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Huang et al.

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(54) **LAMINATION PROCESS, AND MANUFACTURING METHOD OF SEMICONDUCTOR PACKAGE USING A CHUCK**

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Related U.S. Application Data

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(51) **Int. Cl.**

H01L 21/48	(2006.01)
B32B 38/18	(2006.01)
H01L 23/00	(2006.01)

(52) **U.S. Cl.**
CPC ***B32B 38/1858*** (2013.01); ***H01L 21/4857*** (2013.01); ***H01L 24/96*** (2013.01)

(58) **Field of Classification Search**
CPC B32B 38/1858; B32B 37/0046; B32B 38/1825; H01L 21/6838; H01L 21/67121; H01L 21/02104–02697
See application file for complete search history.

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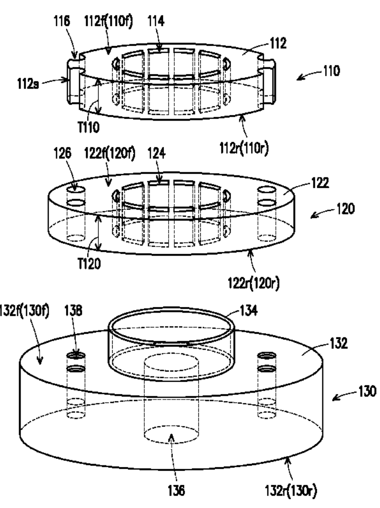
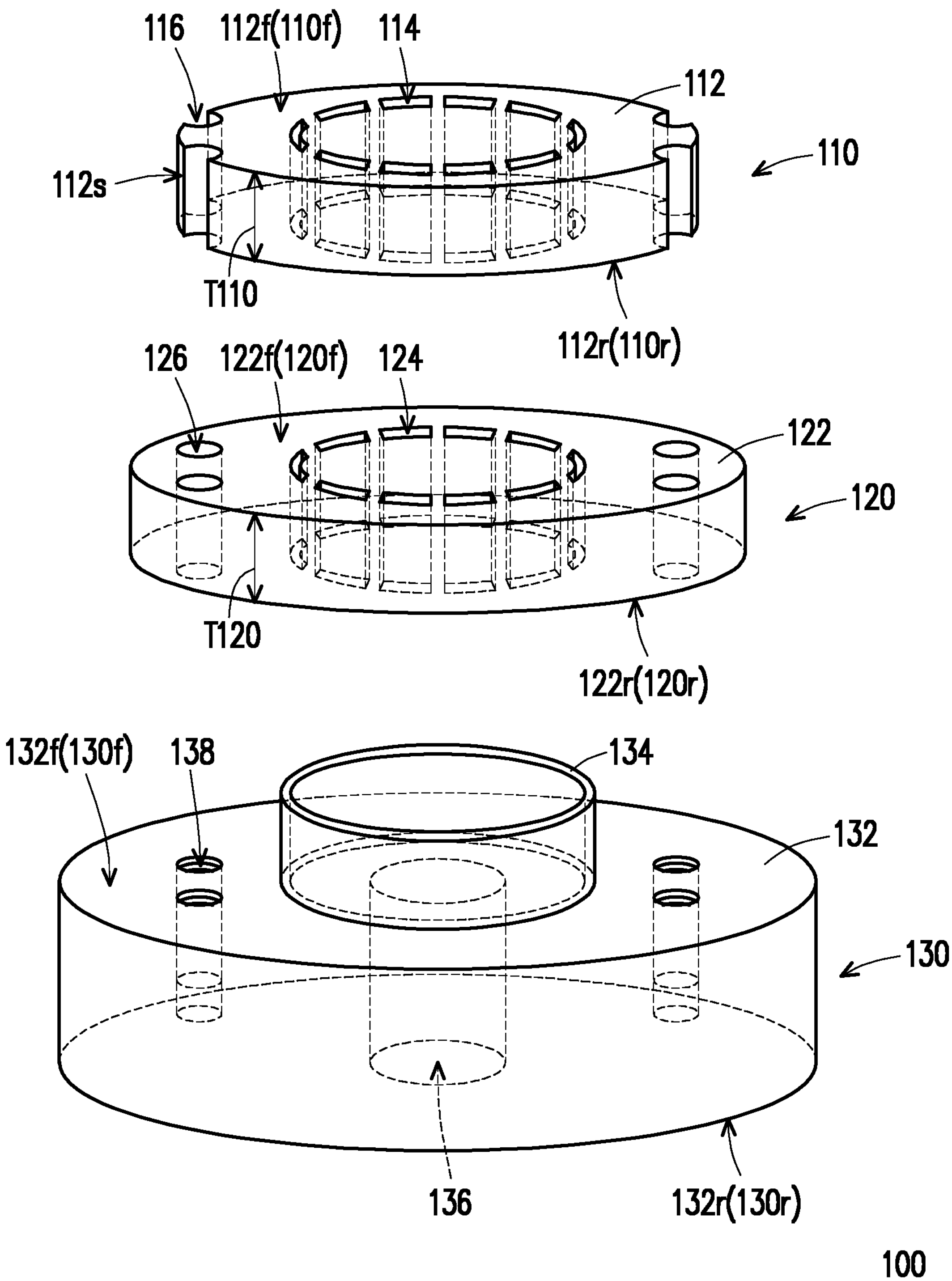
(74) *Attorney, Agent, or Firm* — JCIPRNET

(57) **ABSTRACT**

A lamination chuck for lamination of film materials includes a support layer and a top layer. The top layer is disposed on the support layer. The top layer includes a polymeric material having a Shore A hardness lower than a Shore hardness of a material of the support layer. The top layer and the support layer have at least one vacuum channel formed therethrough, vertically extending from a top surface of the top layer to a bottom surface of the support layer.

20 Claims, 24 Drawing Sheets




116
112f(110f)
114
112
112s
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T110
112r(110r)
126
122f(120f)
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122r(120r)
132f(130f)
138
134
132
130
136
132r(130r)
100

FIG. 1A

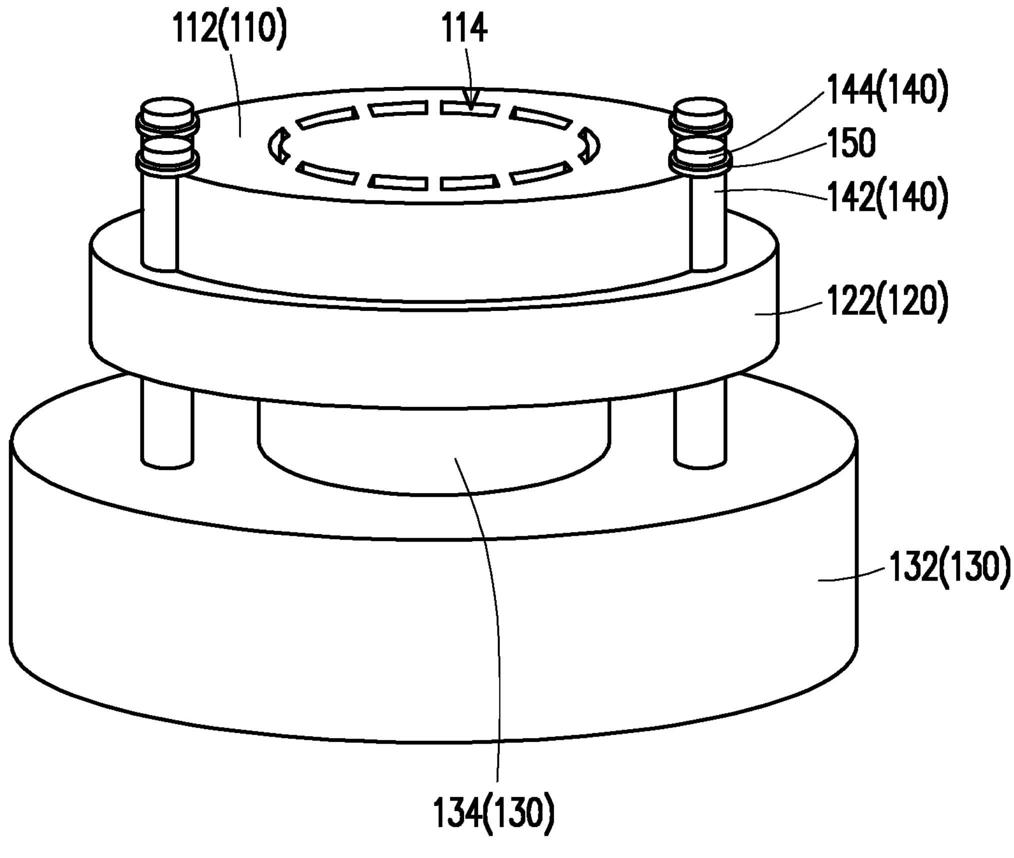


FIG. 1B

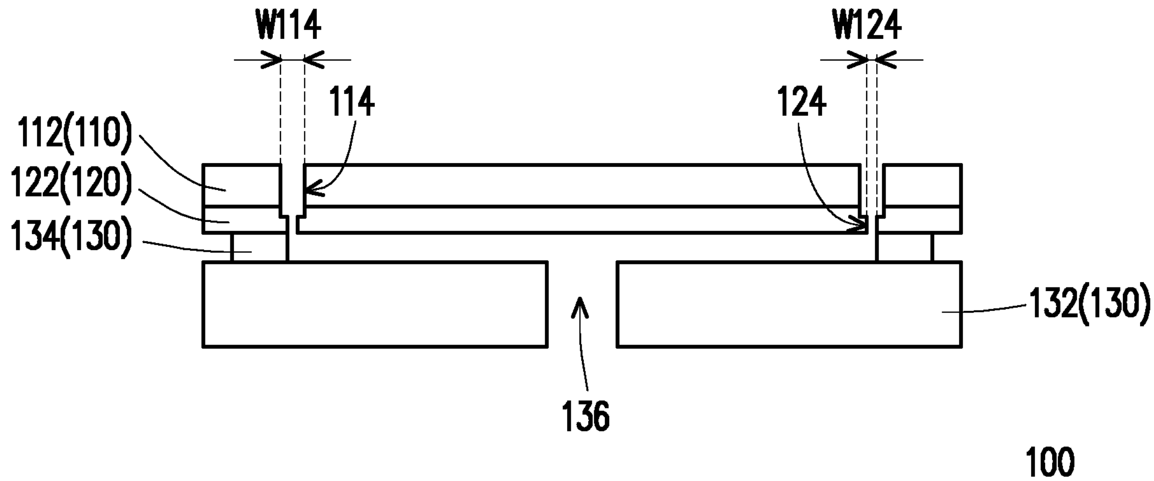
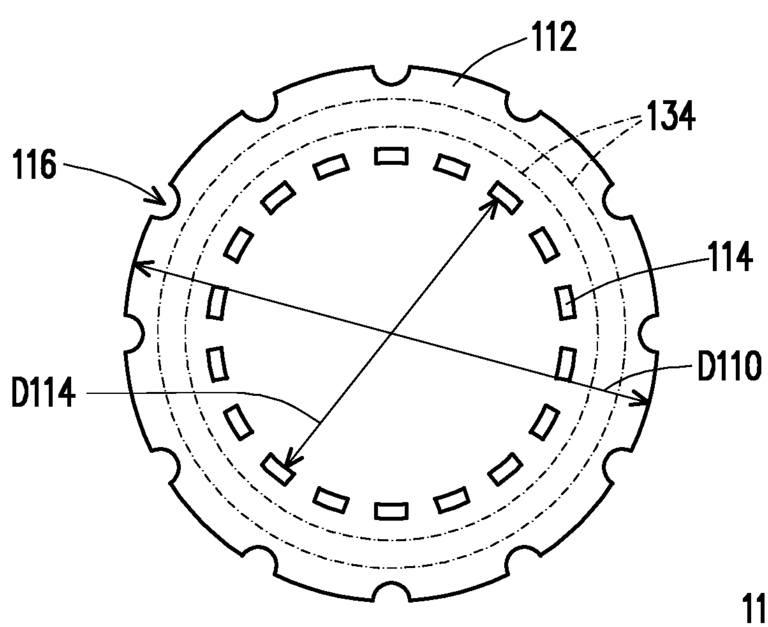

W114
W124
114
124
112(110)
122(120)
134(130)
132(130)
136
100

FIG. 2A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134
116
114
D110
D114
110

FIG. 2B

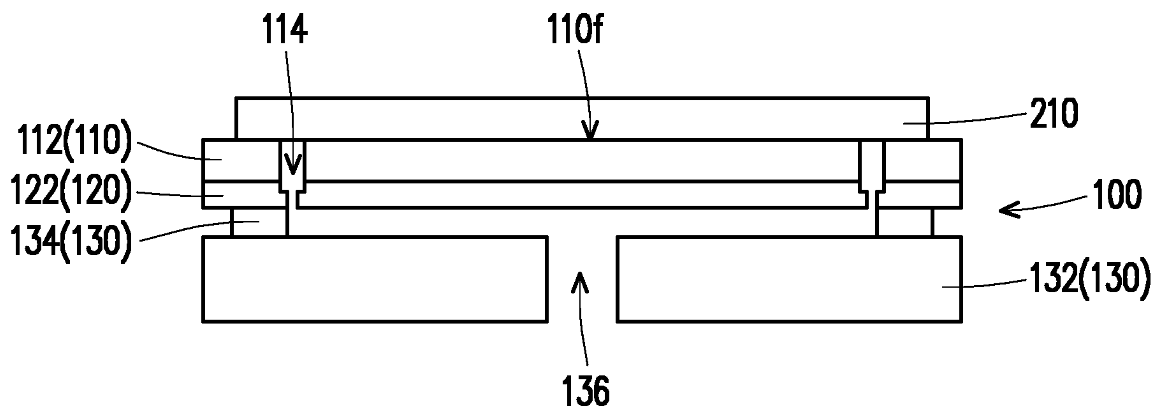

114
110f
210
112(110)
122(120)
100
134(130)
132(130)
136

FIG. 3A

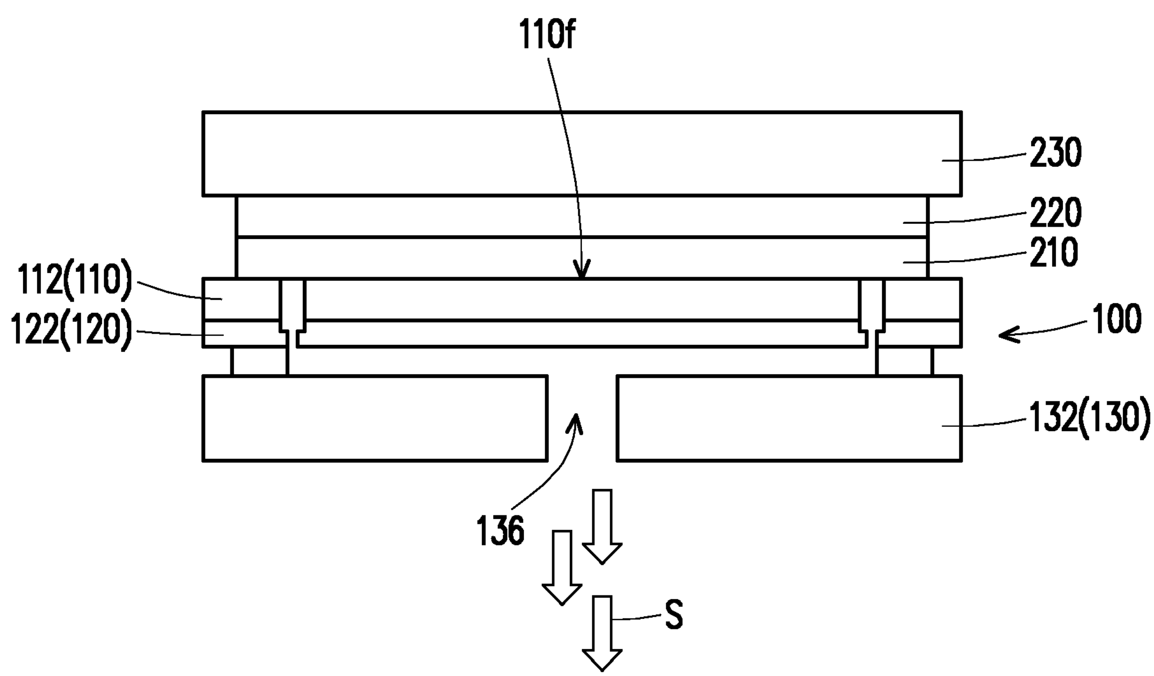

110f
230
220
210
112(110)
122(120)
100
132(130)
136
S

FIG. 3B

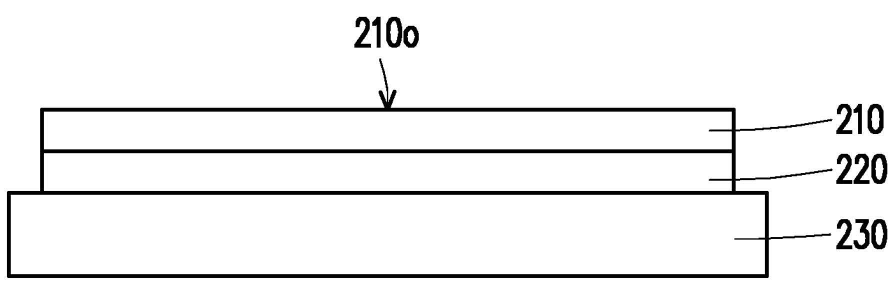


FIG. 3C

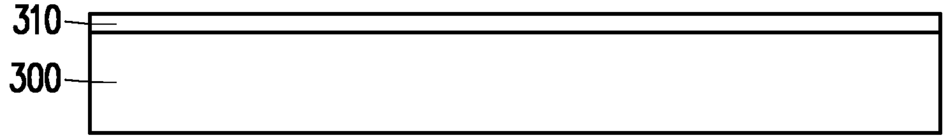


FIG. 4A

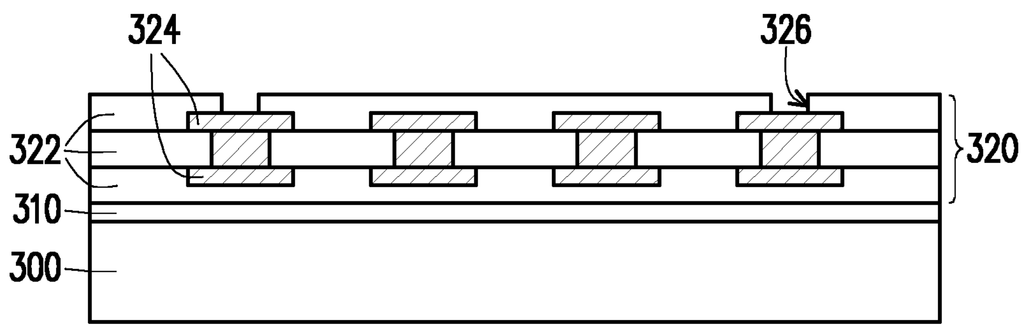
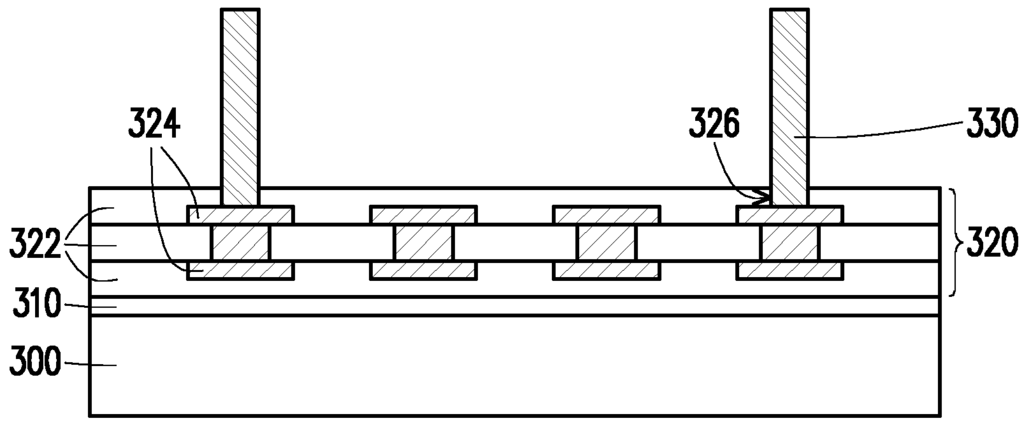


FIG. 4B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322
320
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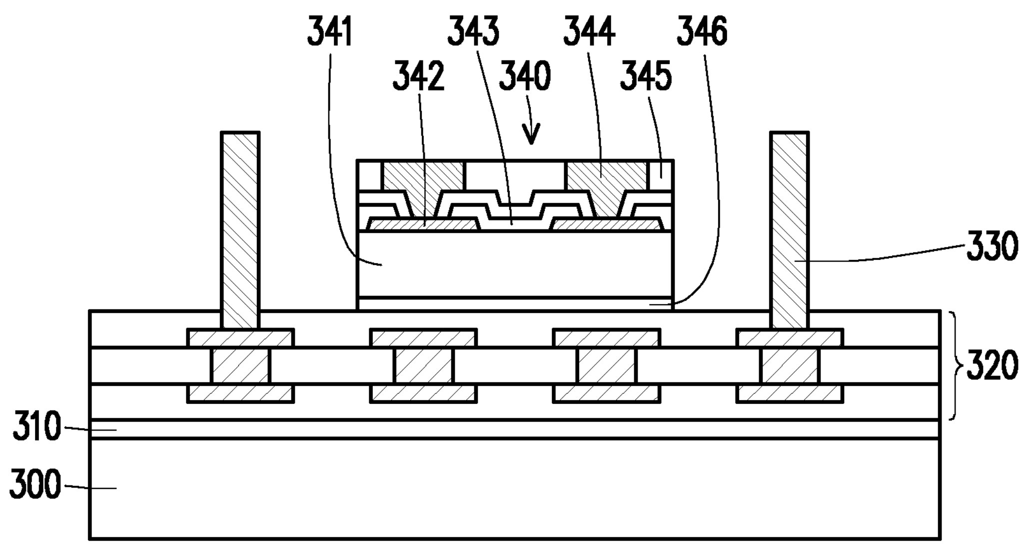
300

FIG. 4C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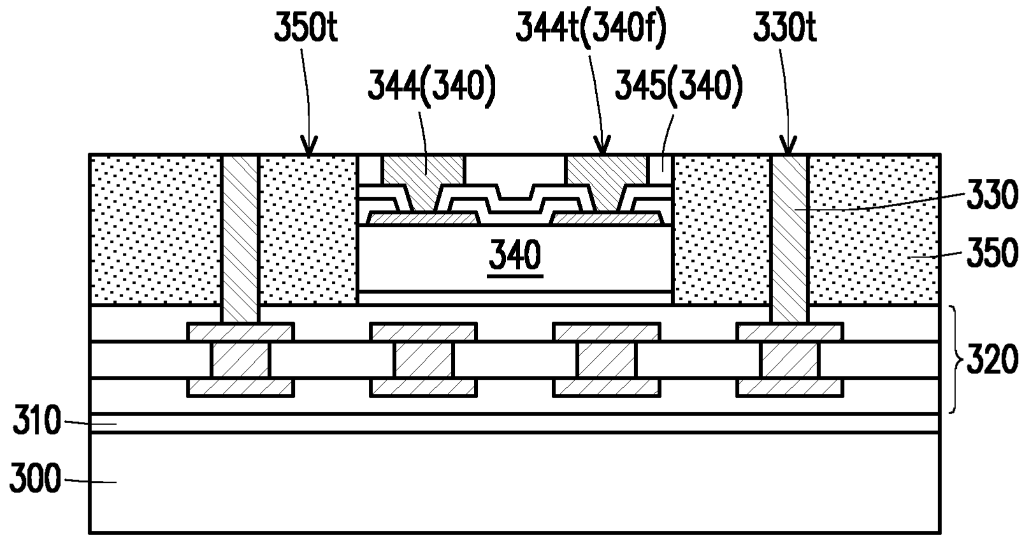
344
346
342
340
345
330
320
310
300

FIG. 4D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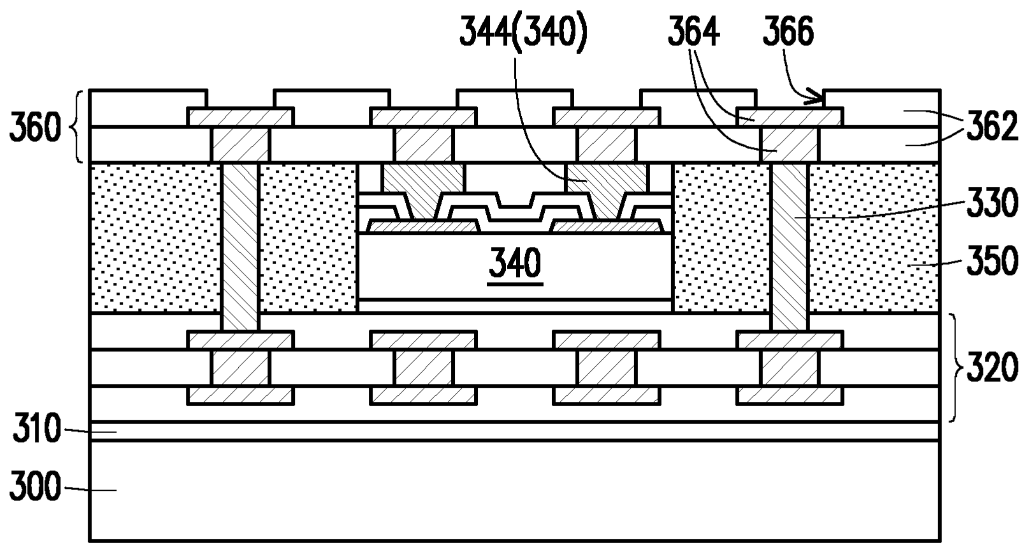
344t(340f)
330t
344(340)
345(340)
330
350
340
320
310
300

FIG. 4E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366
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362
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320
310
300

FIG. 4F

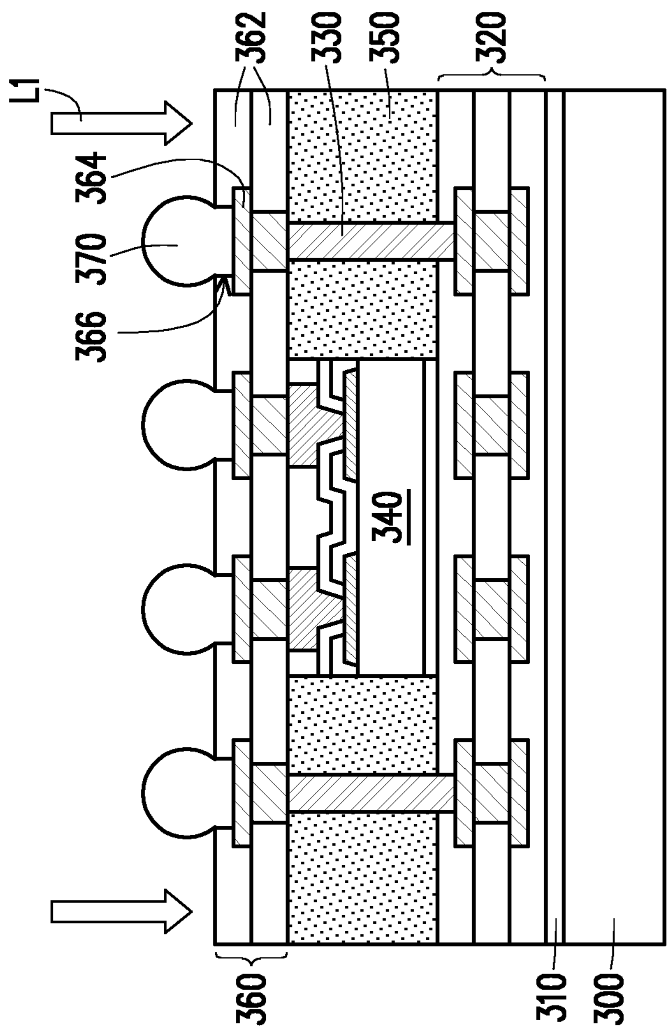

FIG. 4G

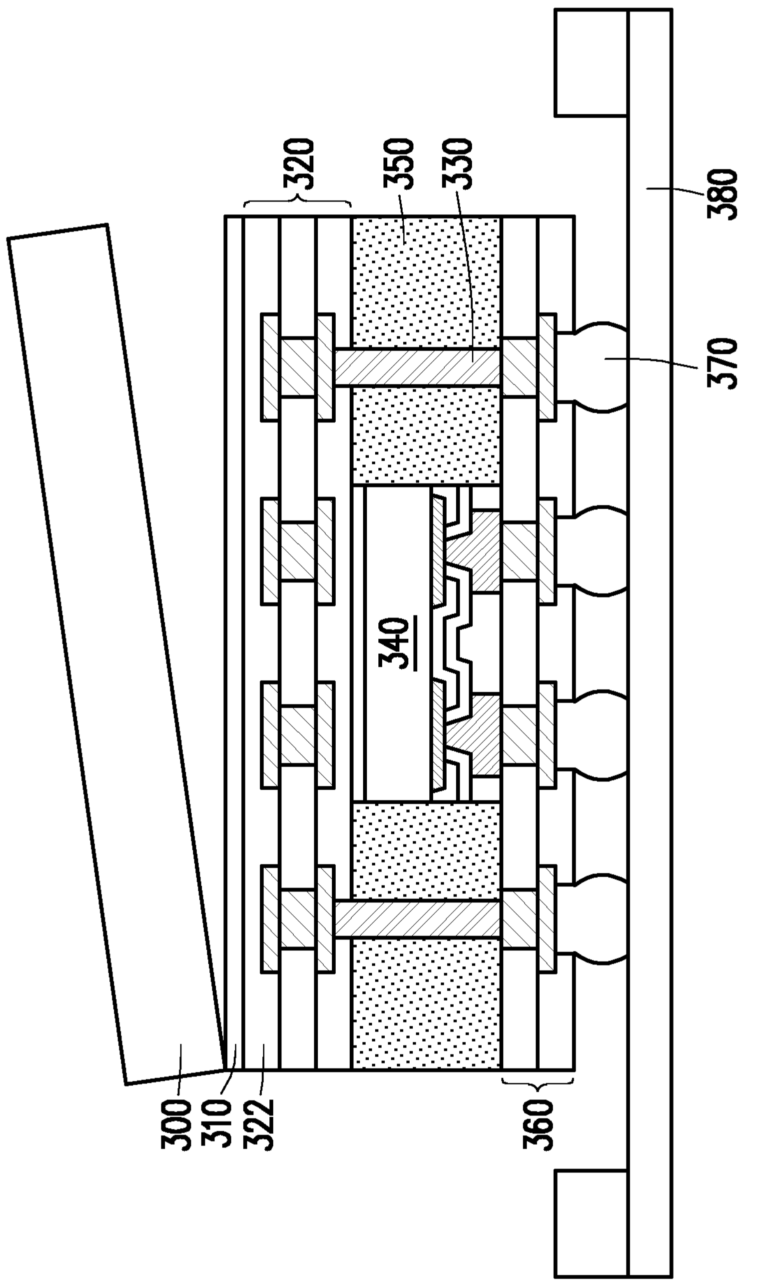

FIG. 4H

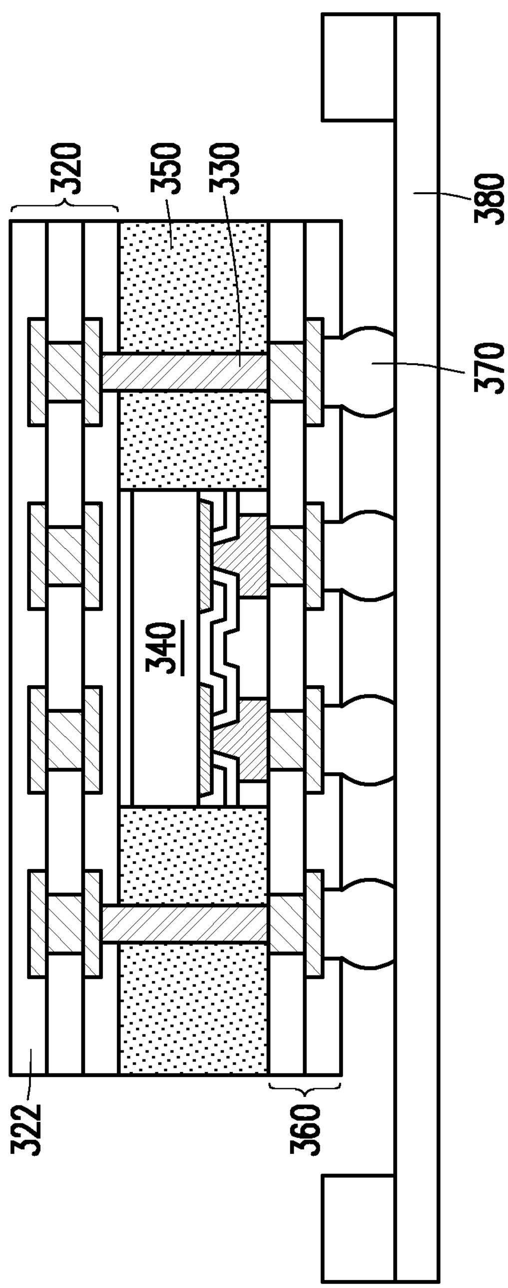

FIG. 4I

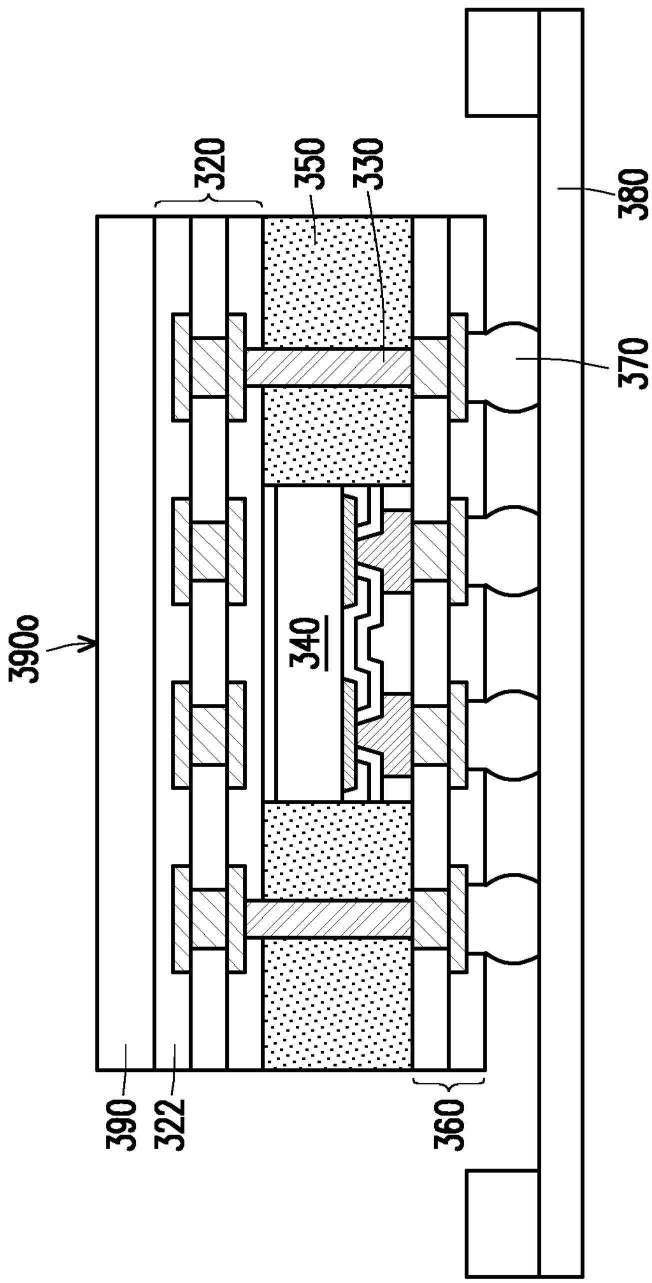

FIG. 4J

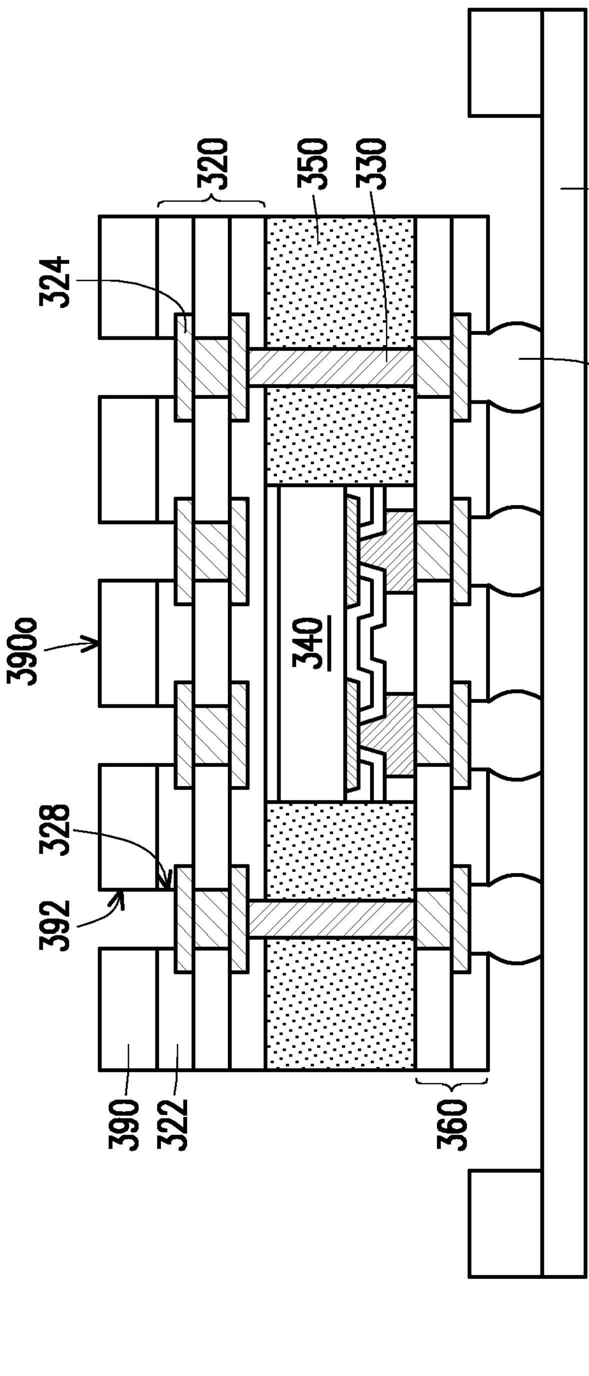

FIG. 4K

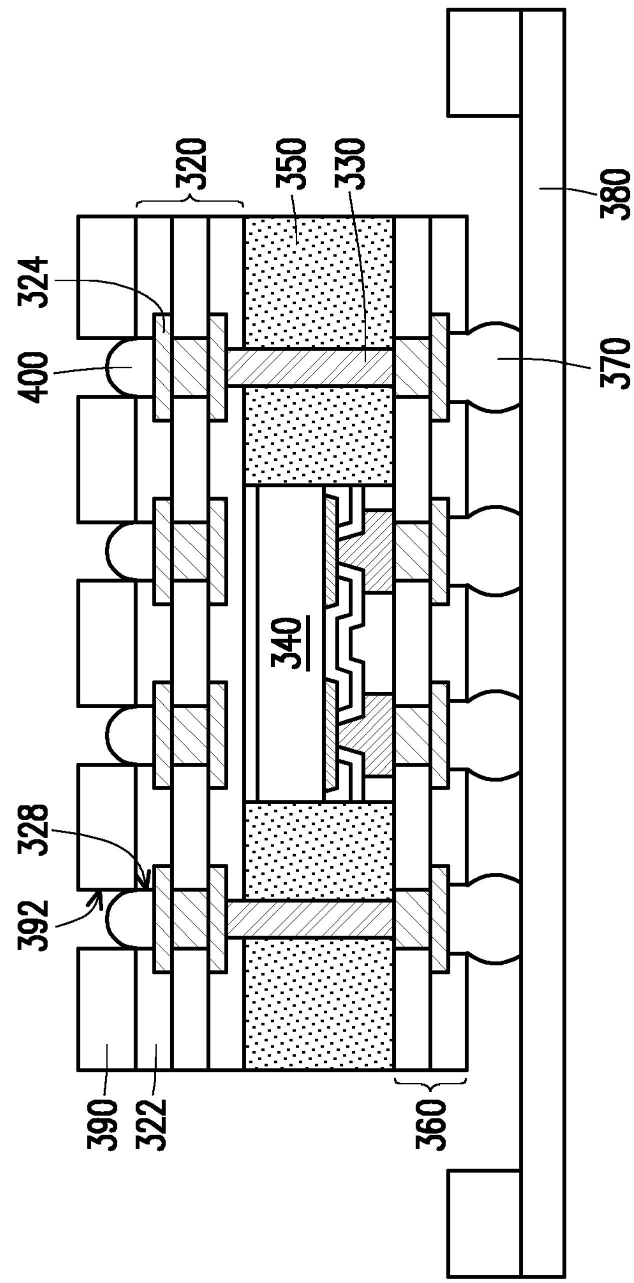

FIG. 4L

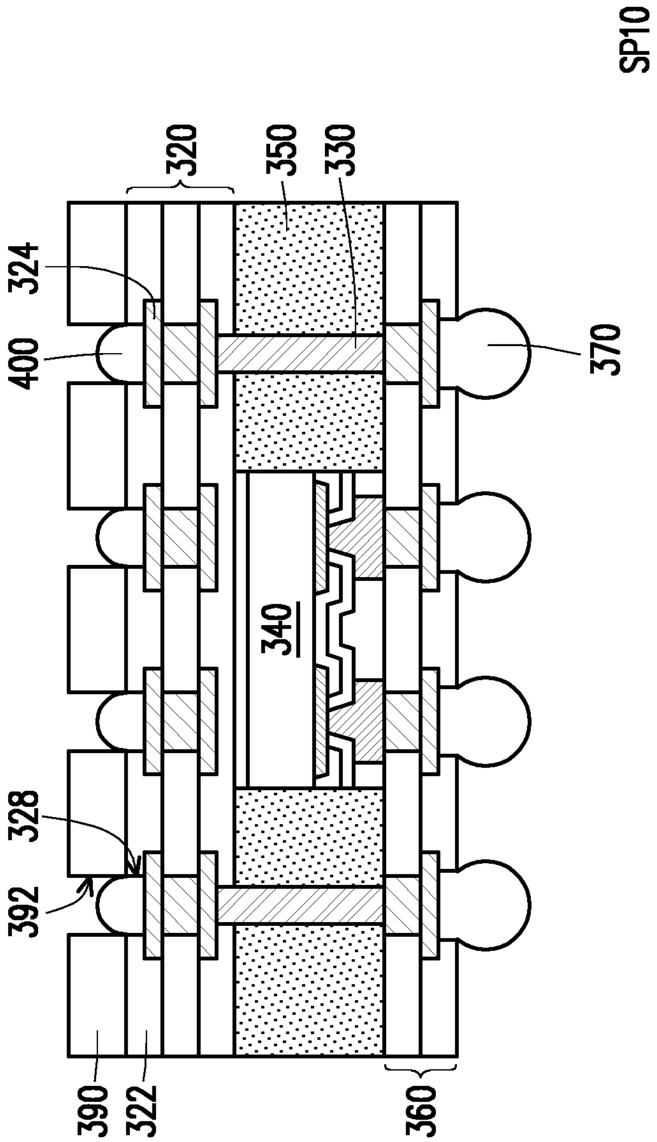

FIG. 4M

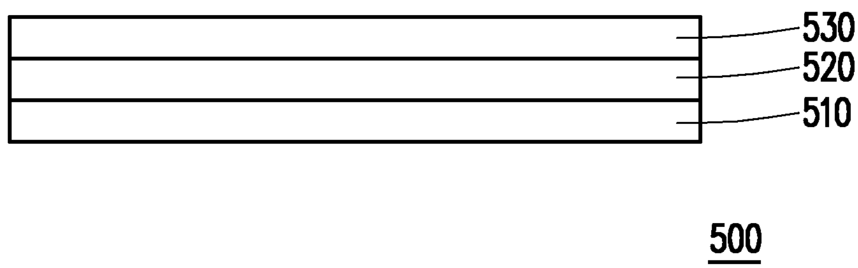

FIG. 5A

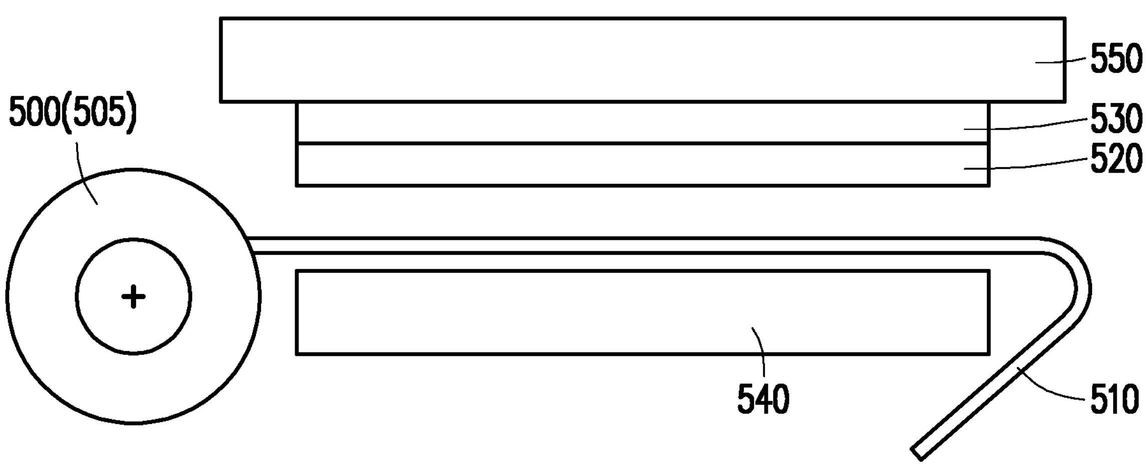

FIG. 5B

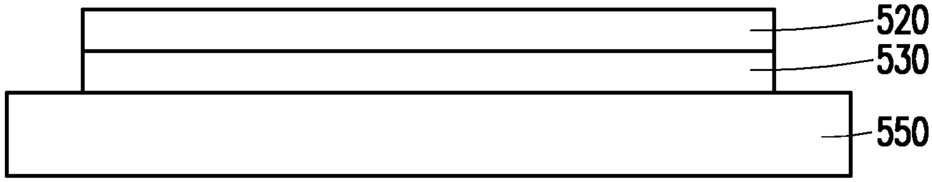

FIG. 5C

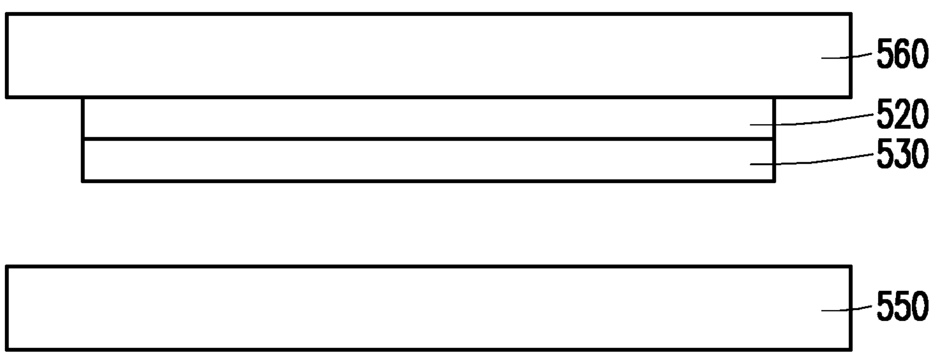

FIG. 5D

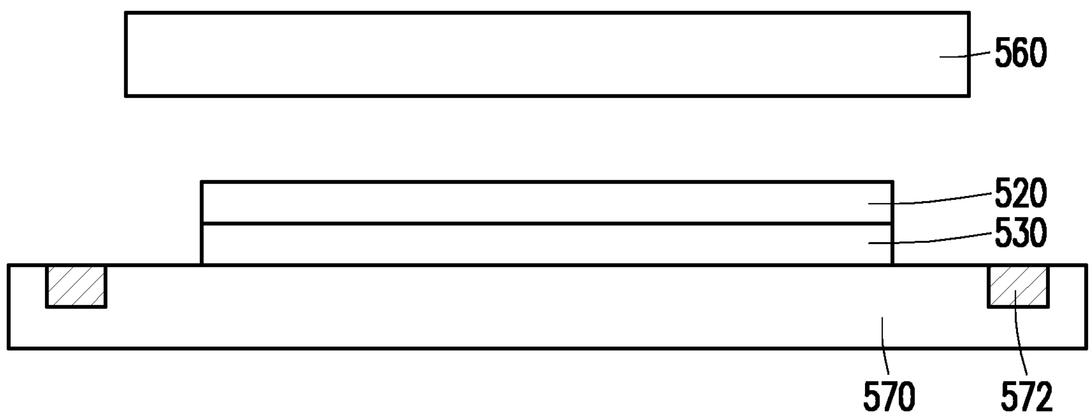

FIG. 5E

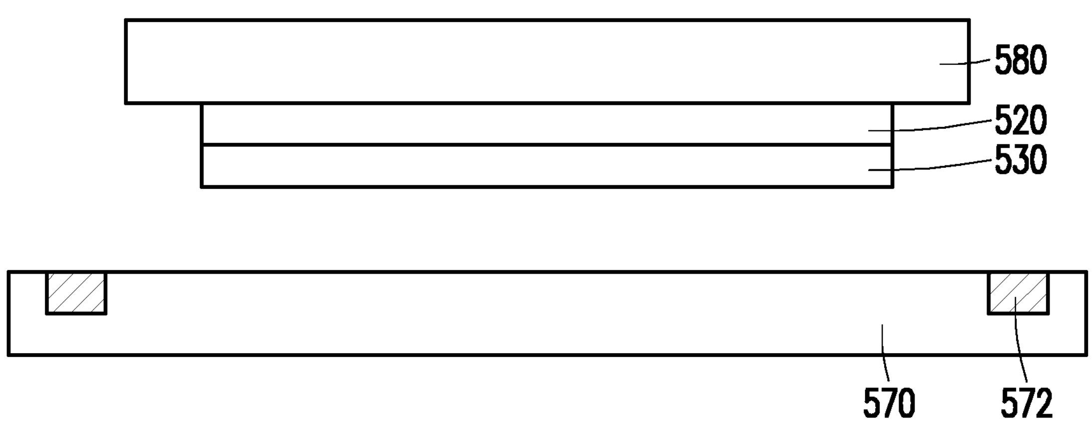

FIG. 5F

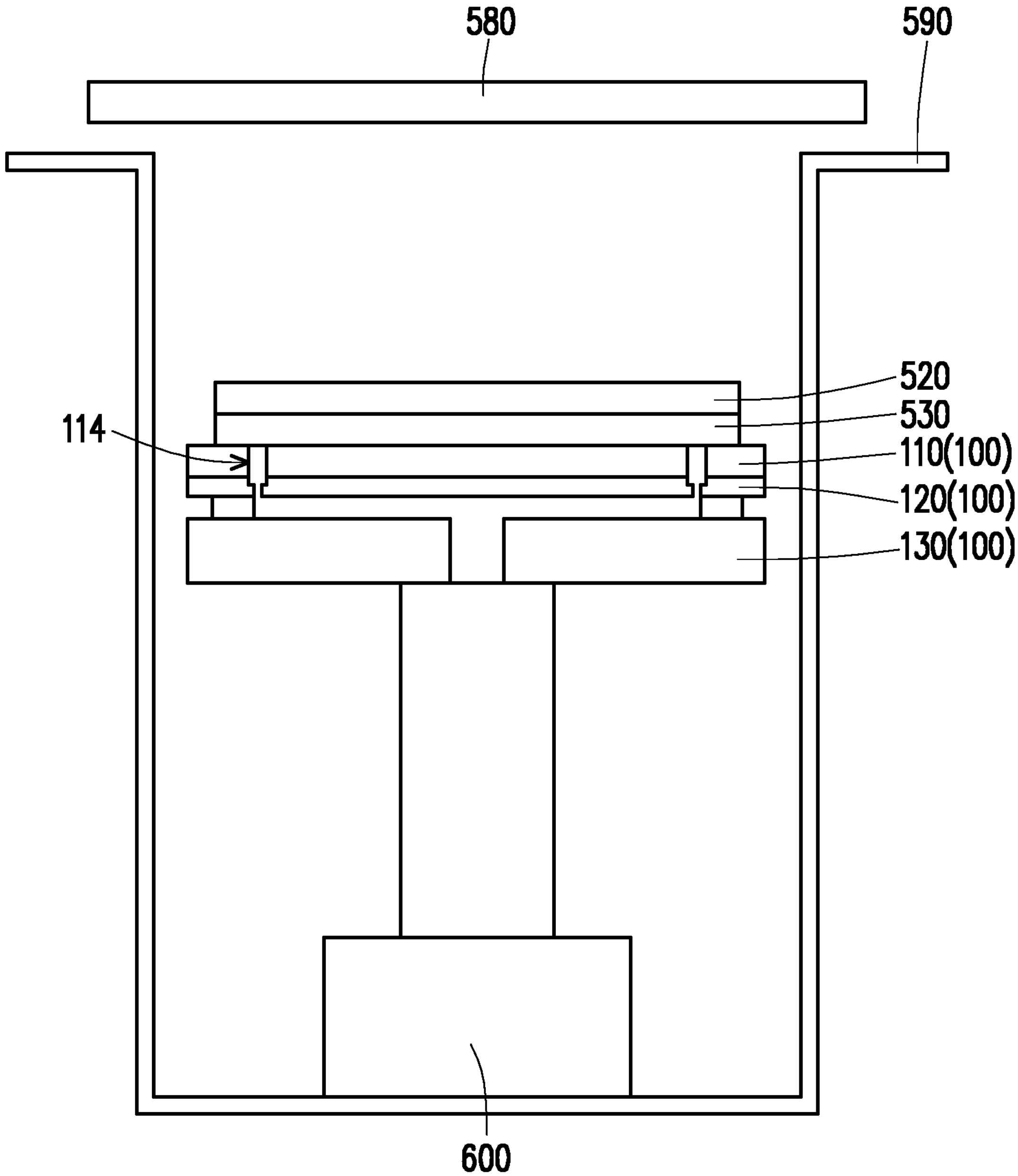

FIG. 5G

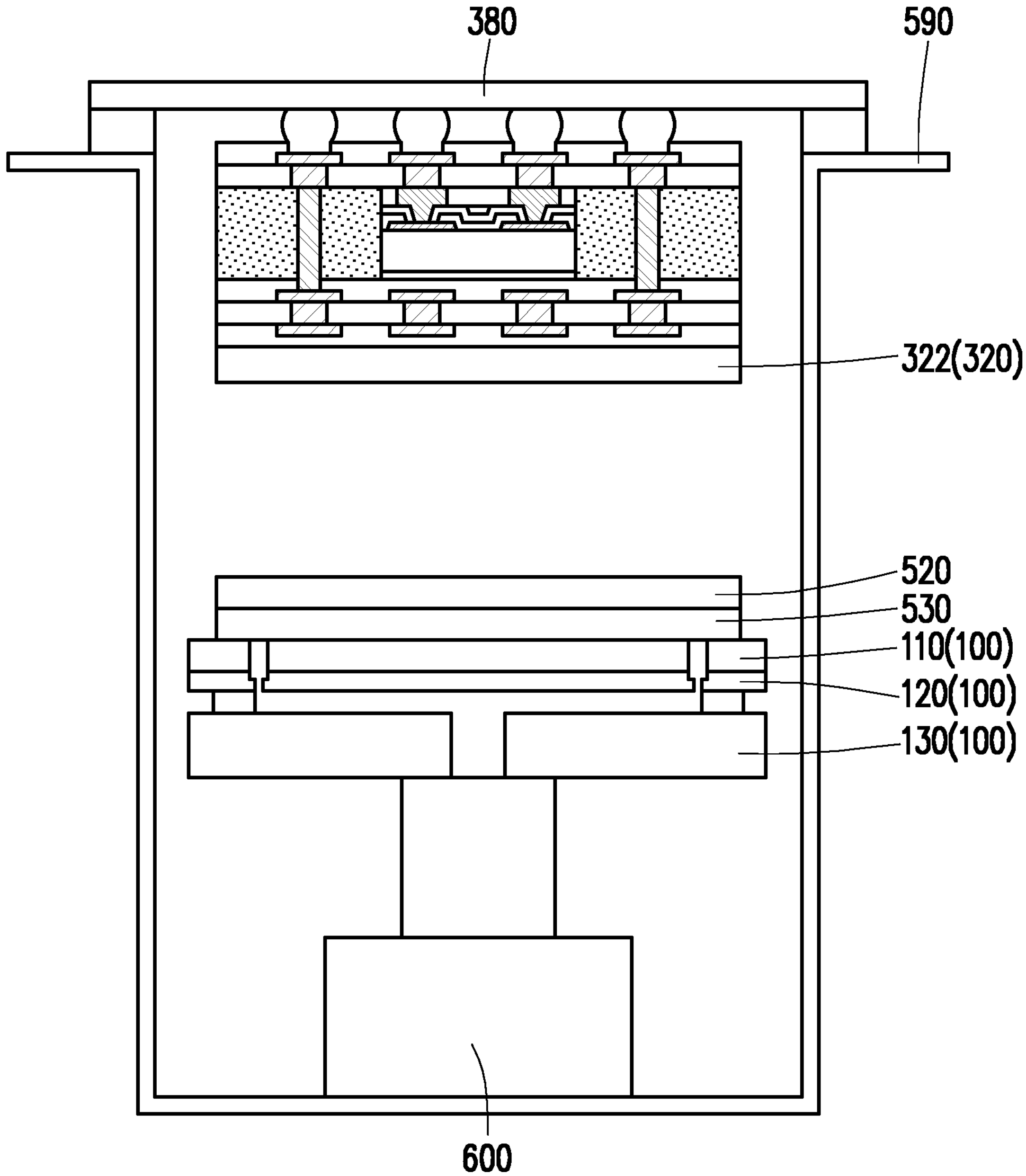

FIG. 5H

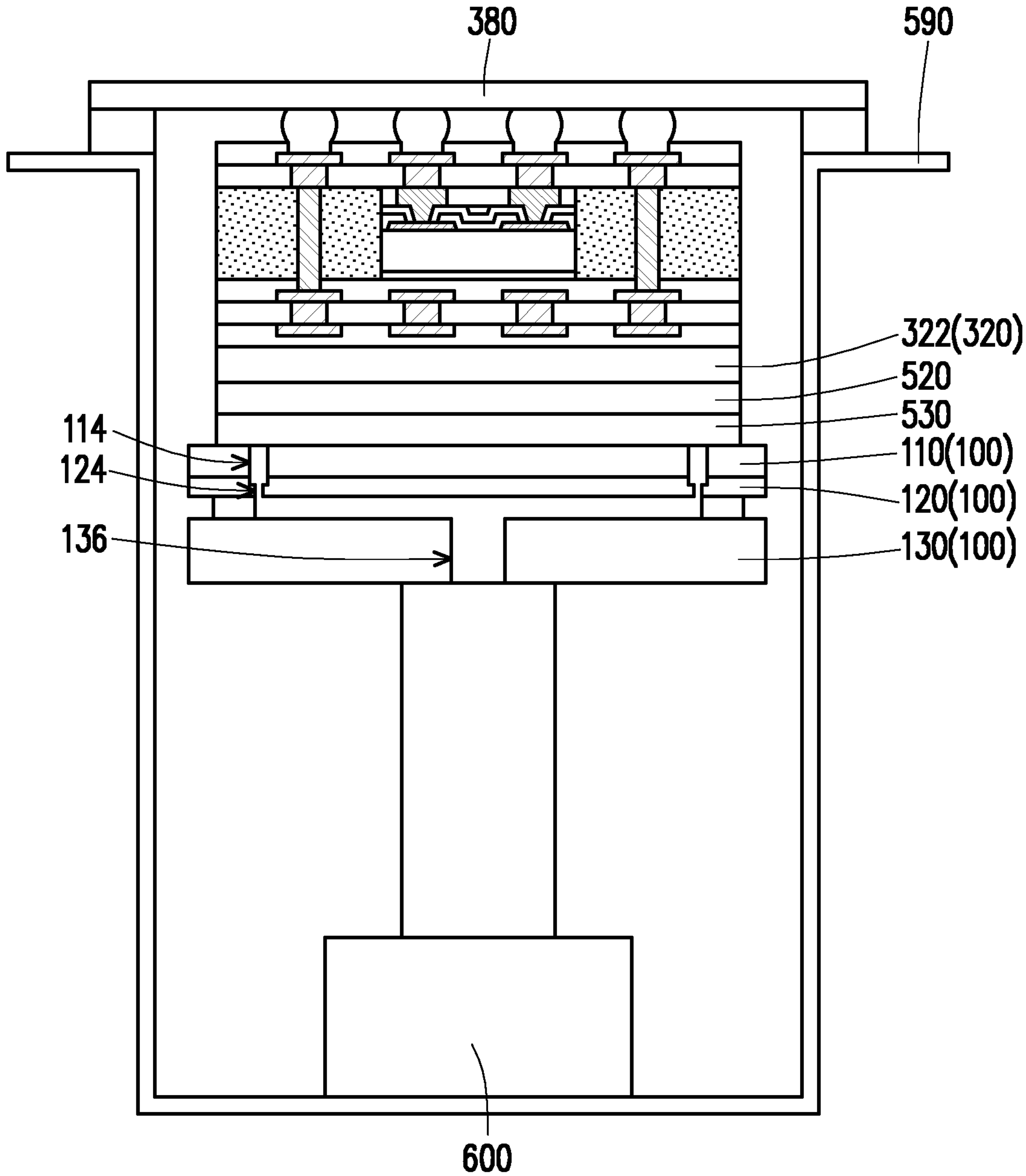

FIG. 5I

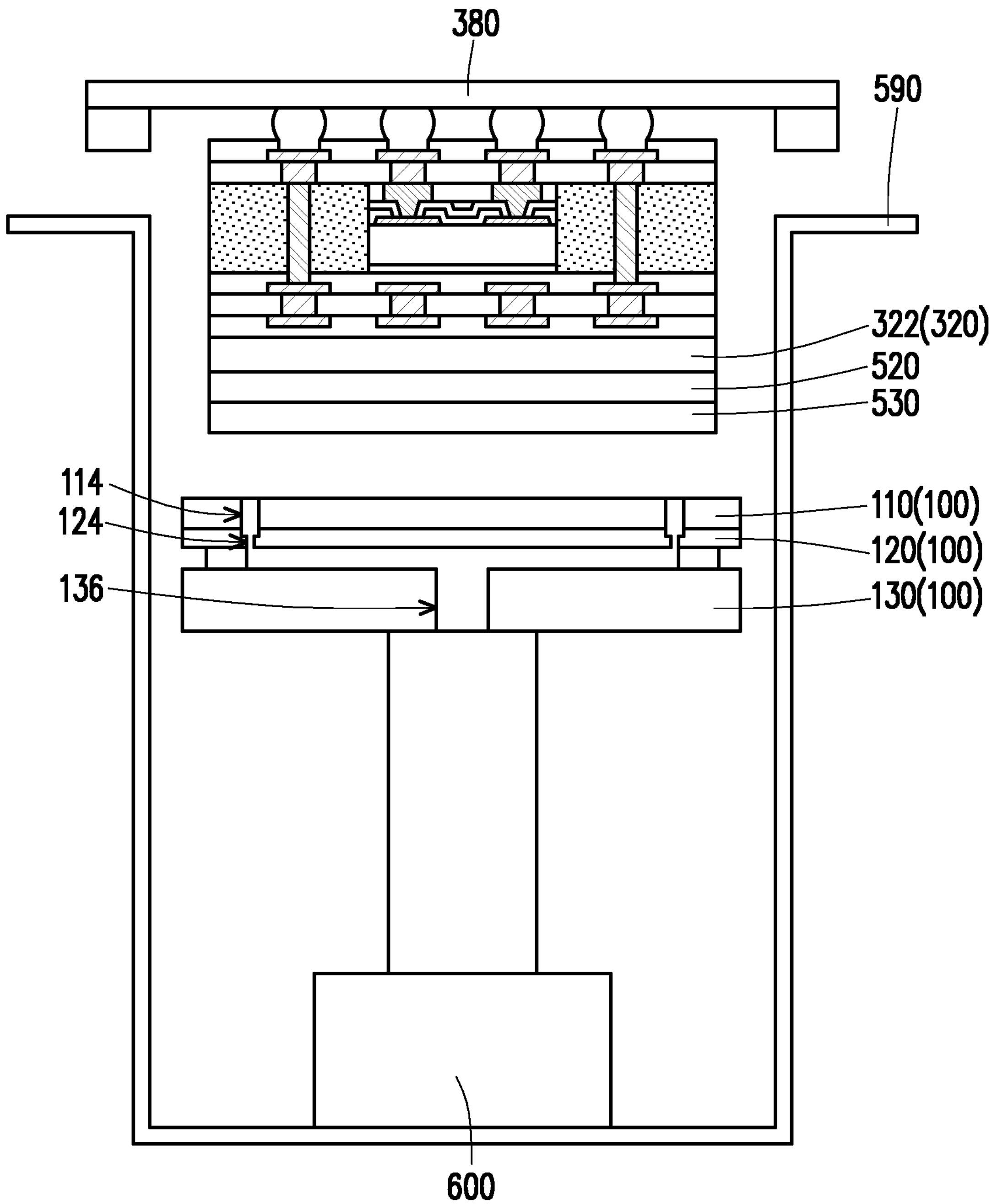

FIG. 5J

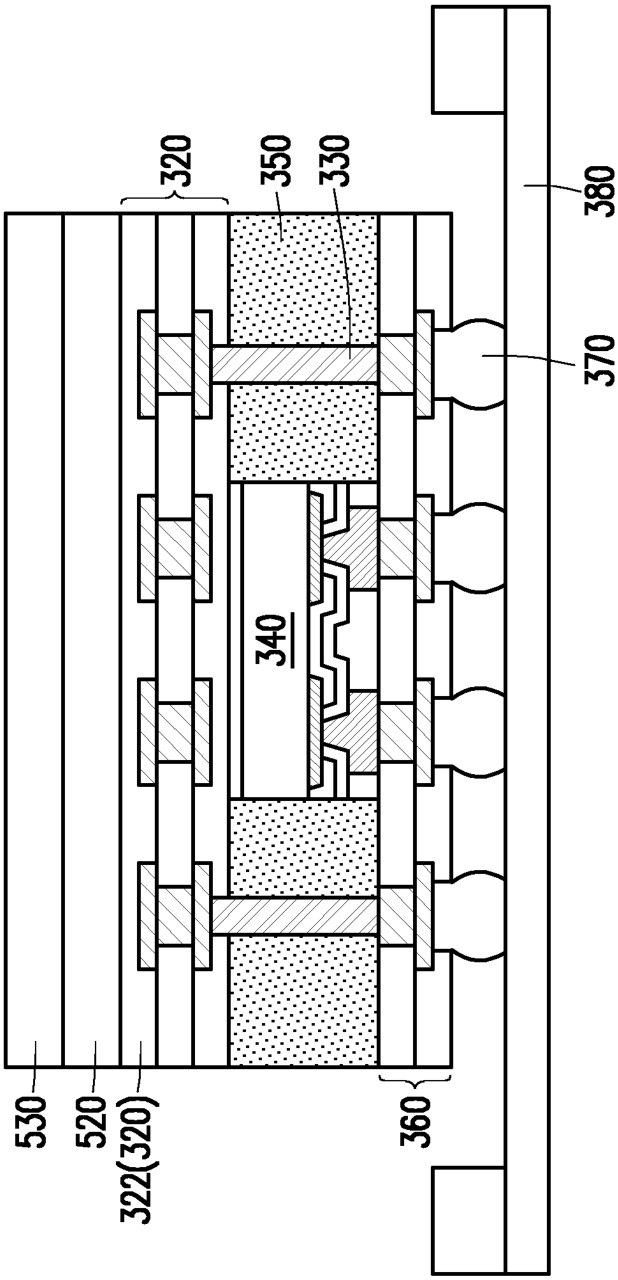

FIG. 5K

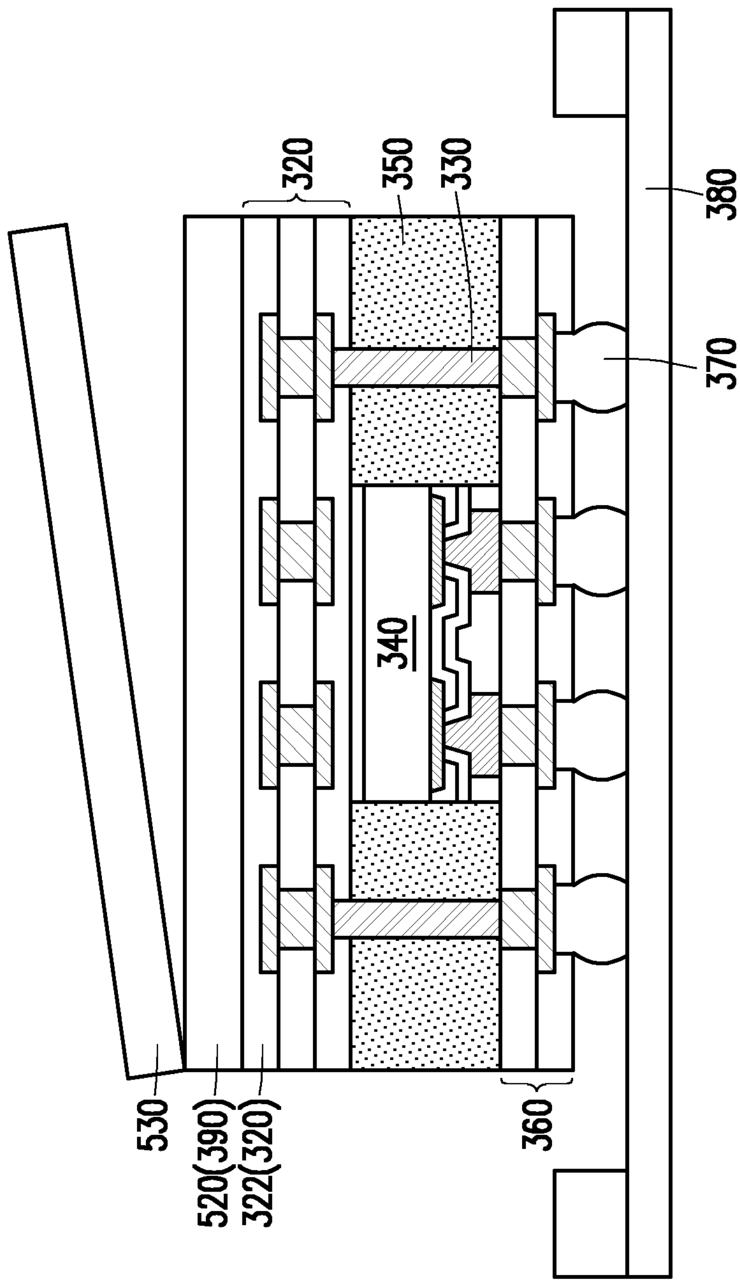

FIG. 5L

LAMINATION PROCESS, AND MANUFACTURING METHOD OF SEMICONDUCTOR PACKAGE USING A CHUCK

CROSS-REFERENCE TO RELATED APPLICATION

This application is a divisional application of and claims the priority benefit of a prior application Ser. No. 17/395,440, filed on Aug. 5, 2021, now pending. The prior application Ser. No. 17/395,440 claims the priority benefit of U.S. provisional application Ser. No. 63/168,274, filed on Mar. 31, 2021. The entirety of the above-mentioned patent application is hereby incorporated by reference herein and made a part of this specification.

BACKGROUND

Semiconductor devices and integrated circuits used in a variety of electronic apparatus, such as cell phones and other mobile electronic equipment, are typically manufactured on a single semiconductor wafer. The dies of the wafer may be processed and packaged with other semiconductor devices or dies at the wafer level, and various technologies and applications have been developed for wafer level packaging. Integration of multiple semiconductor devices has become a challenge in the field. To respond to the increasing demand for miniaturization, higher speed, and better electrical performance (e.g., lower transmission loss and insertion loss), more creative packaging and assembling techniques are actively researched.

BRIEF DESCRIPTION OF THE DRAWINGS

Aspects of the present disclosure are best understood from the following detailed description when read with the accompanying figures. It is noted that, in accordance with the standard practice in the industry, various features are not drawn to scale. In fact, the dimensions of the various features may be arbitrarily increased or reduced for clarity of discussion.

FIG. **1**A is a schematic exploded view of a lamination chuck according to some embodiments of the present disclosure.

FIG. **1**B is a schematic perspective view of a lamination chuck according to some embodiments of the present disclosure.

FIG. **2**A is a schematic cross-sectional view of a lamination chuck according to some embodiments of the present disclosure.

FIG. **2**B is a schematic top view of a top layer of a lamination chuck according to some embodiments of the present disclosure.

FIG. **3**A to FIG. **3**C are schematic cross-sectional views of structures formed during a lamination process according to some embodiments of the present disclosure.

FIG. **4**A to FIG. **4**M are schematic cross-sectional view of structures formed during a manufacturing process of a semiconductor package according to some embodiments of the present disclosure.

FIG. **5**A to FIG. **5**L are schematic cross-sectional views of structures formed during a lamination process according to some embodiments of the disclosure.

DETAILED DESCRIPTION

The following disclosure provides many different embodiments, or examples, for implementing different features of the provided subject matter. Specific examples of components and arrangements are described below to simplify the present disclosure. These are, of course, merely examples and are not intended to be limiting. For example, the formation of a first feature over or on a second feature in the description that follows may include embodiments in which the first and second features are formed in direct contact, and may also include embodiments in which additional features may be formed between the first and second features, such that the first and second features may not be in direct contact. In addition, the present disclosure may repeat reference numerals and/or letters in the various examples. This repetition is for the purpose of simplicity and clarity and does not in itself dictate a relationship between the various embodiments and/or configurations discussed.

Further, spatially relative terms, such as "beneath," "below," "lower," "above," "upper" and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. The spatially relative terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. The apparatus may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein may likewise be interpreted accordingly.

Other features and processes may also be included. For example, testing structures may be included to aid in the verification testing of the 3D packaging or 3DIC devices. The testing structures may include, for example, test pads formed in a redistribution layer or on a substrate that allows the testing of the 3D packaging or 3DIC, the use of probes and/or probe cards, and the like. The verification testing may be performed on intermediate structures as well as the final structure. Additionally, the structures and methods disclosed herein may be used in conjunction with testing methodologies that incorporate intermediate verification of known good dies to increase the yield and decrease costs.

FIG. **1**A is a schematic exploded view of a lamination chuck **100** according to some embodiments of the disclosure. FIG. **1**B is a schematic perspective view of the lamination chuck **100** according to some embodiments of the disclosure. FIG. **2**A is a schematic cross-sectional view of the lamination chuck **100** according to some embodiments of the disclosure. FIG. **2**B is a schematic cross-sectional view of a top layer **110** of the lamination chuck **100** according to some embodiments of the disclosure. Referring to FIG. **1**A to FIG. **2**B, the top layer **110** may have a body **112** including (or made of) a soft and elastic material, such as a polymeric material. In some embodiments, the polymeric material includes a rubber with Shore A hardness in the range from 20 to 50. In some embodiments, the polymeric material includes powder-free sponge, such as carbon powder free sponge (compatible with clean room class 100 regulation whereas substantially zero particle number for the particle size larger than 5 microns) with Shore A hardness in the range from 10 to 20 and being a porous material having tiny close pores of about or less than 10 microns. In some embodiments, the top layer **110** includes one or more vacuum channels **114**, extending through the body **112** from one side to the opposite side of the body **112** along a thickness direction of the body **112**. The vacuum channels **114** may extend completely through the body **112**, in a direction perpendicular to the front surface **112*f*** and the opposite rear surface **112*r*** of the body **112**, thus creating fluidic communication between opposite sides of the body **112**. A side surface **112*s*** of the body **112** joints the front surface **112*f*** (the front surface **110*f*** of the top layer **110**) to the opposite rear surface **112*r*** (the rear surface **110*r*** of the top layer **110**). The side surface **112*s*** may be considered an outer edge of the top layer **110**. In some embodiments, the body **112** may have a cylindrical shape, for example with a height (e.g., a thickness T**110** of the body **112**) in the range from 400 micrometers to about 3 millimeters. However, the shape of the body **112** (and of the lamination chuck **100**) is not particularly limited, and, while in the drawings the lamination chuck **100** and the top layer **110** are shown as cylindrical, with circular outlines, other shapes (e.g., elliptical, polygonal—rectangular, square, pentagonal, hexagonal, heptagonal, octagonal, etc.) are also contemplated within the scope of the disclosure, for example depending on the shape of the substrate to be processed.

In some embodiments, the vacuum channel(s) **114** may have an outline substantially parallel to a section of the side surface **112*s*** of the body **112**. For example, when the body **112** has a cylindrical shape, the vacuum channel(s) may be formed in an annular arc shape, at a certain distance from the side surface **112*s*** of the body **112**. In some embodiments, a plurality of vacuum channels **114** is formed in the top layer **110**, extending at a (in some cases, regular) distance from each other along the periphery of the top layer **110**, with ends opening at the front surface **112*f*** of the body and at the opposite rear surface **112*r*** of the body. For example, for a cylindrical body **112** such as the one of FIG. **1** and FIG. **2**B, the vacuum channels **114** may be formed as arcs of an annular region of inner diameter D**114** smaller than the diameter D**110** of the top layer **110**, where the annular region of inner diameter D**114** and the circumference of the body **112** of diameter D**110** are concentric. For example, the ratio of the inner diameter D**114** of the annular region of the vacuum channels **114** to the diameter D**110** of the top layer **110** may be about in the range from 0.98 to 0.99. By way of example and not of limitation, when the diameter D**110** of the top layer **110** is about 300 mm, the inner diameter D**114** of the annular region where the vacuum channels **114** are formed may be in the range from 295 to 297 mm. In some embodiments, the width W**114** of the vacuum channels **114** (measured in a radial direction for annular shapes, and perpendicular to the edges for frame shapes) may be up to about 1 mm, for example up to about 800 micrometers. While specific shapes and geometries have been described above for the vacuum channels **114**, the disclosure is not limited thereto. For example, the region in which the vacuum channels **114** are formed is not limited to be an annular region, and, in some alternative embodiments, may be shaped as a frame of different outlines (e.g., elliptical, polygonal—square, rectangular, pentagonal, hexagonal, octagonal, etc.). Similar relationships to the one described above may exist between characteristic dimensions of the other shapes when the top layer **110** and/or the region of the vacuum channels **114** are formed in other shapes. For example, the top layer **110** may be rectangular or square, and the region of the vacuum channel **114** may be a concentric rectangular or square frame region, with the ratio of the respective diagonals in the range indicated above. In some embodiments, combinations of different shapes are also possible (e.g., a square top layer **110** and a concentric annular region for the vacuum channels **114**), with the ratio of the characteristic dimensions of the shapes being in the above range (e.g., the ratio of the inner diameter D**114** of the annual region to a diagonal of the square, etc.).

In some embodiments, the top layer **110** is disposed on a support layer **120**. The support layer **120** may have a body **122** including (or made of) a rigid material. That is, the material of the body **122** may be harder than the material of the body **112**. For example, the body **122** may include (or be made of) a hard metal or alloys, such as stainless steel or aluminum alloys with Rockwell B-type hardness of about 70-90. In some embodiments, the body **122** of the support layer **120** is larger than the body **112** of the top layer **110**, so that when the body **112** is disposed on the body **122**, the body **122** laterally protrudes with respect to the body **112**. In some embodiments, the body **112** of the top layer **110** is bonded to body **122** of the support layer **120**, for example by thermal pressing. The body **122** may present similar features to the body **112**. For example, the body **112** and the body **122** may have similar shapes, so that if the body **112** is cylindrical, also the body **122** is cylindrical. However, the disclosure is not limited thereto, and other combinations of shapes (e.g., a cylindrical body **112** on a parallelepiped body **122**, etc.) are possible and contemplated in the disclosure. In some embodiments, the thickness T**120** of the support layer **120** may be about in the range from 3 mm to 7 mm, for example about 5 mm.

In some embodiments, one or more vacuum channels **124** are formed extending from one side to an opposite side of the body **122** along a thickness direction of the body **122**, that is, extending from the front surface **122*f*** of the body **122** (the front surface **120*f*** of the support layer **120**) up to the opposite rear surface **122*r*** (the rear surface **120*r*** of the support layer **120**). The one or more vacuum channels **124** are formed in positions corresponding to the one or more vacuum channels **114** of the top layer **110**. As such, when the top layer **110** is disposed on the support layer **120**, the vacuum channels **114** of the top layer **110** are aligned with the vacuum channels **124** of the support layer **120**, thus forming combined vacuum channels (**114+124**) extending from the front surface **112*f*** of the top layer **112** to the rear surface **122*r*** of the support layer **120**. In some embodiments, the vacuum channels **124** may be formed of similar shape to the vacuum channels **114**. For example, in the lamination chuck **100** of FIG. **1** both the vacuum channels **114** and the vacuum channels **124** have the outlines of annular arcs. In some embodiments, the vacuum channels **124** may have substantially the same sizes as those of the vacuum channels **114**. In some embodiments, the vacuum channels **124** may be narrower than the vacuum channels **114**, so that the width W**124** of the vacuum channels **124** (measured along the same radial direction as the width W**114**) may be smaller than the width W**114** of the vacuum channels **114**. That is, proceeding from the front surface **110*f*** of the top layer **110** towards the rear surface **120*r*** of the support layer **120**, the combined vacuum channels (**114+124**) may become increasingly narrow. In some embodiments, the upper part of the vacuum channel(s) **124** have the same width W**114** as the overlying vacuum channel(s) **114**, and the lower part of the vacuum channel(s) **124** have the narrower width W**124**. That is, the constriction of the combined vacuum channel(s) (**114+124**) may be located along the vacuum channel(s) **124** of the support layer **120**.

In some embodiments, the top layer **110** and the support layer **120** may be disposed on a base **130**. The base **130** includes a body **132** on which the support layer **120** and the top layer **110** are disposed. In some embodiments, the base **130** includes an insulation wall **134** protruding from a front surface **132*f*** of the body **132** (a front surface **130*f*** of the base **130**), and, when assembled, the support layer **120** rests on the insulation wall **134**. As illustrated by the footprint of the insulation wall **134** illustrated in FIG. **2**B with dash-dotted lines, an inner dimension of the insulation wall **134** may be sufficiently large so that the insulation wall **134** encircles the vacuum channels **114**, **124** when the support layer **120** and the top layer **110** are disposed on the base **130**. That is, the vacuum channels **124** open to an area encircled by the insulation walls **134**. In some embodiments, the insulation wall **134** has a similar shape as the region in which the vacuum channels **114**, **124** are formed. For example, when the vacuum channels **114**, **124** are formed as annular arcs of an annular region, the insulation wall **134** may have an annular shape with an inner diameter larger than the outer diameter of the annular region in which the vacuum channels **114**, **124** are formed. However, as for the region where the vacuum channels **114**, **124** are formed, also the shape of the insulation wall **134** is not limited by the disclosure. In some alternative embodiments, the insulation wall **134** may form frames of different outline (e.g., elliptical, polygonal-rectangular, square, pentagonal, hexagonal, heptagonal, octagonal, etc.). In some embodiments, the rear surface **120***r* of the support layer **120** may be substantially flat (e.g., as shown in FIG. 1A) so that the support layer **120** rests on the insulation wall **134**, and is separated from the front surface **132***r* of the body **132** by a distance corresponding to the thickness of the insulation wall **134**.

In some embodiments, one or more through holes **136** are formed in the region of the base **130** encircled by the insulation wall **134**. For example, a through hole **136** is illustrated in FIG. **1**A as vertically extending in the central region of the base **130** from the rear surface **132***r* of the body **132** to the front surface **132***f* of the body **132**, with the end at the side of the front surface **132***f* being surrounded by the insulation wall **134**. In some embodiments, the insulation wall **134** acts as a spacer between the body **132** of the base and the support layer **120**, so that a gap remains between the rear surface **120***r* of the support layer **120** and the front surface **132***f* of the body **132**. Therefore, even though the through hole **136** of the base **130** is vertically misaligned with respect to the vacuum channels **124**, **114**, such vacuum channels **114**, **124** are still connected to the through hole **136**, so that fluidic communication is established between the rear surface **130***r* of the base **130** and the front surface **110***f* of the top layer **110**. That is, the when the top layer **110** and the support layer **120** are disposed on the base **130**, the combined vacuum channels (**114**+**124**) may be considered branches of a channel extending from the end of the through hole **136** at the rear surface **130***r* of the base to the ends of the vacuum channels **114** at the front surface **110***f* of the top layer **110**. In some embodiments, by connecting a vacuum pump to the through hole **136** of the base **130**, a suction applied to the through hole **136** is transmitted to the vacuum channels **114**, **124**. In some embodiments, the insulation wall **134** contacts the support layer **120**, whereby the suction applied to the through hole **136** of the base **130** is also applied to the vacuum channels **114**, **124**. In some embodiments, connecting structures (not shown) may be formed at the rear side **130***r* of the base **130**, to connect the lamination chuck **100** to the vacuum pump and/or any other machine which may be needed when operating the lamination chuck **100**. For example, the lamination chuck **100** may be additionally connected to servo motors enabling movement (e.g., vertical movement) of the lamination chuck **100** during operation.

In some embodiments, the top layer **110** and the support layer **120** may be secured to the base **130** via fasteners **140**, such as screws, bolts or the like or the like. For example, the support layer **120** may have formed therethrough one or more through holes **126**, in which fasteners **140** are disposed to be tightened into holes **138** formed in the base **130**. One or both of the through holes **126** of the support layer **120** and the holes **138** of the base **130** may be threaded. In some embodiments, the holes **138** of the base **130** may be blind holes. In some embodiments, fastening semi-holes **116** are formed along the side surface **112***s* of the body **112**. The fastening semi-holes **116** may be hemicylindrical concavities formed at intervals from each other along the side surface **112***s* of the body **112**, and, as the vacuum channels **114**, may extend from the front surface **112***f* of the body **112** to the rear surface **112***r* of the body **112**, for the entire thickness T**110** of the top layer **110**. In some embodiments, when the lamination chuck **100** is assembled, the fastening semi-holes **116** are vertically aligned with the through holes **126** of the support layer **120** and the holes **138** of the base **130**. For example, when screws are used as the fasteners **140**, the body **142** of the screws may be at least partially accommodated in the fastening semi-holes **116**, and further pass through the through holes **126** to be received in the holes **138**. The heads **144** of the screws may at least partially overlap with the front surface **110***f* of the top layer **110**. In some embodiments, washers **150** may be inserted between the heads **144** of the screws and the front surface **110***f* of the top layer **110**, to increase the contact area in which the fastening force of the screws is exercised. In FIG. **1**A and FIG. **1**B only a few fastening semi-holes **116**, through holes **126**, holes **138**, and fasteners **140** are illustrated for clarity purpose, but it should be noted that the fastening semi-holes **116** (with associated through holes **126** and holes **138**) may be formed in several positions all along the side surface **112***s* of the body **112**, for example as illustrated in FIG. **2**B, and that the disclosure is not limited by the number of fasteners **140** used to assemble the lamination chuck **100**.

FIG. **3**A to FIG. **3**C are schematic cross-sectional views of structures formed during a lamination process in which the lamination chuck **100** is used according to some embodiments of the disclosure. In some embodiments, the lamination chuck **100** may be used for laminating a film material **210** on a lamination substrate **220**. For example, the film material **210** may be disposed on the lamination chuck **110**, and the lamination chuck **110** with the film material **210** disposed thereon may then be brought into contact with the lamination substrate **220**. Upon application of pressure and/or heating, the film material **210** may be laminated on the lamination substrate **220**. In FIG. **3**A, a film material **210** to be laminated is disposed on the front surface **110***f* of the top layer **110** of the lamination chuck **100**. In some embodiments, the film material **210** is disposed so as to cover the vacuum channels **114** of the top layer **110**. In some embodiments, disposing the film material **210** on the front surface **110***f* of the top layer **110** may include performing a preliminary alignment step, so that the film material **210** is ready to be laminated at a desired position of a lamination substrate **220** (illustrated, e.g., in FIG. **3**B). In some embodiments, the film material **210** may be pre-cut, and one or more transfer operations may be performed to ensure correct alignment of the film material **210** with the lamination substrate **220**.

In FIG. **3**B, the film material **210** is contacted with the lamination substrate **220**. In some embodiments, the lamination substrate **220** may be disposed on a carrier **230**, which may be a temporary carrier such as a frame or the like, or may be part of the desired product structure together with the lamination substrate **220**. In some embodiment, before the film material **210** on the lamination chuck **100** is brought into contact with the lamination substrate **220**, suction S may be applied to the through hole **136** of the base **130**, for example by activation of a vacuum pump (not shown), and the suction S may be transmitted to the film material **210** in correspondence of the vacuum channels **114** of the lamination chuck **110**. In some embodiments, the applied suction S may be such to generate a pressure differential with respect to atmospheric pressure, so that the film material **210** is tense on the front surface **110***f* of the top layer **110**. In some embodiments, by including a soft material in the top layer **110**, tearing of the film material **210** upon application of the suction S may be avoided or reduced. The magnitude of the pressure differential may be regulated according to the nature of the film material **210**. In some embodiments, the suction S may be such to generate a pressure differential of about 60 kPa to 80 kPa with respect to atmospheric pressure. In some embodiments, after the suction S has been applied, the lamination chuck **100** with the film material **210** disposed thereon are contacted (e.g., pressed) against the lamination substrate **220**, and heat may be applied as required. The contact force between the lamination substrate **220** and the film material **210** and the temperature if heating is applied may be set depending on the materials to be laminated. In some embodiments, the contact force may be such to result in a pressure of about 1 Kg/cm^2 to about 5 Kg/cm^2, and the temperature may be in a range from about 70° C. to about 130° C.

Referring to FIG. **3**B and FIG. **3**C, after the film material **210** is laminated to the lamination substrate **220**, the film material **210** may be separated from the lamination chuck **100**, while remaining on the lamination substrate **220**. In some embodiments, by laminating the film material **210** to the lamination substrate **220** with a lamination chuck **110** of the disclosure, a smooth outer surface **210***o* of the laminated film material **210** on the lamination substrate **220** may be obtained. The outer surface **210***o* of the laminated film material **210** may correspond to the surface contacting the top layer **110** of the lamination chuck **100**. For example, indentation and irregularities of the film material **210** laminated on the lamination substrate **220** may be smaller than about 50 micrometers.

In some embodiments, the type of film material **210** to be laminated is not particularly limited. For example, the lamination chuck **100** may be used in vacuum lamination processes of various types of film materials **210** as encountered in semiconductor manufacturing, such as dielectric films (e.g., back-side dielectric layers, dielectric layers of redistribution structures, solder resist, etc.), adhesive films (e.g., die-attach films), or the like. As a non-limiting example, in FIG. **4**A to Figure are illustrated schematic cross-sectional views of structures formed during a manufacturing process of a semiconductor package SP**10** according to some embodiments of the disclosure.

In FIG. **4**A, a carrier **300** having a de-bonding layer **310** formed thereon is provided. In some embodiments, the carrier **300** is a glass substrate, a metal plate, a plastic supporting board or the like, but other suitable substrate materials may be used as long as the materials are able to withstand the subsequent steps of the process. In some embodiments, the de-bonding layer **310** includes a light-to-heat conversion (LTHC) release layer, which facilitates peeling the carrier **300** away when required by the manufacturing process.

In FIG. **4**B, a redistribution structure **320** is formed over the carrier **300**, for example on the de-bonding layer **310**. In some embodiments, the redistribution structure **320** includes dielectric layers **322** and redistribution conductive layers **324** alternately stacked. The redistribution conductive layers **324** extend horizontally in between consecutively stacked dielectric layers **322** and vertically through openings of the underlying dielectric layers **322** to establish electrical connection with the underlying redistribution conductive layers **324**. In some embodiments, the outermost dielectric layer **322** (e.g., the dielectric layer **322** closer to the carrier **300**), may be not patterned, so that the outermost redistribution conductive layer **324** is fully separated from the carrier **300** (or the de-bonding layer **310**). In some embodiments, the innermost dielectric layer **322** (e.g., the dielectric layer **322** further from the carrier **300**) includes openings **326** exposing sections of the innermost redistribution conductive layer **324**.

In some embodiments, the dielectric layers **322** may, independently from each other, include polyimide, epoxy resin, acrylic resin, phenol resin, benzocyclobutene (BCB), polybenzooxazole (PBO), or any other suitable polymer-based dielectric material. The dielectric layers **322** may be formed by suitable fabrication techniques such as spin-on coating, chemical vapor deposition (CVD), plasma-enhanced chemical vapor deposition (PECVD), or the like. In some embodiments, the redistribution conductive layers **324** may independently include aluminum, titanium, copper, nickel, tungsten, and/or alloys thereof, for example. The redistribution conductive layers **324** may be formed by electroplating, deposition, and/or photolithography and etching. It should be noted that the number of redistribution conductive layers **324** and dielectric layers **322** illustrated in FIG. **4**B is merely for illustrative purposes, and the disclosure is not limited thereto. In some alternative embodiments, more or fewer redistribution conductive layers **324** and dielectric layers **322** may be formed depending on the circuit design.

In some embodiments, the carrier **300** is a wafer-size carrier, and the redistribution structure **320** is formed all over the carrier **300**, so that the manufacturing process may be performed at a reconstructed wafer level. That is, a plurality of semiconductor packages may be manufactured simultaneously on the carrier **300**, as a plurality of package units corresponding to different regions of the reconstructed wafer. For example, the redistribution structure **320** may be formed so as to match in size and span the carrier **300**. While in FIG. **4**A to FIG. **4**L one of such package units is illustrated, the disclosure does not limit the number of package units simultaneously formed on the carrier **300**. In some alternative embodiments, the semiconductor package being manufactured may be a wafer-size semiconductor package, so that the entire carrier **300** may be wafer-shaped and may correspond to a single package unit. In some embodiments, the semiconductor package being manufactured may be a panel-size semiconductor package, so that the carrier **300** may be panel-shaped and may correspond to a single package unit.

Referring to FIG. **4**C, in some embodiments, through interlayer vias ("TIVs") **330** are formed on the redistribution structure **320** over the carrier **300**. In some embodiments, the TIVs **330** are through integrated fan-out ("InFO") vias. In some embodiments, the TIVs **330** are formed by forming a mask pattern (not shown) having one or more openings in correspondence of the openings **326** of the redistribution structure **320**, and forming a metallic material filling up the openings of the mask pattern to form the TIVs **330** by electroplating or deposition. In some embodiments, a seed layer (not shown) may be formed before the mask pattern to facilitate formation of the metallic material within the openings. It should be noted that whilst two TIVs **330** are illustrated in FIG. **4**C, the disclosure does not limit the number of TIVs **330** to be included. In some alternative embodiments, fewer or more TIVs **330** may be formed.

In some embodiments, referring to FIG. **4**D, one or more semiconductor dies **340** are disposed on the redistribution structure **320** amongst the TIVs **330**, for example by a pick-and-place method. In some embodiments, the semiconductor die **340** may include a semiconductor substrate **341** having active and/or passive devices formed therein, conductive pads **342** formed at the top surface of the semiconductor substrate **341**, and a protective layer **343** formed on the top surface of the semiconductor substrate **341**. Portions of the conductive pads **342** are exposed through openings of the protective layer **343**. In some embodiments, the protective layer **343** may be a composite structure including stacked layers of one or more materials. In some embodiments, the semiconductor dies **340** may include metal posts **344** filling the openings of the protective layer **343** to contact the conductive pads **342**, and a protective layer **345** disposed on the protective layer **313** and surrounding the metal posts **344**. In some embodiments, the semiconductor die **340** is disposed with the semiconductor substrate **341** directed towards the redistribution structure **320** and the conductive pads **342** disposed away from the redistribution structure **320**. In some embodiments, a die attach film **346** is disposed on the semiconductor substrate **341**, to secure the semiconductor die **340** to the redistribution structure **320**.

The structure illustrated in FIG. **4**D for the semiconductor die **340** is merely an example, and other structures are contemplated within the scope of the disclosure. The semiconductor die **340** may be configured to perform any desired function. For example, the semiconductor die **340** may be or include a logic die, such as a central processing unit (CPU) die, a graphic processing unit (GPU) die, a micro control unit (MCU) die, an input-output (I/O) die, a baseband (BB) die, or an application processor (AP) die. In some embodiments, the semiconductor die **340** includes a memory die such as a high bandwidth memory die. The disclosure is not limited by the type or number of semiconductor dies **340** included in a given package unit. For example, when multiple semiconductor dies **340** are included, the semiconductor dies **340** may be the same type of dies or perform the same functions. In some embodiments, the semiconductor dies **340** included in a same package unit may be different types of dies or perform different functions.

In some embodiments, an encapsulant **350** is formed on the redistribution structure **320** to laterally encapsulate the semiconductor die **340** and the TIVs **330**. A material of the encapsulant **320** includes a molding compound, a polymeric material, such as polyimide, epoxy resin, acrylic resin, phenol resin, benzocyclobutene (BCB), polybenzoxazole (PBO), a combination thereof, or other suitable polymer-based dielectric materials. In some embodiments, the encapsulant is formed by a sequence of over-molding and planarization steps, whereby the material of the encapsulant **350** is removed until the metal posts **344** of the semiconductor die **340** and the top surfaces **330***t* of the TIVs **330** are exposed. In some embodiments, portions of the metal posts **344**, the protective layer **345**, and/or the TIVs **330** may also be removed during planarization of the encapsulant **350**. Following planarization, the top surfaces **330***t* of the TIVs **330**, and the front surface **340***f* of the semiconductor die **340** at which the metal posts **344** are exposed may be substantially coplanar with the top surface **350***t* of the encapsulant **350**.

In FIG. **4**F, according to some embodiments, a redistribution structure **360** is formed on the encapsulated semiconductor die **340** and the TIVs **330**, with similar processes and materials as previously described for the redistribution structure **320**. The redistribution structure **360** includes dielectric layers **362** and redistribution conductive layers **364** alternately stacked, in a number according to routing requirements. The innermost dielectric layer **362** (the dielectric layer **362** closer to the encapsulant **350**) includes openings exposing at their bottom the TIVs **330** or the metal posts **344**, so that the redistribution conductive layers **364** may establish electrical connection to the TIVs **330** and the semiconductor die **340**. In some embodiments, the semiconductor die **340** may be electrically connected to the redistribution structure **320** via the redistribution structure **360** and the TIVs **330**. The outermost dielectric layer **362** (the dielectric layer **362** further from the encapsulant **350**) includes openings **366** exposing sections of the outermost redistribution conductive layer **364**.

In some embodiments, as illustrated in FIG. **4**G, connective terminals **370** are formed in the openings **366** of the redistribution structure **360** contacting the redistribution conductive layer **364**, to allow electrical connection with external devices (not shown). In some embodiments, the connective terminals **370** may include C4-bumps, and, optionally, under-bump metallurgies formed in the openings **366**. In some embodiments, a pre-cutting step may be optionally performed, for example after the connective terminals **370** have been formed. The pre-cutting step may include marking the exposed surface of the redistribution structure **360** where the connective terminals **370** have been formed in between adjacent package units. In some embodiments, the markings are formed by laser radiation **L1** impinging on the redistribution structure **360** without cutting through the whole thickness of the reconstructed wafer.

In FIG. **4**H, the structure formed in FIG. **4**G is flipped and mounted on a frame **380**, with the connective terminals **370** directed towards the frame **380**. In some embodiments, the connective terminals **370** may be embedded in protective tapes (not shown) to be mechanically protected during the subsequent steps of the manufacturing process. In some embodiments, the carrier **300** may be removed. For example, following irradiation of the de-bonding layer **310**, the adhesion between the carrier **300** and the de-bonding layer **310** may be reduced, so that it may be possible to separate the carrier from the de-bonding layer.

Referring to FIG. **4**H and FIG. **4**I, residuals of the de-bonding layer **310** may be removed, for example during a plasma-cleaning step, so that the outermost dielectric layer **322** of the redistribution structure **320** is exposed for further processing. In FIG. **4**J, a back-side insulating layer **390** is laminated on the dielectric layer **322** of the redistribution structure **320**. In some embodiments, the back-side insulating layer **390** is of shape and size equal the redistribution structure **320**, so as to completely cover the redistribution structure **320**. In some embodiments, the back-side insulating layer **390** includes a polymeric dielectric material. For example, the back-side insulating layer **390** may include Ajinomoto build-up film, polyimide, epoxy resins, or the like. In some embodiments, the back-side insulating layer **390** includes Ajinomoto build-up film. In some embodiments, the back-side insulating layer **390** is laminated on the dielectric layer **322** by using the lamination chuck **100** of FIG. **1**A, for example via similar process steps as previously described with reference to FIG. **3**A to FIG. **3**C. As such, the back-side insulating layer **390** may be formed with a smooth outer surface **390***o*. For example, indentation and irregularities of the back-side insulating layer **390** may be smaller than about 50 micrometers.

Referring to FIG. **4**K, vertically aligned openings **392** and **328** are respectively formed in the back-side insulating layer **390** and the outermost dielectric layer **322**, for example via laser drilling. The outermost redistribution conductive layer **324** of the redistribution structure **320** is thus exposed at the bottom of the openings **322**. In some embodiments, because the back-side insulating layer **390** has been laminated by using a lamination chuck **100** such as the one of FIG. **1**A, the outer surface **390***o* on which the laser light impinges to form the openings **392** may be substantially flat, so that openings **392** of neater shape may be formed. In some embodiments, the critical dimensions for shapes and sizes of the laser drill process may be improved as a consequence of the enhanced flatness of the outer surface **390***o*. For example, size of indentations and/or irregularities at the outer surface **390***o* may be smaller than 50 micrometers. After formation of the openings **392**, **328**, a cleaning step may be performed to remove residuals of the ablated dielectric materials.

In FIG. **4**L, connectors **400** are formed at the bottom of the openings **328** to contact the redistribution conductive layer **324**. For example, solder material may be disposed at the bottom of the openings **328** on the exposed portions of the redistribution conductive layer **324**, and a reflux step may be performed to form the connectors **400**. In some embodiments, the solder material of the connectors **400** includes eutectic solder containing lead or lead-free. In some embodiments, the solder material of the connectors **400** includes non-eutectic solder. In some embodiments, the solder material of the connectors **400** contains Sn, SnAg, SnPb, SnAgCu, SnAgZn, SnZn, SnBiIn, SnIn, SnAu, SnCu, SnZnIn, SnAgSb, or similar soldering alloys. In some embodiments, the solder material is applied as a solder paste. A cleaning step (e.g., to remove residuals of soldering flux) may be optionally performed. When the manufacturing process is performed at a reconstructed wafer level, the semiconductor packages SP**10** illustrated in FIG. **4**M may be obtained following a singulation step, for example via mechanical or laser saw, removal from the frame **380**, and cleaning.

In the following, some aspects of the lamination of the back-side insulating layer **390** of FIG. **4**J according to some embodiments will be briefly described with reference to FIG. **5**A to FIG. **5**L. In FIG. **5**A, is illustrated a film material **500** to be laminated as the back-side insulating layer **390** of FIG. **4**J according to some embodiments of the disclosure. In some embodiments, the film material **500** may be any suitable dielectric material which may be formed as a film, such as organic polymeric materials or the like. For example, the film material **500** may include Ajinomoto build-up film, polyimide, epoxy resins, or the like. In some embodiments, the film material **500** includes Ajinomoto build-up film. In some embodiments, a lamination film **520** (e.g., Ajinomoto build-up film) is disposed between a cover film **510** and a support film **530**. Materials of the cover film **510** and the supporting film **530** are not particularly limited, and may include organic polymers such as PET or the like.

As illustrated in FIG. **5**B, in some embodiments the film material **500** may be provided as a roll **505**. In some embodiments, the film material **500** may be unrolled and pre-cut on a cutting table **540** before being disposed on a transport table **550**. In some embodiments, the film material **500** is pre-cut according to the size and shape of the lamination substrate on which the lamination film **520** is to be laminated. Referring to FIG. **5**B and FIG. **5**C, in some embodiments, the cover film **510** may be removed during the pre-cutting step, and the lamination film **520** may be disposed on the transport table **550** with the support film **530** contacting the transport table **550**. That is, the support film **530** may be interposed between the lamination film **520** and the transport table **550**. After cutting, the transport table **550** may be flipped with respect to the cutting position.

Referring to FIG. **5**C and FIG. **5**D, the transport table **550** with the lamination film **520** thereon is brought to face a transfer table **560**, to which the lamination film **520** and the support film **530** are transferred. When on the transfer table **560**, the lamination film **520** is disposed between the support film **530** and the transfer table **560**, contacting the transfer table **560**. In FIG. **5**E, the lamination film **520** is then transferred from the transfer table **560** to the alignment table **570**. The alignment table **570** may include one or more alignment marks **572** formed thereon, which may be recognized, for example by an optical sensor, so that the lamination film **520** and the support film **530** are disposed on the alignment table **570** in a position which results in pre-alignment of the lamination film **520** with respect to the lamination substrate. On the alignment table **570**, the support film **530** may be interposed between the lamination film **520** and the alignment table **570**.

Referring to FIG. **5**F and FIG. **5**G, in some embodiments the lamination film **520** is transferred from the alignment table **570** to top layer **110** of the lamination chuck **100**, for example via a transfer table **580** which may be part of an intermediary robot (not shown). On the transfer table **580**, the lamination film **520** is disposed between the support film **530** and the transfer table **580**, while on the lamination chuck **100** the support film **530** is disposed in contact with the top layer **110**, in between the top layer **110** and the lamination film **520**. The support film **530** with the lamination film **520** thereon are disposed on the lamination chuck **100** so as to cover the vacuum channel(s) **114** of the top layer **110**. In some embodiments, the lamination chuck **100** is located in a lamination chamber **590**, for example connected to a servo motor **600** capable of vertically displacing the lamination chuck **100**. For example, the lamination chuck **100** may be connected to the servo motor **600** via connecting structures (not shown) formed on the base **130**.

Referring to FIG. **5**G and FIG. **5**H, after the lamination film **520** is disposed on the lamination chuck **100**, the lamination chuck **100** may be transported towards the bottom of the lamination chamber **590**, for example by action of the servo motor **600**. Then, the frame **380** with the structure of FIG. **4**I formed thereon may be disposed on the lamination chamber **590**, with the outermost dielectric layer **322** of the redistribution structure **320** directed towards the lamination film **520**. That is, the outermost dielectric layer **322** may be the lamination substrate on which the lamination film **520** is subsequently laminated. Referring to FIG. **5**I, suction may then be applied to the through hole **136** of the lamination chuck **100**. The suction may be transmitted through the vacuum channels **124**, **114** to the support film **530**, whereby the lamination film **520** and the support film **530** are well tensed on the top layer **110** of the lamination chuck **100**, as previously described with reference to FIG. **3**B. The vacuum pump (not shown) to apply the suction may be integrated or be a separate piece with respect to the servo motor **600**. In some embodiments, the applied suction may be such to generate a pressure differential with respect to atmospheric pressure of about 60 kPa to 80 kPa within the lamination chamber **590**. That is, the pressure in the lamination chamber **590** may be 60 kPa to 80 kPa lower than the pressure outside the chamber. The lamination chuck **100** may then be brought towards the wafer on the frame **380**, so that the lamination film **520** contacts the outermost dielectric layer **322**. For example, the lamination chuck **100** may be lifted by action of the servo motor **600** until the lamination film **520** contacts the outermost dielectric layer **322**. In some embodiments, by action of the servo motor **600**, the lamination film **520** may be pressed against the outermost dielectric layer **322**, for example with a pressure in the range from about 1 Kg/cm^2 to about Kg/cm^2. Depending on the materials to be laminated, the temperature may be about in the range from 70° C. to 130° C.

In FIG. **5**J, after lamination, the frame **380** may be removed from the lamination chamber **590**. Following lamination, the support film **530** may be detached from the lamination chuck **100**, remaining attached to the lamination film **520** on the outermost dielectric layer **322**. That is, as illustrated in FIG. **5**K, the lamination film **520** and the support film **530** may be initially stacked on the outermost dielectric layer **322**. Upon removal of the support film **530** (e.g., by peeling as illustrated in FIG. **5**L), the structure of FIG. **4**J may be obtained, with the lamination film **520** remaining on the outermost dielectric layer **322** to act as the back-side insulating layer **390**.

In accordance with some embodiments of the disclosure, a lamination chuck for lamination of film materials includes a support layer and a top layer. The top layer is disposed on the support layer. The top layer includes a polymeric material having a Shore A hardness lower than a Shore hardness of a material of the support layer. The top layer and the support layer have at least one vacuum channel formed therethrough, vertically extending from a top surface of the top layer to a bottom surface of the support layer.

In accordance with some embodiments of the disclosure, a lamination method of a film material on a substrate includes the following steps. A film material is disposed on a chuck. The chuck includes a vacuum channel extending from a front surface of the chuck to a rear surface of the chuck. The chuck further includes a polymeric material disposed at the front surface of the chuck. The film material covers one end of the vacuum channel located at the front surface of the chuck. Suction is applied at an opposite end of the vacuum channel. The opposite end of the vacuum channel is located at the rear surface of the chuck, whereby the film material is tensed on the front surface of the chuck. The film material tensed on the chuck is contacted with the substrate. The chuck is separated from the substrate. The film material remains on the substrate after the chuck is separated from the substrate.

In accordance with some embodiments of the disclosure, a manufacturing method of a semiconductor package includes the following steps. A redistribution structure is formed. The redistribution structure includes a first dielectric layer. A dielectric film is laminated to the first dielectric layer. Laminating the dielectric film to the first dielectric layer includes the following steps. The dielectric film is disposed on a chuck. The chuck includes a channel extending therethrough. The dielectric film covers an end of the channel. The end of the channel is formed through a polymeric material of the chuck. Suction is applied at another end of the channel, so that the suction is transmitted to the dielectric film. The dielectric film disposed on the chuck is pressed against the first dielectric layer.

The foregoing outlines features of several embodiments so that those skilled in the art may better understand the aspects of the present disclosure. Those skilled in the art should appreciate that they may readily use the present disclosure as a basis for designing or modifying other processes and structures for carrying out the same purposes and/or achieving the same advantages of the embodiments introduced herein. Those skilled in the art should also realize that such equivalent constructions do not depart from the spirit and scope of the present disclosure, and that they may make various changes, substitutions, and alterations herein without departing from the spirit and scope of the present disclosure.

What is claimed is:

1. A lamination method of a film material on a substrate, comprising:

providing a chuck comprising a top layer with a polymetric material and a support layer supporting the top layer, wherein the chuck has vacuum channels arranged along an arc path concentric to a circumference of the top layer, each of the vacuum channels extends through the top layer and the support layer, and wherein the support layer comprises a through hole between the vacuum channels and an outer side edge of the support layer, the top layer comprises a hemicylindrical concavity located at an outer side edge of the top layer, the hemicylindrical concavity extends from a top surface of the top layer to a bottom surface of the top layer, and the hemicylindrical concavity aligns with the through hole of the support layer;

disposing the film material on the top layer of the chuck to cover one end of the each of the vacuum channels;

applying suction at an opposite end of the each of the vacuum channels, whereby the film material is tensed on a front surface of the chuck;

contacting the film material tensed on the chuck with the substrate; and

separating the chuck from the substrate, wherein the film material remains on the substrate after the chuck is separated from the substrate.

2. The lamination method of claim **1**, wherein the chuck with the tensed film material thereon is pressed against the substrate with a pressure of 1 Kg/cm^2 to 5 Kg/cm^2.

3. The lamination method of claim **1**, further comprising heating at a temperature in the range from 70 to 130° C. when the tensed film material disposed on the chuck contacts the substrate.

4. The lamination method of claim **1**, wherein the suction is applied so that a pressure differential with respect to atmospheric pressure is in the range from 60 KPa to 80 KPa.

5. The lamination method of claim **1**, wherein the polymeric material at the front surface of the chuck comprises at least one material selected from a rubber having a Shore A hardness of 20 to 50 and a powder free sponge material, and the film material is disposed on the polymeric material.

6. The lamination method of claim **5**, wherein the chuck comprises:

the top layer, comprising the polymeric material thermally bonded to the support layer, the support layer including a material having higher Shore hardness than the polymeric material of the top layer, and further comprises

a base layer, to which the support layer and the top layer are fastened,

wherein in a radial direction of the chuck, each of the vacuum channels has a first width in the top layer and a second width in the support layer, and the first width is different from the second width.

7. A manufacturing method of a semiconductor package, comprising:

forming a redistribution structure, the redistribution structure comprising a first dielectric layer; and

laminating a dielectric film to the first dielectric layer,

wherein laminating the dielectric film to the first dielectric layer comprises:

disposing the dielectric film on a chuck, wherein the chuck comprises a top layer and a support layer supporting the top layer and includes a channel extending therethrough, and the dielectric film covers an end of the channel, the end of the channel being formed through a polymeric material of the chuck, and wherein the support layer comprises a through hole between the channel and an outer side edge of the support layer, the top layer comprises a hemicylindrical concavity located at an outer side edge of the top layer, the hemicylindrical concavity extends from a top surface of the top layer to a bottom surface of the top layer, and the hemicylindrical concavity aligns with the through hole of the support layer;

applying suction at another end of the channel, whereby the suction is transmitted to the dielectric film and distributed along arc paths of an annular region formed by the channel; and

pressing the dielectric film disposed on the chuck against the first dielectric layer.

8. The manufacturing method of claim **7**, wherein disposing the dielectric film on the chuck comprises:

cutting the dielectric film and disposing the cut dielectric film on a first carrier;

transferring the cut dielectric film on an alignment table; and

transferring the aligned dielectric film to the chuck.

9. The manufacturing method of claim **8**, wherein the dielectric film is disposed on a supporting film, and the supporting film is disposed between the dielectric film and the chuck, in contact with the polymeric material of the chuck, so that the suction is exercised on the dielectric film through the supporting film.

10. The manufacturing method of claim **7**, wherein the other end of the channel is located at a rear surface of the chuck, the channel is a branched channel, the end of the channel covered by the dielectric film is an end of one of plural branches of the channel formed through the polymeric material of the chuck, the plural branches of the channel have ends located at a front surface of the chuck along the arc paths of the annular region, and the dielectric film covers the ends of the plural branches of the channel located at the front surface of the chuck.

11. The manufacturing method of claim **7**, further comprising providing a reconstructed wafer including semiconductor dies, an encapsulant encapsulating the semiconductor dies, and the redistribution structure formed on the encapsulated semiconductor dies.

12. The manufacturing method of claim **7**, further comprising firing a laser towards the laminated dielectric film to form openings in the laminated dielectric film.

13. A lamination method of a film material on a substrate, comprising:

disposing the film material on a chuck having a soft surface, wherein the chuck includes vacuum channels arranged along a periphery of the soft surface along an arc path concentric to a circumference of the soft surface, and the film material covers the vacuum channels, and wherein the chuck comprises a top layer and a support layer supporting the top layer, the support layer comprises a through hole between the vacuum channels and an outer side edge of the support layer, the top layer comprises a hemicylindrical concavity located at an outer side edge of the top layer, the hemicylindrical concavity extends from a top surface of the top layer to a bottom surface of the top layer, and the hemicylindrical concavity aligns with the through hole of the support layer;

holding the film material on the chuck by a vacuum force provided in the vacuum channels;

contacting the film material with the substrate; and

separating the chuck from the substrate, wherein the film material remains on the substrate after the chuck is separated from the substrate.

14. The lamination method of claim **13**, wherein the chuck with the film material thereon is pressed against the substrate with a pressure of 1 Kg/cm^2 to 5 Kg/cm^2.

15. The lamination method of claim **13**, further comprising heating at a temperature in the range from 70 to 130° C. when the film material disposed on the chuck contacts the substrate.

16. The lamination method of claim **13**, wherein a suction is applied to the vacuum channels to generate the vacuum force by a pressure differential with respect to atmospheric pressure is in the range from 60 KPa to 80 KPa.

17. The lamination method of claim **13**, wherein the soft surface comprises at least one material selected from a rubber having a Shore A hardness of 20 to 50 and a powder free sponge material, and the film material is disposed on the polymeric material.

18. The lamination method of claim **17**, wherein the chuck comprises:

the top layer, comprising the polymeric material thermally bonded to the support layer, the support layer including a material having higher Shore hardness than the polymeric material of the top layer, and

a base layer, to which the support layer and the top layer are fastened,

wherein each of the vacuum channels extends from the top layer to the base layer.

19. The lamination method of claim **13**, wherein disposing the film material on the chuck comprises:

forming the film material by disposing a lamination film on a supporting film;

cutting the film material and disposing the cut film material on a first carrier;

transferring the cut film material on an alignment table; and

transferring the aligned film material to the chuck, wherein the supporting film is disposed between the lamination film and the chuck, in contact with the soft surface of the chuck.

20. The lamination method of claim **19**, further removing the supporting film from the lamination film after separating the chuck from the substrate.

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