The second end face **122** protrudes from the second surface **112**. The height of the electric conductive pillar **120** relative to the second surface **112** is greater than the thickness of the insulating base **110**. Extension direction of the electric conductive pillar **120** is perpendicular to the second surface **112**.

A portion of the thermal conductive frame **130** is received in the insulating base **110**. The thermal conductive frame **130** includes a top plate **131** and a plurality of thermal conductive pillars **132** perpendicularly interconnected with the top plate **131**. The top plate **131** is received in the groove **114**. The thermal conductive pillars **132** perpendicularly extend from the border of the top plate **131**. There is no thermal conductive pillar **132** formed on the middle area of the top plate **131**. Extension direction of the thermal conductive pillar **132** is equal to that of the electric conductive pillar **120**. The material of the thermal conductive frame **130** is thermally conductive metal such as copper, aluminum, or silver. In one embodiment, the material of the thermal conductive frame **130** is copper, is the same as that of the electric conductive pillar **120**. In one embodiment, the height of the electric conductive pillar **120** relative to the insulating base **110** is equal to that of the thermal conductive pillar **132** relative to the insulating base **110**.

The interposer **100** also includes a plurality of first contact pads **150**. The first contact pads **150** are formed on the first surface **111**. The first contact pads **150** are aligned with the electric conductive pillars **120**. The first contact pad **150** is electrically connected with the first end face **121** of an electric conductive pillar **120**.

In an alternative embodiment, a solder mask layer **101** is formed on the first surface **111**. A plurality of openings **1011** are defined in the solder mask layer **101**. The first contact pads **150** are exposed through the openings **1011**.

FIG. **3** shows an interposer **200** according to a second embodiment. The structure of the interposer **200** is similar to that of the interposer **100** of the first embodiment. The interposer **200** includes an insulating base **210**, a plurality of electric conductive pillars **220**, a thermal conductive connector **240**, a plurality of conductive vias **250**, and a thermal conductive frame **230**.

The insulating base **210** includes a first surface **211** and a second surface **212** opposite to the first surface **211**. A plurality of through holes **213** is defined in the insulating base **210**. The diameter of the through hole **213** gradually reduces from the first surface **211** to the second surface **212**.

The electric conductive pillars **220** are aligned with the conductive vias **250**. Extension direction of the electric conductive pillars **220** is perpendicular to the second surface **212**. A height of each electric conductive pillar **220** is greater than the thickness of the insulating base **210**.

The thermal conductive frame **230** is formed on the second surface **212**. The thermal conductive frame **230** includes a top plate **231** and a plurality of thermal conductive pillars **232**. The top plate **231** includes a top surface **2311** facing away from the thermal conductive pillars **232**. The top surface **2311** is in contact with the second surface **212**. The top surface **2311** and the second surface **212** are coplanar. The thermal conductive pillars **232** perpendicularly extend from the border of the top plate **231**. There is no thermal conductive pillar **232** formed on the middle area of the top plate **131**. The material of the thermal conductive frame **230** is thermally conductive metal such as copper, aluminum, or silver. In one embodiment, the material of the thermal conductive frame **230** is copper and is same as that of the electric conductive pillar **220**.

The thermal conductive connector **240** is also formed on the second surface **212**. The thermal conductive connector **240** interconnects between the thermal conductive frame **230** and an electric conductive pillar **220**.

The interposer **200** also includes a plurality of first contact pads **260**. The first contact pad **260** is defined on the first surface **211**. Each of the first contact pads **260** is electrically connected with a conductive via **250**. In one embodiment, the first contact pad **260** and the conductive via **250** corresponding to the first contact pad **260** are integrated.

FIG. **4** shows an interposer **300** according to a third embodiment. The structure of the interposer **300** is similar to that of the interposer **100** of the first embodiment. The interposer **300** includes an insulating base **310**, a plurality of electric conductive pillars **320**, and a thermal conductive frame **330**.

The insulating base **310** includes a first surface **311** and a second surface **312** opposite to the first surface **311**. A plurality of through holes **313** is defined in the insulating base **310**. The through holes **313** are separated from each other. A receiving hole **314** is defined in the second surface **311** through to the first surface **312**. The receiving hole **314** is surrounded by the through holes **313**.

The electric conductive pillars **320** are aligned with and received in the through holes **313**. The electric conductive pillar **320** includes a first end face **321** and a second end face **322** opposite to the first end face **321**. The height of each electric conductive pillar **320** is greater than the thickness of the insulating base **310** in this embodiment. The first end face **321** and the first surface **311** are coplanar. The second end face **322** protrudes from the second surface **312**. A height of the electric conductive pillar **320** relative to the second surface **312** is greater than the thickness of the insulating base **310**.

The thermal conductive frame **330** is partially received in the receiving hole **314**. The thermal conductive frame **330** includes a top plate **331** and a plurality of thermal conductive pillars **332** perpendicularly interconnected with the top plate **331**. The top plate **331** includes a top surface **3311** facing away from the thermal conductive pillars **332**. The top surface **3311** and the first surface **311** are coplanar. The thermal conductive pillars **332** perpendicularly extend from the border of the top plate **331**. Extension direction of the thermal conductive pillar **332** is equal to that of the electric conductive pillar **320**. The material of the thermal conductive frame **330** is thermally conductive metal such as copper, aluminum, or silver. In one embodiment, the material of the thermal conductive frame **330** is copper, the same as that of the electric conductive pillar **320**.

The interposer **300** also includes a plurality of first contact pads **350**. The first contact pad **350** is defined on the first surface **311**. Each of the first contact pads **350** is aligned with and electrically connected with an electric conductive pillar **320**.

In an alternative embodiment, a solder mask layer is formed on the first surface of the second or the third embodiment. A plurality of openings is defined in the solder mask layer. The first contact pads are exposed through the corresponding openings.

The interposer can also includes a thermal conductive connector of the first or the third embodiment. The thermal conductive frame and some of the electric conductive pillars are interconnected through the thermal conductive connectors.

FIG. **5** shows a POP structure **10** according to a fourth embodiment. The POP structure **10** includes a first package substrate **20**, a first chip **30**, a second package substrate **40**, a second chip **50**, a first solder **60**, a second solder **70**, and an interposer of the first embodiment, the second embodiment, or the third embodiment. In this embodiment, an interposer **100** is provided according to the first embodiment.

The first package substrate **20** includes a first base layer **21**, a first circuit layer **22**, a second circuit layer **23**, a first solder mask layer **24**, a second solder mask layer **25**, and a plurality of solder balls **26**. The first circuit layer **22** and the second circuit layer **23** are formed on the opposite surface of the first base layer **21**. The first solder mask layer **24** is formed on the surface of the first circuit layer **22**. The second solder mask layer **25** is formed on the surface of the second circuit layer **23**.

The first base layer **21** is a multilayer substrate. The first base layer **21** includes a plurality of resin layers alternating with a plurality of circuit layers. The first base layer **21** includes a third surface **2110** and a fourth surface **2120** opposite to the third surface **2110**. The first circuit layer **22** is formed on the third surface **2110**. The second circuit **23** is formed on the fourth surface **2120**. In one embodiment, the first circuit layer **22**, the second circuit layer **23**, and the other circuit layer of the first base layer **21** are electrically connected through a plurality of conductive vias.

Portions of the first circuit layer **22** are exposed through the first solder mask layer **24**. The exposed portions of the first circuit layer **22** are defined to be a plurality of third contact pads **2210** and a plurality of fourth contact pads **2220**. The third contact pads **2210** are arranged in an array. The third contact pads **2210** are surrounded by the fourth contact pads **2220**.

Portions of the second circuit layer **23** are exposed through the second solder mask layer **25**. The exposed portions of the second circuit layer **23** are defined to be a plurality of fifth contact pads **2310**. The fifth contact pads **2310** are arranged in an array. The third contact pads **2210**, the fourth contact pads **2220** and the fifth contact pads **2310** are electrically connected through circuit layers and conductive holes.

Each of the solder balls **26** is aligned with and is attached on a fifth contact pad **2310**.

The first chip **30** is packed on the first solder mask layer **24** side of the first package substrate **20** by a flip-chip technology. The first chip **30** is adhered on the first solder mask layer **24** by a first packaging adhesive **32**. The first packaging adhesive **32** is made of high heat dissipation material such as thermally conductive adhesive. The first chip **30** includes a plurality of contact pads aligned with the third contact pads **2210**. The contact pads of the first chip **30** and the corresponding third contact pads **2210** are electrically interconnected by conductive holes **31**. The first chip **30** is received in the thermal conductive frame **130**. The first chip **30** and the top plate **131** are interconnected through a heat dissipation bonding sheet **33** for quickly dissipating to the top plate **131** heat created by the first chip **30**.

The electric conductive pillars **120** are aligned with and electrically connected with the fourth contact pads **2220** through the first solder **60**.

The second package substrate **40** includes two conductive layers. The second package substrate **40** is formed on the interposer **100** and opposite to the first package substrate **20**. The second package substrate **40** includes a second base layer **42**, a third circuit layer **43**, a fourth circuit layer **44**, a third solder mask layer **45**, and a fourth solder mask layer **46**. The third circuit layer **43** and the fourth circuit layer **44** are formed on the opposite surface of the second base layer **42**. The third solder mask layer **45** is formed on the surface of the third circuit layer **43**. The fourth solder mask layer **46** is formed on the surface of the fourth circuit layer **44**.

The second base layer **42** includes a fifth surface **421** and a sixth surface **422** opposite to the fifth surface **421**. The third circuit layer **43** is formed on the fifth surface **421**. The fourth circuit **44** is formed on the sixth surface **422**. The third circuit layer **43** and the fourth circuit layer **44** are electrically connected through a plurality of conductive vias **47**. The second base layer **42** is an insulating material or an inner circuit board including circuit layers and insulating layers.

Portions of the third circuit layer **43** are exposed through the third solder mask layer **45**. The exposed portions of the third circuit layer **43** are defined to be a plurality of sixth contact pads **431**. A chip fixing area is defined on the third solder mask layer **45**. The chip fixing area is surrounded by the sixth contact pads **431**.

Portions of the fourth circuit layer **44** are exposed through the fourth solder mask layer **46**. The exposed portions of the fourth circuit layer **44** are defined to be a plurality of seventh contact pads **441**. The seventh contact pads **441** are aligned with the first contact pads **150**. The seventh contact pad **441** and the first contact pad **150** are electrically connected through the second solder **70**. The sixth contact pads **431** and the seventh contact pads **441** are electrically connected through the third circuit layer **43**, the fourth circuit layer **44**, and the conductive vias **47**.

The second chip **50** is attached on the third solder mask layer **45**. In one embodiment, the second chip **50** is a wire bonding chip. The second chip **50** is electrically interconnected with the sixth contact pads **431**. In detail, the second chip **50** includes a plurality of soldering contacts and a plurality of soldering wires **501** extended from the soldering contacts. The soldering wires **501** are aligned with and electrically connected with the sixth contact pads **431**. The second chip **50** and the third circuit layer **43** are electrically connected through the soldering wires **501**.

In one embodiment, the second chip **50** is adhered on the chip fixing area of the third solder mask layer **45** through a adhesive layer. The soldering wires **501** are soldered with the sixth contact pads **431**. The material of the soldering wires **501** is gold. The soldering wires **501**, the second chip **50**, the third solder mask layer **45** and the sixth contact pads **431** are all covered by a second packaging adhesive **502**. The second packaging adhesive **502** is black gum or other packaging adhesive.

The interposer **100** and the second package substrate **40** are also covered by the second packaging adhesive **502** if the cross-section area of the first package substrate **20** is greater than that of the interposer **100** and the second package substrate **40**. The interposer **100** and the second package substrate **40** are also covered by the second packaging adhesive **502** in this embodiment.

In this embodiment, the first chip **30** is received in the thermal conductive frame **130**, thus heat created by the first chip **30** can be dissipated to the thermal conductive frame **130** and out of the POP structure **10**. Therefore, the disclosed POP structure **10** provides better heat dissipation.

FIG. **6** shows a POP structure including an interposer of the second embodiment. The seventh contact pads **441** are electrically connected with the correspondingacco conductive vias or the first contact pads **250** through the second solder **70**. The thermal conductive connector **240** is interconnected between the thermal conductive frame **230** and an electric conductive pillar **220**. Therefore, the heat created by the first chip can be dissipated to the electric conductive pillar **220**, and thence to the first package substrate **20** and the second package substrate **40** through the thermal conductive frame **230**. Thus, the disclosed POP structure **10** provides improved heat dissipation.

FIG. **7** shows a POP structure including an interposer according to the third embodiment. The top surface **3311** of the top plate **331** and the first surface **311** are coplanar. Therefore, the overall thickness of the POP structure is decreased.

While certain embodiments have been described and exemplified above, various other embodiments will be apparent to those skilled in the art from the foregoing disclosure. The present disclosure is not to be limited to the particular embodiments described and exemplified but is capable of considerable variation and modification without departure from the scope of the appended claims.

What is claimed is:

1. An interposer, comprising:

an insulating base, the insulating base including a first surface and a second surface opposite to the first surface; a plurality of electric conductive pillars, the electric conductive pillars extending through in the insulating base, extension direction of the electric conductive pillars being perpendicular to the second surface, the height of the electric conductive pillar relative to the second surface being greater than the thickness of the insulating base; and a thermal conductive frame, the thermal conductive frame attached on one side of the insulating base, the thermal conductive frame being configured for receiving a component; wherein the thermal conductive frame includes a top plate and a plurality of thermal conductive pillars perpendicularly extending from the top plate, the top plate partially received in the insulating base, extension direction of the thermal conductive pillar being perpendicular to the second surface, a height of the thermal conductive pillar relative to the second surface being greater than the thickness of the insulating base.

2. The interposer of claim **1**, wherein a height of the electric conductive pillars relative to the insulating base is equal to that of the thermal conductive pillars relative to the insulating base.

3. The interposer of claim **1**, wherein the top plate includes a top surface facing away from the thermal conductive pillars, the top surface and the first surface being coplanar.

4. The interposer of claim **1**, wherein the top plate includes a top surface facing away from the thermal conductive pillars, the top surface located within the insulating base.

5. The interposer of claim **1**, wherein the electric conductive pillar includes a first end face and a second end face opposite to the first end face, the first end face and the first surface being located on a same plane, the second end face protruding from the second surface.

6. The interposer of claim **5**, wherein the interposer includes a plurality of first contact pads, the first contact pads formed on the first surface, the first contact pads being aligned with and electrically connected with the electric conductive pillars.

7. The interposer of claim **1**, wherein the interposer includes a thermal conductive connector, the thermal conductive connector interconnected between the thermal conductive frame and an electric conductive pillar.

8. An interposer, comprising:

an insulating base, the insulating base including a first surface and a second surface opposite to the first surface; a plurality of conductive vias, the conductive vias arranged in the insulating base; a plurality of electric conductive pillars, the electric conductive pillars being aligned with the conductive vias respectively, extension direction of the electric conductive pillar being perpendicular to the second surface, the height of the electric conductive pillars relative to the second surface being greater than the thickness of the insulating base; a thermal conductive frame, the thermal conductive frame attached on one side of the insulating base, the thermal conductive frame being configured for receiving a component; wherein the thermal conductive frame includes a top plate and a plurality of thermal conductive pillars perpendicular extending from the top plate, the top plate includes a top surface facing away from the thermal conductive pillars, the top surface being in contact with the second surface, extension direction of the thermal conductive pillars being perpendicular to the second surface, the height of the thermal conductive pillar relative to the second surface being greater than the thickness of the insulating base; wherein the interposer includes a thermal conductive connector, the thermal conductive connector interconnected between the thermal conductive frame and one electric conductive pillar.

9. The interposer of claim **8**, wherein the height of the electric conductive pillars relative to the insulating base is equal to that of the thermal pg,**23** conductive pillar relative to the insulating base.

10. The interposer of claim **8**, wherein the interposer includes a solder mask layer and a plurality of first contact pads, the first contact pads formed on the first surface, the first contact pads being aligned with and electrically connected with the electric conductive pillars, the solder mask layer formed on the first surface, a plurality of openings defining in the solder mask layer, the openings being aligned with the first contact pads, the first contact pads exposed through the corresponding openings.

11. A package on package structure, comprising a first package substrate, a first chip, a second package substrate, a second chip, a first solder, a second solder and an interposer of claim **1**; the first package substrate formed on the second surface side of the interposer; the first package substrate including a plurality of first contact pads and a plurality of second contact pads; the first chip and the first package substrate being electrically interconnected through the first contact pads; one side of the electric conductive pillars being aligned with and electrically connected with the first contact pad through the first solder; the first chip arranged in the thermal conductive frame; the second package substrate formed on the first surface side of the interposer; the second package substrate including a plurality of third contact pads aligned with and electrically interconnected with electric conductive pillars; the other side of the electric conductive pillars being aligned with and electrically connected with the third contact pad through the second solder.

12. The interposer of claim **11**, wherein the cross-section area of the first package substrate is greater than that of the interposer and the second package substrate, the interposer and, pg,**24** a packaging adhesive covers the second package substrate.

13. The interposer of claim **11**, wherein the first package substrate includes a plurality of fourth contact pads, the fourth contact pads being opposite to the first contact pads, a solder ball formed on the fourth contact pad.

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