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| | First Named Inventor | Ping-Jung Yang |
| | Art Unit | |
| | Examiner Name | |
| | Attorney Docket Number | Mars16-001-US-C03 |

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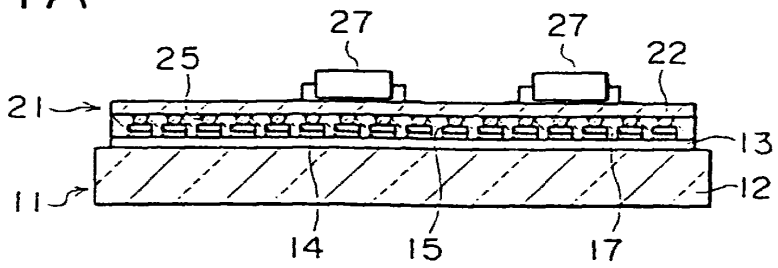
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## (54) Video display and manufacturing method therefor

(57) Disclosed herein are a video display and a manufacturing method therefor, more particularly a video display including a display panel (11) having a plurality of anodes (13) and cathodes (15) arranged orthogonally to each other so as to form a grid, a printed wiring board (21) having a drive circuit with wirings (23) for driving the display panel (11) and a plurality of bumps (25) for electrically connecting the wirings (23) to the anodes (13) and the cathodes (15), and an adhesive layer (17) for bonding the display panel (11) and the printed wiring board (21) to form a multilayer structure. With this structure, a large-sized video image with no discontinuities can be displayed, and the thickness of the video display can also be reduced.

FIG.1A




EP 1 026 744 A1

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IPR2026-00067
TSMC EX1002 Page 18

## Description

**[0001]** The present invention relates to a video display having a display panel provided with anodes and cathodes arranged such as to form a grid, and also a manufacturing method for such a video display.

**[0002]** FIG. 5A is a plan view of a related art electroluminescent (EL) display panel in an active matrix drive type EL video display, and FIG. 5B is a cross section view taken along the line B-B in FIG. 5A. As shown in FIGS. 5A and 5B, the EL display panel 11 includes a glass substrate 12, a plurality of anodes 13 formed on one surface of the glass substrate 12 opposite to the display surface of the EL display panel 11 so as to be arranged in rows, for example, a plurality of EL phosphor layers 14 formed in the form of a matrix, an insulating layer (not shown) formed on the EL phosphor layers 14, and a plurality of cathodes 15 formed on the insulating layer so as to be arranged in columns, for example.

**[0003]** To drive the EL display panel 11, a drive circuit must be connected to the anodes 13 and the cathodes 15. To this end, the related art EL display panel 11 shown in FIGS. 5A and 5B is formed with an L-shaped region 16 along adjacent two sides of the EL display panel 11 as a dedicated region for electrical connection of the anodes 13 and the cathodes 15 to the drive circuit. Although not shown, electronic components constituting the drive circuit are mounted on a printed wiring board separate from the EL display panel 11, and wirings formed on the printed wiring board are connected at first ends to the electronic components and connected at second ends to the anodes 13 and the cathodes 15 in the L-shaped region 16.

**[0004]** However, in the related art EL display panel 11 having the L-shaped region 16 dedicated for electrical connection, no video image is displayed in this region 16. Further, if the area of the EL display panel 11 is large, the yield of such large EL display panels manufactured is reduced. In addition, the area of the EL display panel 11 that can be manufactured is limited.

**[0005]** Accordingly, it is desirable to planarly join a plurality of EL display panels 11 as shown in FIG. 6 to thereby display a single large-sized video image. However, since no video image is displayed in each region 16, the large-sized video image displayed on the plural EL display panels 11 planarly joined has discontinuities corresponding to the regions 16. That is, a large-sized video image with no discontinuities cannot be displayed by the configuration shown in FIG. 6.

**[0006]** Furthermore, since the electronic components constituting the drive circuit are mounted on the printed wiring board separate from the EL display panel 11, the total thickness of the EL display panel 11 and the printed wiring board is large, so that it is difficult to reduce the thickness of the entire EL video display using the related art EL display panel 11 mentioned above.

**[0007]** It is accordingly an aim of the present invention to provide a video display which can display a large-sized video image with no discontinuities and is of reduced thickness.

**[0008]** It is another aim of the present invention to provide a manufacturing method for the video display mentioned above.

**[0009]** In accordance with a preferred aspect of the present invention, there is provided a video display comprising a display panel having a plurality of anodes and cathodes arranged orthogonally to each other so as to form grids; a printed wiring board having a drive circuit with wirings for driving the display panel and a plurality of bumps for electrically connecting the wirings of the drive circuit to the anodes and the cathodes; and an adhesive layer for bonding the display panel and the printed wiring board to form a multilayer structure. That is, the anodes and the cathodes of the display panel are electrically connected through the bumps to the wirings of the printed wiring board, and the display panel and the printed wiring board are bonded together through the adhesive layer. With this structure, the display panel is not required to have any dedicated region for electrically connecting the anodes and the cathodes of the display panel to the drive circuit for driving the display panel. Further, the total thickness of the display panel and the printed wiring board is small.

**[0010]** Preferably, the drive circuit comprises a plurality of electronic components mounted on one surface of the printed wiring board for driving the display panel, and the bumps are formed on the other surface of the printed wiring board. That is, the electronic components for driving the display panel are mounted on one surface of the printed wiring board oppositely-directed to its bump forming surface. With this structure, the electronic components for driving the display panel are integrated with the display panel.

**[0011]** In accordance with another preferred aspect of the present invention, there is provided a manufacturing method for a video display, comprising the steps of: preparing a display panel having a plurality of anodes and cathodes arranged orthogonally to each other so as to form grids; preparing a printed wiring board having a drive circuit with wirings for driving the display panel and a plurality of bumps for electrically connecting the wirings of the drive circuit to the anodes and the cathodes; forming an adhesive layer on any one of one surface of the display panel on which the anodes and the cathodes are provided and one surface of the printed wiring board on which the bumps are provided; and electrically connecting the anodes and the cathodes through the bumps to the wirings and bonding the display panel through the adhesive layer to the printed wiring board. That is, the anodes and the cathodes of the display panel and the wirings of the printed wiring board are electrically connected together through the bumps, and the display panel and the printed wiring board are bonded together through the adhesive layer. Accordingly, it is possible to manufacture a video display in which the display panel is not required to have any ded-



IPR2026-00067
TSMC EX1002 Page 19

icated region for electrically connecting the anodes and the cathodes of the display panel to the drive circuit for driving the display panel, and the total thickness of the display panel and the printed wiring board can be reduced.

**[0012]** Preferably, the manufacturing method further comprises the step of mounting a plurality of electronic components for driving the display panel on the other surface, oppositely-directed to the surface with bumps, of the printed wiring board. That is, the electronic components for driving the display panel are mounted on one surface of the printed wiring board oppositely-directed to its bump forming surface. Accordingly, it is possible to manufacture a video display in which the electronic components for driving the display panel are integrated with the display panel.

**[0013]** Other aims and features of the invention will be more fully understood from the following detailed description and appended claims when taken with the accompanying drawings.

**[0014]** Preferred embodiments of the present invention will now be described hereinbelow by way of example only with reference to the accompanying drawings, in which:

FIG. 1A is a sectional side view of an EL video display according to a preferred embodiment of the present invention;
FIG. 1B is a plan view of an EL display panel constituting the EL video display shown in FIG. 1A;
FIG. 1C is a plan view of a flexible printed wiring board constituting the EL video display shown in FIG. 1A;
FIGS. 2A to 2D are sectional side views showing a manufacturing method for the EL video display shown in FIG. 1A;
FIGS. 3A to 3D are sectional side views showing various preferred embodiments of a bump used in the EL video display shown in FIG. 1A;
FIG. 4 is a plan view of a large-sized display panel obtained by planarly joining a plurality of EL display panels according to the preferred embodiment;
FIG. 5A is a plan view of an EL display panel in the related art;
FIG.5B is a cross section view taken along the line B-B in FIG. 5A; and
FIG. 6 is a plan view of a large-sized display panel obtained by planarly joining a plurality of EL display panels in the related art.

**[0015]** There will now be described a preferred embodiment of the present invention applied to an active matrix drive type EL video display and its manufacturing method with reference to FIGS. 1A to 4. In manufacturing the EL video display shown in FIGS. 1A to 1C, an EL display panel 11 is first prepared by sequentially forming anodes 13, EL phosphor layers 14, an insulating layer (not shown), and cathodes 15 on one surface of a glass substrate 12 which surface is opposite to the display surface of the EL display panel 11, by vapor deposition, CVD, etc. as shown in FIG. 2A.

**[0016]** As shown in FIG. 1B, the anodes 13, the EL phosphor layers 14, and the cathodes 15 are formed substantially uniformly on the glass substrate 12, so that the EL display panel 11 has no L-shaped region dedicated for electrical connection as in the related art configuration shown in FIG. 5A. As usual, the anodes 13 are formed by vapor deposition of an aluminum layer or a chromium layer, for example, on an ITO (indium-tin oxide) layer, and the cathodes 15 are formed by vapor deposition of an aluminum layer or a gold layer, for example.

**[0017]** In the next step, an adhesive layer 17 is formed on the EL display panel 11 so as to cover the anodes 13, the EL phosphor layers 14, and the cathodes 15 as shown in FIG. 2B. The adhesive layer 17 is formed of a thermoplastic resin softening at a relatively low temperature, such as polyester, vinyl chloride, vinyl acetate, polyamide, and polyurethane. The adhesive layer 17 is formed on the EL display panel 11 by print coating of such a resin once heated to be softened or by thermal transfer of such a resin coated on a film.

**[0018]** In the next step, a flexible printed wiring board 21 to be connected to the anodes 13 and the cathodes 15 of the EL display panel 11 is prepared as shown in FIG. 2C. The flexible printed wiring board 21 has a substrate 22 formed of a flexible material such as polyimide, polyethyleneterephthalate, liquid crystal polymer, and glass epoxy resin.

**[0019]** As shown in FIGS. 1C and FIGS. 3A to 3D, foil-like copper wirings 23 are formed on one surface of the substrate 22 which surface is opposite to the lower surface of the substrate 22 as viewed in FIG. 2C opposing to the EL display panel 11. Further, a plurality of through holes 24 are formed in the substrate 22 at its peripheral portion along adjacent two sides of the substrate 22 where the copper wirings 23 are to be connected to the anodes 13 and the cathodes 15. FIGS. 3A to 3D show various preferred embodiments of a bump 25 formed of a conductive material for providing electrical connection of the copper wirings 23 to the anodes 13 and the cathodes 15. Each through hole 24 may have a relatively large size as shown in FIGS. 3A to 3C, or may have a relatively small size as shown in FIG. 3D.

**[0020]** In each of the preferred embodiments shown in FIGS. 3A to 3C, the bump 25 is formed in the relatively large through hole 24 so as to project from the substrate 22 to its upper side opposite to the copper wiring 23. In the preferred embodiment shown in FIG. 3D, a copper pattern 26 is formed in the relatively small through hole 24 and at a portion of the substrate 22 in the vicinity of the through hole 24 on the upper side opposite to the copper wiring 23, and the bump 25 is formed on the copper pattern 26 integrated with the copper wiring 23. In each of the preferred embodiments shown in FIGS. 3A to 3D, the height of the bump 25 is



IPR2026-00067
TSMC EX1002 Page 20

set to 10 μm to 100 μm.

**[0021]** The bump 25 shown in each of the preferred embodiments shown in FIGS. 3A and 3D is formed by print coating a conductive paste thermally curing at a relatively low temperature, such as a silver paste or a copper paste. The bump 25 shown in FIG. 3B is formed by forming a relatively thick copper film by electroplating or electroless plating, next forming a nickel coating on the surface of this copper film by electroless plating, and finally plating this nickel coating with gold or palladium.

**[0022]** In the bump 25 shown in FIG. 3B, the nickel coating is formed to facilitate the plating with gold or palladium, and the gold or palladium plate is formed to prevent oxidation of the copper film and thereby enhance stability of electrical contact. The bump 25 shown in FIG. 3C is formed by melting the tip of a gold wire to form a gold ball, next ultrasonic bonding the gold ball to the copper wiring 23, and finally tearing off the gold wire.

**[0023]** In the next step, the flexible printed wiring board 21 is put on the EL display panel 11 so that the bumps 25 are aligned with the anodes 13 and the cathodes 15 as shown in FIG. 2D. In this condition, the whole is heated to a temperature at which the adhesive layer 17 is softened, and pressure is applied to make the bumps 25 to be pressed onto the anodes 13 and the cathodes 15. Thereafter, the whole is cooled to harden the adhesive layer 17. As a result, the bumps 25 are electrically connected to the anodes 13 or the cathodes 15, and the flexible printed wiring board 21 is mechanically fixed to the EL display panel 11 by the adhesive layer 17.

**[0024]** In the next step, electronic components 27 constituting a drive circuit for driving the EL display panel 11 are bonded to the copper wirings 23 of the flexible printed wiring board 21 by soldering or conductive adhesive as shown in FIGS. 1A and 1C, thereby electrically connecting the electronic components 27 to the flexible printed wiring board 21 and mechanically fixing them together.

**[0025]** As apparent from FIG. 1B, in the EL video display manufactured by the above-mentioned method, the EL display panel 11 has no dedicated region for electrically connecting the anodes 13 and the cathodes 15 to the electronic components 27. Accordingly, by planarly joining a plurality of such EL display panels 11 in this preferred embodiment as shown in FIG. 4, a large-sized video image with joints thereof hardly seen can be created.

**[0026]** While the adhesive layer 17 is preliminarily formed on the EL display panel 11 as shown in FIG. 2B, the adhesive layer 17 may be preliminarily formed on the flexible printed wiring board 21. Further, while there has been described a specific preferred embodiment of the present invention applied to an active matrix drive type EL video display and its manufacturing method, the present invention is applicable also to any video displays other than the EL video display, such as a liquid crystal display, and their manufacturing method. Further, the EL video display according to the present invention may include a simple matrix drive type EL video display.

**[0027]** In the video display according to the present invention, the display panel is not required to have any dedicated region for electrically connecting the anodes and the cathodes of the display panel to the drive circuit for driving the display panel. Accordingly, by planarly joining a plurality of such display panels, a large-sized video image with no discontinuities can be displayed. Further, since the total thickness of the display panel and the printed wiring board is small, the thickness of the video display can be reduced as a whole.

**[0028]** Further, the electronic components for driving the display panel can be integrated with the display panel, thereby facilitating handling, maintenance, etc.

**[0029]** In the manufacturing method for the video display according to the present invention, it is possible to manufacture a video display in which the display panel is not required to have any dedicated region for electrically connecting the anodes and the cathodes of the display panel to the drive circuit for driving the display panel, and the total thickness of the display panel and the printed wiring board can be reduced. Accordingly, a large-sized video image with no discontinuities can be displayed, and a thin video display can be manufactured.

**[0030]** Further, it is possible to manufacture a video display in which the electronic components for driving the display panel are integrated with the display panel. Accordingly, a video display with easy handling, maintenance, etc. can be manufactured.

**[0031]** While the invention has been described with reference to specific embodiments, the description is illustrative and is not to be construed as limiting the scope of the invention. Various modifications and changes may occur to those skilled in the art without departing from the scope of the invention as defined by the appended claims.

## Claims

**1.** A video display, comprising:

a display panel having a plurality of anodes and cathodes arranged, preferably orthogonally to each other, so as to form a grid;
a printed wiring board having a drive circuit with wirings for driving said display panel and a plurality of bumps for electrically connecting said wirings of said drive circuit to said anodes and said cathodes; and
an adhesive layer for bonding said display panel and said printed wiring board to form a multilayer structure.

**2.** A video display according to claim 1, wherein said



IPR2026-00067
TSMC EX1002 Page 21

drive circuit comprises a plurality of electronic components mounted on one surface of said printed wiring board for driving said display panel, and said bumps are formed on the other surface of said printed wiring board.

**3.** A manufacturing method for a video display, comprising the steps of:

preparing a display panel having a plurality of anodes and cathodes arranged, preferably orthogonally to each other, so as to form a grid;
preparing a printed wiring board having a drive circuit with wirings for driving said display panel and a plurality of bumps for electrically connecting said wirings of said drive circuit to said anodes and said cathodes;
forming an adhesive layer on any one of one surface of said display panel on which said anodes and said cathodes are provided and one surface of said printed wiring board on which said bumps are provided; and
electrically connecting said anodes and said cathodes through said bumps to said wirings and bonding said display panel through said adhesive layer to said printed wiring board.

**4.** A manufacturing method according to claim 3, further comprising the step of mounting a plurality of electronic components for driving said display panel on the other surface, oppositely-directed to the surface with the bumps, of said printed wiring board.

**5.** A video display according to claim 1 or manufacturing method according to claim 3, wherein said display panel comprises an active matrix drive type electroluminescent display panel.

**6.** A video display according to claim 1 or manufacturing method according to claim 3, wherein said display panel comprises a liquid crystal display panel.

**7.** A video display according to claim 1 or manufacturing method according to claim 3, wherein said display panel comprises a simple matrix drive type electroluminescent display panel.

**8.** A video display according to claim 1 or manufacturing method according to claim 3, wherein each of said bumps comprises a bump formed by melting the tip of a gold wire to form a gold ball, next ultrasonically bonding said gold ball to a copper wiring, and finally tearing off said gold wire.



IPR2026-00067
TSMC EX1002 Page 22

FIG.1A

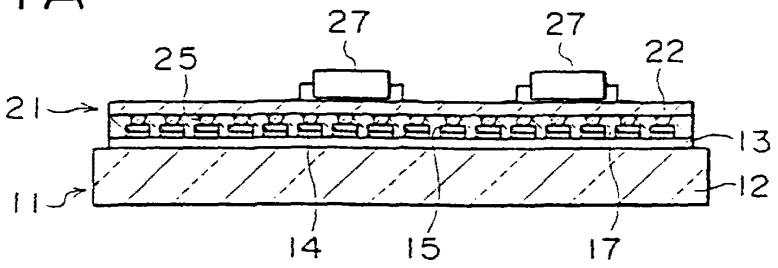



FIG.1B

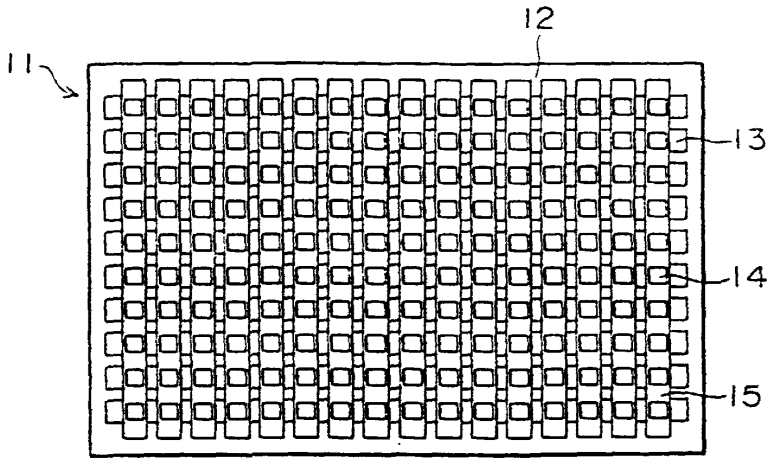
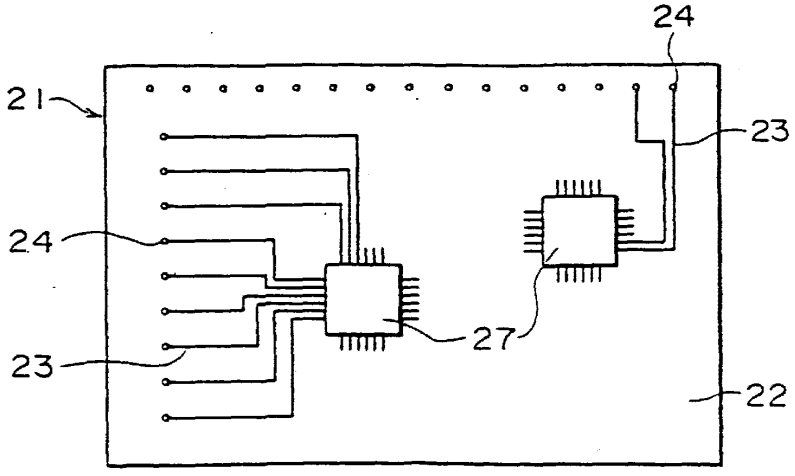



FIG.1C






IPR2026-00067
TSMC EX1002 Page 23

FIG. 2A

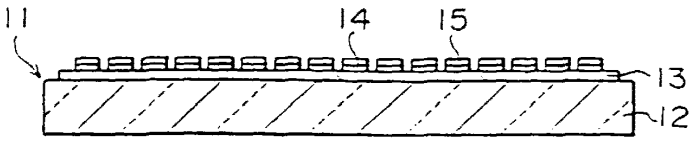
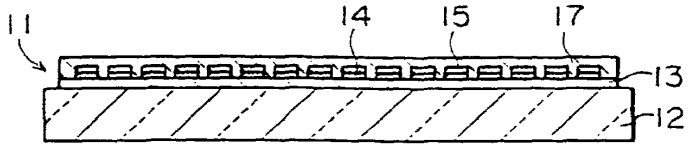



FIG. 2B



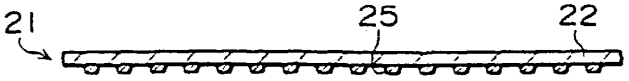




FIG. 2C

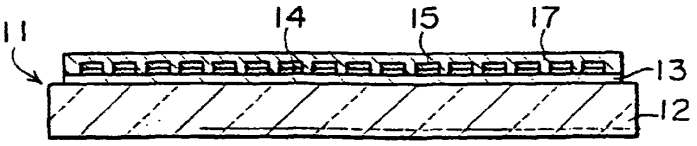
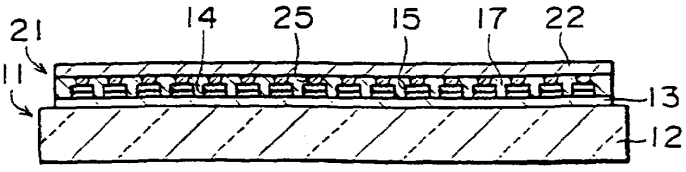



FIG. 2D






IPR2026-00067
TSMC EX1002 Page 24

FIG. 3A

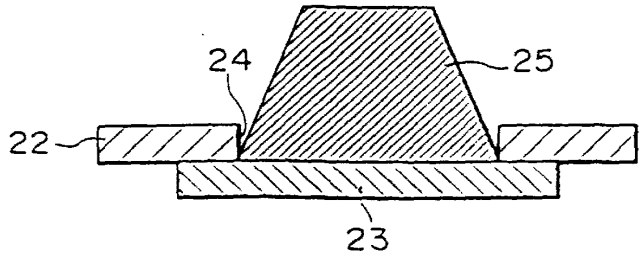



FIG. 3B

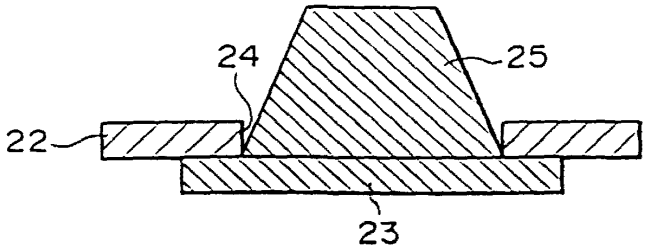



FIG. 3C

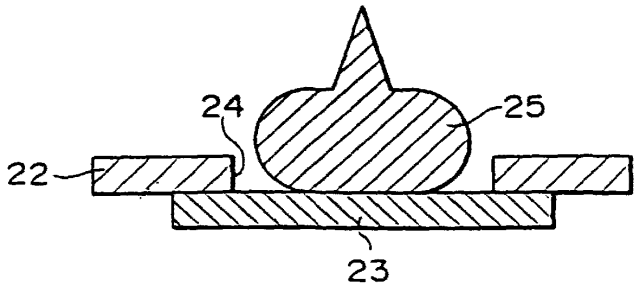
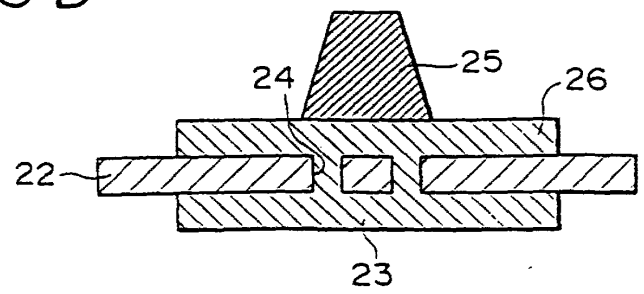


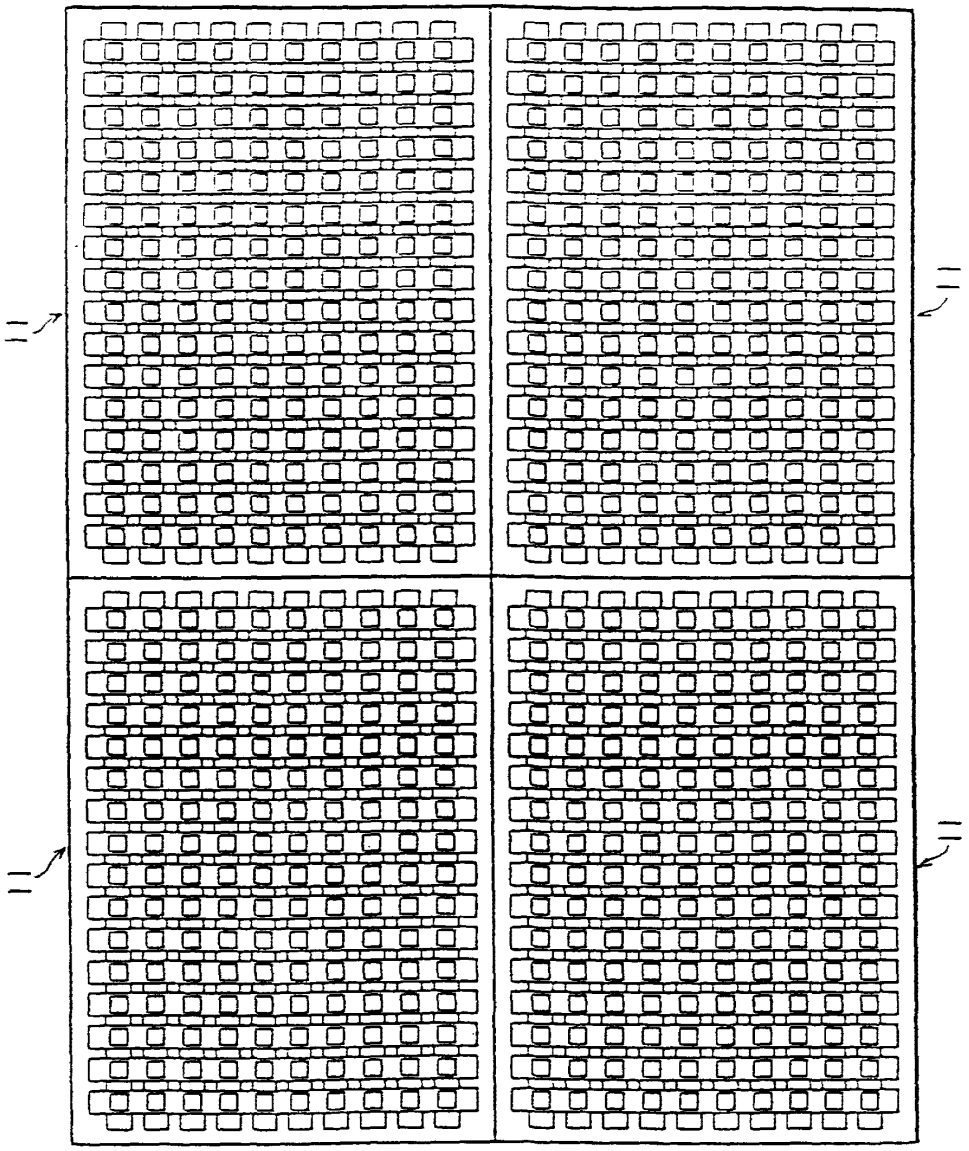

FIG. 3D






IPR2026-00067
TSMC EX1002 Page 25

FIG.4





IPR2026-00067
TSMC EX1002 Page 26

FIG.5A

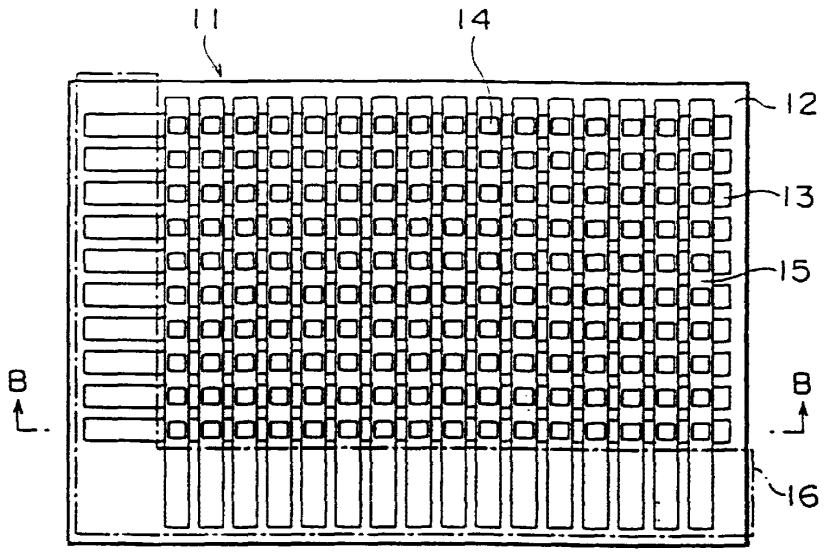
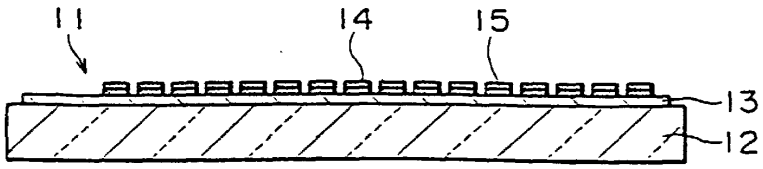


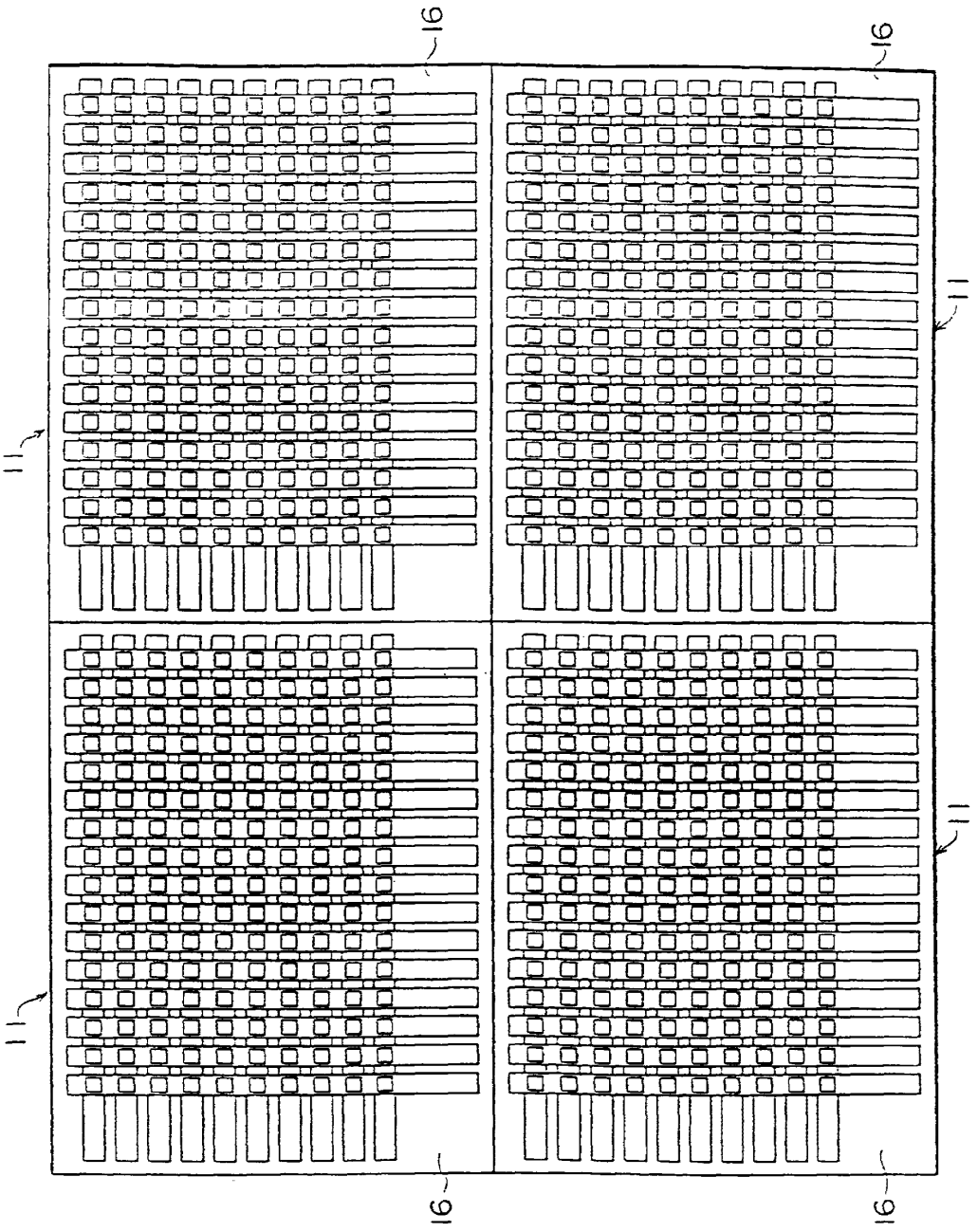

FIG.5B






IPR2026-00067
TSMC EX1002 Page 27

FIG.6






IPR2026-00067
TSMC EX1002 Page 28

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 00 30 0217

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int.Cl.7) |
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| | | | TECHNICAL FIELDS SEARCHED (Int.Cl.7) |
| | | | H01L |

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
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| THE HAGUE | 16 June 2000 | Fransen, L |

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IPR2026-00067
TSMC EX1002 Page 29

## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 00 30 0217

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16-06-2000

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82



IPR2026-00067
TSMC EX1002 Page 30

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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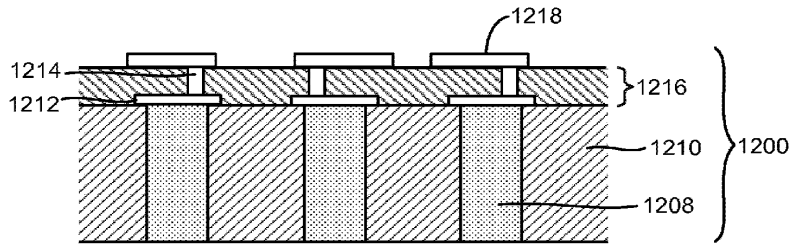



**Figure 12A**

(57) Abstract: This disclosure provides systems, methods and apparatus for interposers in compact three-dimensional (3-D) device packages. In one aspect, one or more methods of fabricating an interposer using an additive process are provided. The additive process can involve depositing flowable dielectric material around a plurality of metal interconnect posts after forming the plurality of metal interconnect posts on a carrier substrate. In another aspect, an interposer including through-glass vias and one or more passive devices is provided.

WO 2013/138452 A1

# LOW COST INTERPOSER FABRICATED WITH ADDITIVE PROCESSES

## CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to U.S. Patent Application 13/418,834, filed March 13, 2012, titled "LOW COST INTERPOSER FABRICATED WITH ADDITIVE PROCESSES," all of which is incorporated herein by this reference for all purposes.

## TECHNICAL FIELD

[0002] This disclosure relates generally to three-dimensional (3-D) device packaging and more particularly to electrically conductive interconnects for 3-D device packages.

## DESCRIPTION OF THE RELATED TECHNOLOGY

[0003] Electromechanical systems include devices having electrical and mechanical elements, actuators, transducers, sensors, optical components (e.g., mirrors) and electronics. Electromechanical systems can be manufactured at a variety of scales including, but not limited to, microscales and nanoscales. For example, microelectromechanical systems (MEMS) devices can include structures having sizes ranging from about a micron to hundreds of microns or more. Nanoelectromechanical systems (NEMS) devices can include structures having sizes smaller than a micron including, for example, sizes smaller than several hundred nanometers. Electromechanical elements may be created using deposition, etching, lithography, and/or other micromachining processes that etch away parts of substrates and/or deposited material layers, or that add layers to form electrical and electromechanical devices.

[0004] One type of electromechanical systems device is called an interferometric modulator (IMOD). As used herein, the term interferometric modulator or interferometric light modulator refers to a device that selectively absorbs and/or reflects light using the principles of optical interference. In some implementations, an interferometric modulator may include a pair of conductive plates, one or both of which may be transparent and/or reflective, wholly or in part, and capable of relative motion upon application of an appropriate electrical signal. In an implementation, one plate may include a stationary layer deposited on a substrate and the other plate may include a reflective membrane separated from the stationary layer by an air gap. The position of one plate in relation to another can change the optical interference of light incident on



IPR2026-00067
TSMC EX1002 Page 32

the interferometric modulator. Interferometric modulator devices have a wide range of applications, and are anticipated to be used in improving existing products and creating new products, especially those with display capabilities.

[0005] Device packaging in electromechanical systems can protect the functional units of the system from the environment, provide mechanical support for the system components, and provide a high-density interface for stacked electrical interconnections between devices and substrates.

## SUMMARY

[0006] The systems, methods and devices of the disclosure each have several innovative aspects, no single one of which is solely responsible for the desirable attributes disclosed herein.

[0007] One innovative aspect of the subject matter described in this disclosure can be implemented in a method of forming an interposer. The method can include forming a sacrificial layer on a carrier substrate and forming a plurality of interconnect posts on the sacrificial layer. The plurality of interconnected posts can be oriented substantially perpendicular to the carrier substrate. One or more flowable dielectric layers can be deposited and solidified to cover the sacrificial layer and the plurality of interconnect posts. The solidified dielectric material can be planarized to expose the plurality of interconnect posts and to form an interposer layer releasably attached to the carrier substrate via the sacrificial layer. In some implementations, the one or more flowable dielectric layers can include one or more spin-on dielectrics or one or more epoxy layers. In some implementations, forming a plurality of interconnect posts can include plating metal posts in a patterned photoresist layer.

[0008] The method can further include forming one or one more passive components on the solidified dielectric material. Examples of passive components include resistors, capacitors, and inductors. In some implementations, one or more passive components can be formed after planarizing the solidified dielectric material. In some implementations, one or more passive components can be formed after forming the sacrificial layer on the carrier substrate and before depositing any flowable dielectric layers. The method can further include plating the plurality of interconnect posts with solderable material. In some implementations, the method can further include forming one or more routing layers on the solidified dielectric material.



IPR2026-00067
TSMC EX1002 Page 33

[0009] Another innovative aspect of this disclosure can be implemented in an interposer. The interposer can include an additive glass interposer layer and one or more metal interconnect posts extending through the glass interposer layer. In some implementations, a routing layer including electrically conductive routing lines can be connected to the one or more metal interconnect posts. The density of the routing lines can greater than the density of the interconnect posts. Examples of metals in a metal interconnect post can include nickel, nickel alloy, and copper. In some implementations, the metal interconnect posts can have height to width aspect ratios of greater than about 5:1. Example heights of the metal interconnect posts range from about 10 microns to about 100 microns, and in some cases as much as about 500 microns. Example widths of the metal interconnect posts range from about 5 microns to about 100 microns. Example thicknesses of the glass interposer layer can range from about 10 microns to about 500 microns. In some implementations, the interposer can include one or more passive components on the glass interposer layer. In some implementations, a metal interconnect post can include an interconnect cap that protrudes from the spin-on glass substrate. An interconnect cap can include a solderable material in some implementations.

[0010] Another innovative aspect of this disclosure can be implemented in a method of forming an interposer that includes using an additive process to fabricate an additive glass interposer layer on a carrier substrate and integrating one or more passive components within the interposer layer during the additive process. Examples of passive components include resistors, capacitors and inductors. In some implementations, using the additive process includes depositing flowable dielectric material around a plurality of metal interconnect posts and the carrier substrate after forming the plurality of metal interconnect posts on the carrier substrate.

[0011] Another innovative aspect of this disclosure can be implemented in an apparatus. The apparatus can include a packaging substrate, an interposer layer in electrical communication with the packaging substrate, and one or more dies positioned over the interposer layer. The interposer layer can include a solidified dielectric material, one or more metal interconnect posts extending through the solidified dielectric material, and a routing layer including electrically conductive routing lines connected to the one or more metal interconnect posts. In some implementations, the density of electrical connections from the routing layer to the one or more dies is greater than the density of electrical connections from the interposer layer to the packaging



IPR2026-00067
TSMC EX1002 Page 34

substrate. In some implementations, the solidified dielectric material can include spin-on-glass or epoxy. Examples of dies include at least one of memory, logic, radio frequency, application specific integrated circuit, and MEMS chips. In some implementations, the one or more dies can include stacked dies. The apparatus can further include one or more passive components within the interposer layer. Examples of passive components include resistors, capacitors and inductors.

[0012] Another innovative aspect of this disclosure can be implemented in an apparatus including an interposer formed by a process including forming a plurality of interconnect posts on a sacrificial layer, the sacrificial layer formed on a carrier substrate; depositing and solidifying one or more flowable dielectric layers around the interconnect posts; planarizing the solidified dielectric material to expose the interconnect posts; and releasing the interposer from the carrier substrate by sacrificially etching the sacrificial layer.

[0013] The apparatus can further include one or more routing layers on an upper side or a lower side of the interposer. At least one passive component can be formed on an upper side or a lower side of the interposer. In some implementations, at least one interconnect post provides strain relief when the interposer is connected between a packaging substrate and an integrated circuit chip. In some implementations, at least one interconnect post allows heat transfer between an integrated circuit chip and a packaging substrate, the interposer connected between the packaging substrate and the integrated circuit chip. The apparatus can further include one or more of an integrated circuit chip and a packaging substrate attached to the interposer. In some implementations, the interposer provides stress isolation between a packaging substrate and an integrated circuit chip attached to the interposer.

[0014] Details of one or more implementations of the subject matter described in this specification are set forth in the accompanying drawings and the description below. Other features, aspects, and advantages will become apparent from the description, the drawings, and the claims. Note that the relative dimensions of the following figures may not be drawn to scale.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Figure 1 shows an example of an isometric view depicting two adjacent pixels in a series of pixels of an interferometric modulator (IMOD) display device.



IPR2026-00067
TSMC EX1002 Page 35

[0016] Figure 2 shows an example of a system block diagram illustrating an electronic device incorporating a 3x3 interferometric modulator display.

[0017] Figure 3 shows an example of a diagram illustrating movable reflective layer position versus applied voltage for the interferometric modulator of Figure 1.

[0018] Figure 4 shows an example of a table illustrating various states of an interferometric modulator when various common and segment voltages are applied.

[0019] Figure 5A shows an example of a diagram illustrating a frame of display data in the 3x3 interferometric modulator display of Figure 2.

[0020] Figure 5B shows an example of a timing diagram for common and segment signals that may be used to write the frame of display data illustrated in Figure 5A.

[0021] Figure 6A shows an example of a partial cross-section of the interferometric modulator display of Figure 1.

[0022] Figures 6B–6E show examples of cross-sections of varying implementations of interferometric modulators.

[0023] Figure 7 shows an example of a flow diagram illustrating a manufacturing process for an interferometric modulator.

[0024] Figures 8A–8E show examples of cross-sectional schematic illustrations of various stages in a method of making an interferometric modulator.

[0025] Figure 9 shows an example of a flow diagram illustrating a manufacturing process for forming an interposer.

[0026] Figure 10 shows an example of a flow diagram illustrating a manufacturing process for forming an interposer.

[0027] Figures 11A–11G show examples of cross-sectional schematic illustrations of various stages in a method of manufacturing an interposer layer.

[0028] Figures 12A–12C show examples of cross-sectional schematic illustrations of varying implementations of interposers with one or more routing layers.

[0029] Figure 13 shows an example of a cross-sectional schematic illustration of stacked dies on an interposer.

[0030] Figures 14A–14D show examples of cross-sectional schematic illustrations of various stages in a method of forming an interposer.

[0031] Figures 15A and 15B show examples of cross-sectional schematic illustrations of an interposer positioned between an integrated circuit chip and a packaging substrate.

[0032] Figures 16A and 16B show examples of system block diagrams illustrating a display device that includes a plurality of interferometric modulators.



IPR2026-00067
TSMC EX1002 Page 36

[0033] Like reference numbers and designations in the various drawings indicate like elements.

## DETAILED DESCRIPTION

[0034] The following detailed description is directed to certain implementations for the purposes of describing the innovative aspects. However, the teachings herein can be applied in a multitude of different ways. The described implementations may be implemented in any device that is configured to display an image, whether in motion (e.g., video) or stationary (e.g., still image), and whether textual, graphical or pictorial. More particularly, it is contemplated that the implementations may be implemented in or associated with a variety of electronic devices such as, but not limited to, mobile telephones, multimedia Internet enabled cellular telephones, mobile television receivers, wireless devices, smartphones, bluetooth devices, personal data assistants (PDAs), wireless electronic mail receivers, hand-held or portable computers, netbooks, notebooks, smartbooks, tablets, printers, copiers, scanners, facsimile devices, GPS receivers/navigators, cameras, MP3 players, camcorders, game consoles, wrist watches, clocks, calculators, television monitors, flat panel displays, electronic reading devices (e.g., e-readers), computer monitors, auto displays (e.g., odometer display, etc.), cockpit controls and/or displays, camera view displays (e.g., display of a rear view camera in a vehicle), electronic photographs, electronic billboards or signs, projectors, architectural structures, microwaves, refrigerators, stereo systems, cassette recorders or players, DVD players, CD players, VCRs, radios, portable memory chips, washers, dryers, washer/dryers, parking meters, packaging (e.g., electromechanical systems (EMS), MEMS and non-MEMS), aesthetic structures (e.g., display of images on a piece of jewelry) and a variety of electromechanical systems devices. The teachings herein also can be used in non-display applications such as, but not limited to, electronic switching devices, radio frequency filters, sensors, accelerometers, gyroscopes, motion-sensing devices, magnetometers, inertial components for consumer electronics, parts of consumer electronics products, varactors, liquid crystal devices, electrophoretic devices, drive schemes, manufacturing processes, electronic test equipment. Thus, the teachings are not intended to be limited to the implementations depicted solely in the Figures, but instead have wide applicability as will be readily apparent to one having ordinary skill in the art.



IPR2026-00067
TSMC EX1002 Page 37

[0035] Some implementations described herein relate to 3-D device packaging and interposer technology. An interposer generally serves as an intermediate layer that can be used for direct electrical interconnection between one device or substrate and a second device or substrate with the interposer positioned in between. For example, an interposer may have a pad configuration on one side that can be aligned with corresponding pads on a first device, and a different pad configuration on a second side that corresponds to pads on a second device. The interposer can contain electrical traces that allow interconnecting pads to be aligned and mated to devices on opposite sides. In some implementations, the interposer includes an interposer layer that has electrically conductive interconnects (vias) extending through the layer. For example, in some implementations, the interposer layer can be a through-glass via layer. For example, in some implementations, the interposer layer can be an additive glass interposer layer. In some implementations, the interposers can further include one or more routing or redistribution layers. In some implementations, the interposer may include a ground plane and/or a power plane. In some implementations, one or more passive components can be integrated within the interposer. In some implementations, one or more devices may be attached to each side of the interposer.

[0036] Some implementations described herein relate to additive processes to fabricate interposers. An additive process can involve depositing flowable dielectric material over a plurality of metal interconnect posts and solidifying the flowable dielectric material. In some implementations, the process can further include forming the plurality of metal interconnect posts on a carrier substrate prior to depositing the flowable dielectric material. For example, the flowable dielectric material may be deposited by spinning, dispensing, extruding, injecting, casting or otherwise disposing the dielectric material around, and in some cases, over the interconnect posts. The interconnect posts may be formed, for example, directly on the carrier substrate or on a sacrificial layer disposed on the carrier substrate. Examples of flowable dielectric material include spin-on dielectric and epoxy materials. The process can further include planarizing the solidified dielectric material to form an interposer layer including through-layer interconnects. In some implementations, one or more passive components can be formed prior to or after forming the solidified dielectric material. In some implementations, one or more routing or redistribution layers can be formed prior to or after forming the solidified dielectric material.



IPR2026-00067
TSMC EX1002 Page 38

[0037] Some implementations relate to additive glass interposer layers. An additive glass interposer layer is any interposer layer formed by solidifying a flowable dielectric material such as a dispensable glass or epoxy around one or more interconnect posts of the interposer layer.

[0038] Particular implementations of the subject matter described in this disclosure can be implemented to realize one or more of the following potential advantages. Forming an interposer layer using an additive process can reduce the cost of fabrication in comparison to subtractive processes that require multiple patterning and deposition operations. Use of a flowable dielectric material around electroplated posts allows relatively thin interposers to be formed. The posts may be formed with a relatively high density. Patterned photoresist materials may be used to form the electroplated posts, which can then be removed and replaced with a stronger material having a high dielectric strength. One or more routing layers separated by thin dielectric layers may be formed prior to or after formation of the posts. Passive components can also be integrated in a cost-efficient manner within the interposer by using an additive process. Additive processes are also scalable to large panel or continuous roll substrates that can further reduce cost.

[0039] Some implementations described herein relate to 3-D device packaging, including packaging of EMS or MEMS devices. An example of a suitable EMS or MEMS device, to which the described implementations may apply, is a reflective display device. Reflective display devices can incorporate interferometric modulators (IMODs) to selectively absorb and/or reflect light incident thereon using principles of optical interference. IMODs can include an absorber, a reflector that is movable with respect to the absorber, and an optical resonant cavity defined between the absorber and the reflector. The reflector can be moved to two or more different positions, which can change the size of the optical resonant cavity and thereby affect the reflectance of the interferometric modulator. The reflectance spectrums of IMODs can create fairly broad spectral bands which can be shifted across the visible wavelengths to generate different colors. The position of the spectral band can be adjusted by changing the thickness of the optical resonant cavity, i.e., by changing the position of the reflector.

[0040] Figure 1 shows an example of an isometric view depicting two adjacent pixels in a series of pixels of an interferometric modulator (IMOD) display device. The IMOD display device includes one or more interferometric MEMS display elements. In these devices, the pixels of the MEMS display elements can be in either a bright or dark state.



IPR2026-00067
TSMC EX1002 Page 39

In the bright ("relaxed," "open" or "on") state, the display element reflects a large portion of incident visible light, e.g., to a user. Conversely, in the dark ("actuated," "closed" or "off") state, the display element reflects little incident visible light. In some implementations, the light reflectance properties of the on and off states may be reversed. MEMS pixels can be configured to reflect predominantly at particular wavelengths allowing for a color display in addition to black and white.

[0041] The IMOD display device can include a row/column array of IMODs. Each IMOD can include a pair of reflective layers, i.e., a movable reflective layer and a fixed partially reflective layer, positioned at a variable and controllable distance from each other to form an air gap (also referred to as an optical gap or cavity). The movable reflective layer may be moved between at least two positions. In a first position, i.e., a relaxed position, the movable reflective layer can be positioned at a relatively large distance from the fixed partially reflective layer. In a second position, i.e., an actuated position, the movable reflective layer can be positioned more closely to the partially reflective layer. Incident light that reflects from the two layers can interfere constructively or destructively depending on the position of the movable reflective layer, producing either an overall reflective or non-reflective state for each pixel. In some implementations, the IMOD may be in a reflective state when unactuated, reflecting light within the visible spectrum, and may be in a dark state when unactuated, reflecting light outside of the visible range (e.g., infrared light). In some other implementations, however, an IMOD may be in a dark state when unactuated, and in a reflective state when actuated. In some implementations, the introduction of an applied voltage can drive the pixels to change states. In some other implementations, an applied charge can drive the pixels to change states.

[0042] The depicted portion of the pixel array in Figure 1 includes two adjacent interferometric modulators 12. In the IMOD 12 on the left (as illustrated), a movable reflective layer 14 is illustrated in a relaxed position at a predetermined distance from an optical stack 16, which includes a partially reflective layer. The voltage $V_0$ applied across the IMOD 12 on the left is insufficient to cause actuation of the movable reflective layer 14. In the IMOD 12 on the right, the movable reflective layer 14 is illustrated in an actuated position near or adjacent the optical stack 16. The voltage $V_{bias}$ applied across the IMOD 12 on the right is sufficient to maintain the movable reflective layer 14 in the actuated position.



IPR2026-00067
TSMC EX1002 Page 40

[0043] In Figure 1, the reflective properties of pixels 12 are generally illustrated with arrows 13 indicating light incident upon the pixels 12, and light 15 reflecting from the IMOD 12 on the left. Although not illustrated in detail, it will be understood by one having ordinary skill in the art that most of the light 13 incident upon the pixels 12 will be transmitted through the transparent substrate 20, toward the optical stack 16. A portion of the light incident upon the optical stack 16 will be transmitted through the partially reflective layer of the optical stack 16, and a portion will be reflected back through the transparent substrate 20. The portion of light 13 that is transmitted through the optical stack 16 will be reflected at the movable reflective layer 14, back toward (and through) the transparent substrate 20. Interference (constructive or destructive) between the light reflected from the partially reflective layer of the optical stack 16 and the light reflected from the movable reflective layer 14 will determine the wavelength(s) of light 15 reflected from the IMOD 12.

[0044] The optical stack 16 can include a single layer or several layers. The layer(s) can include one or more of an electrode layer, a partially reflective and partially transmissive layer, and a transparent dielectric layer. In some implementations, the optical stack 16 is electrically conductive, partially transparent and partially reflective, and may be fabricated, for example, by depositing one or more of the above layers onto a transparent substrate 20. The electrode layer can be formed from a variety of materials, such as various metals, for example indium tin oxide (ITO). The partially reflective layer can be formed from a variety of materials that are partially reflective, such as various metals, e.g., chromium (Cr), semiconductors, and dielectrics. The partially reflective layer can be formed of one or more layers of materials, and each of the layers can be formed of a single material or a combination of materials. In some implementations, the optical stack 16 can include a single semi-transparent thickness of metal or semiconductor which serves as both an optical absorber and conductor, while different, more conductive layers or portions (e.g., of the optical stack 16 or of other structures of the IMOD) can serve to bus signals between IMOD pixels. The optical stack 16 also can include one or more insulating or dielectric layers covering one or more conductive layers or a conductive/absorptive layer.

[0045] In some implementations, the layer(s) of the optical stack 16 can be patterned into parallel strips, and may form row electrodes in a display device as described further below. As will be understood by one having skill in the art, the term "patterned" is used herein to refer to masking as well as etching processes. In some implementations, a



IPR2026-00067
TSMC EX1002 Page 41

highly conductive and reflective material, such as aluminum (Al), may be used for the movable reflective layer 14, and these strips may form column electrodes in a display device. The movable reflective layer 14 may be formed as a series of parallel strips of a deposited metal layer or layers (orthogonal to the row electrodes of the optical stack 16) to form columns deposited on top of posts 18 and an intervening sacrificial material deposited between the posts 18. When the sacrificial material is etched away, a defined gap 19, or optical cavity, can be formed between the movable reflective layer 14 and the optical stack 16. In some implementations, the spacing between posts 18 may be approximately 1–1000 um, while the gap 19 may be less than 10,000 Angstroms (Å).

[0046] In some implementations, each pixel of the IMOD, whether in the actuated or relaxed state, is essentially a capacitor formed by the fixed and moving reflective layers. When no voltage is applied, the movable reflective layer 14 remains in a mechanically relaxed state, as illustrated by the IMOD 12 on the left in Figure 1, with the gap 19 between the movable reflective layer 14 and optical stack 16. However, when a potential difference, e.g., voltage, is applied to at least one of a selected row and column, the capacitor formed at the intersection of the row and column electrodes at the corresponding pixel becomes charged, and electrostatic forces pull the electrodes together. If the applied voltage exceeds a threshold, the movable reflective layer 14 can deform and move near or against the optical stack 16. A dielectric layer (not shown) within the optical stack 16 may prevent shorting and control the separation distance between the layers 14 and 16, as illustrated by the actuated IMOD 12 on the right in Figure 1. The behavior is the same regardless of the polarity of the applied potential difference. Though a series of pixels in an array may be referred to in some instances as "rows" or "columns," a person having ordinary skill in the art will readily understand that referring to one direction as a "row" and another as a "column" is arbitrary. Restated, in some orientations, the rows can be considered columns, and the columns considered to be rows. Furthermore, the display elements may be evenly arranged in orthogonal rows and columns (an "array"), or arranged in non-linear configurations, for example, having certain positional offsets with respect to one another (a "mosaic"). The terms "array" and "mosaic" may refer to either configuration. Thus, although the display is referred to as including an "array" or "mosaic," the elements themselves need not be arranged orthogonally to one another, or disposed in an even distribution, in any instance, but may include arrangements having asymmetric shapes and unevenly distributed elements.



IPR2026-00067
TSMC EX1002 Page 42

[0047] Figure 2 shows an example of a system block diagram illustrating an electronic device incorporating a 3x3 interferometric modulator display. The electronic device includes a processor 21 that may be configured to execute one or more software modules. In addition to executing an operating system, the processor 21 may be configured to execute one or more software applications, including a web browser, a telephone application, an email program, or other software application.

[0048] The processor 21 can be configured to communicate with an array driver 22. The array driver 22 can include a row driver circuit 24 and a column driver circuit 26 that provide signals to, e.g., a display array or panel 30. The cross section of the IMOD display device illustrated in Figure 1 is shown by the lines 1–1 in Figure 2. Although Figure 2 illustrates a 3x3 array of IMODs for the sake of clarity, the display array 30 may contain a very large number of IMODs, and may have a different number of IMODs in rows than in columns, and vice versa.

[0049] Figure 3 shows an example of a diagram illustrating movable reflective layer position versus applied voltage for the interferometric modulator of Figure 1. For MEMS interferometric modulators, the row/column (i.e., common/segment) write procedure may take advantage of a hysteresis property of these devices as illustrated in Figure 3. An interferometric modulator may require, for example, about a 10-volt potential difference to cause the movable reflective layer, or mirror, to change from the relaxed state to the actuated state. When the voltage is reduced from that value, the movable reflective layer maintains its state as the voltage drops back below, e.g., 10 volts, however, the movable reflective layer does not relax completely until the voltage drops below 2 volts. Thus, a range of voltage, approximately 3 to 7 volts, as shown in Figure 3, exists where there is a window of applied voltage within which the device is stable in either the relaxed or actuated state. This is referred to herein as the "hysteresis window" or "stability window." For a display array 30 having the hysteresis characteristics of Figure 3, the row/column write procedure can be designed to address one or more rows at a time, such that during the addressing of a given row, pixels in the addressed row that are to be actuated are exposed to a voltage difference of about 10 volts, and pixels that are to be relaxed are exposed to a voltage difference of near zero volts. After addressing, the pixels are exposed to a steady state or bias voltage difference of approximately 5-volts such that they remain in the previous strobing state. In this example, after being addressed, each pixel sees a potential difference within the "stability window" of about 3–7 volts. This hysteresis property feature enables the pixel



IPR2026-00067
TSMC EX1002 Page 43

design, e.g., illustrated in Figure 1, to remain stable in either an actuated or relaxed pre-existing state under the same applied voltage conditions. Since each IMOD pixel, whether in the actuated or relaxed state, is essentially a capacitor formed by the fixed and moving reflective layers, this stable state can be held at a steady voltage within the hysteresis window without substantially consuming or losing power. Moreover, essentially little or no current flows into the IMOD pixel if the applied voltage potential remains substantially fixed.

[0050] In some implementations, a frame of an image may be created by applying data signals in the form of "segment" voltages along the set of column electrodes, in accordance with the desired change (if any) to the state of the pixels in a given row. Each row of the array can be addressed in turn, such that the frame is written one row at a time. To write the desired data to the pixels in a first row, segment voltages corresponding to the desired state of the pixels in the first row can be applied on the column electrodes, and a first row pulse in the form of a specific "common" voltage or signal can be applied to the first row electrode. The set of segment voltages can then be changed to correspond to the desired change (if any) to the state of the pixels in the second row, and a second common voltage can be applied to the second row electrode. In some implementations, the pixels in the first row are unaffected by the change in the segment voltages applied along the column electrodes, and remain in the state they were set to during the first common voltage row pulse. This process may be repeated for the entire series of rows, or alternatively, columns, in a sequential fashion to produce the image frame. The frames can be refreshed and/or updated with new image data by continually repeating this process at some desired number of frames per second.

[0051] The combination of segment and common signals applied across each pixel (that is, the potential difference across each pixel) determines the resulting state of each pixel. Figure 4 shows an example of a table illustrating various states of an interferometric modulator when various common and segment voltages are applied. As will be readily understood by one having ordinary skill in the art, the "segment" voltages can be applied to either the column electrodes or the row electrodes, and the "common" voltages can be applied to the other of the column electrodes or the row electrodes.

[0052] As illustrated in Figure 4 (as well as in the timing diagram shown in Figure 5B), when a release voltage $VC_{REL}$ is applied along a common line, all interferometric modulator elements along the common line will be placed in a relaxed state,



IPR2026-00067
TSMC EX1002 Page 44

alternatively referred to as a released or unactuated state, regardless of the voltage applied along the segment lines, i.e., high segment voltage $VS_H$ and low segment voltage $VS_L$. In particular, when the release voltage $VC_{REL}$ is applied along a common line, the potential voltage across the modulator (alternatively referred to as a pixel voltage) is within the relaxation window (see Figure 3, also referred to as a release window) both when the high segment voltage $VS_H$ and the low segment voltage $VS_L$ are applied along the corresponding segment line for that pixel.

[0053] When a hold voltage is applied on a common line, such as a high hold voltage $VC_{HOLD\_H}$ or a low hold voltage $VC_{HOLD\_L}$, the state of the interferometric modulator will remain constant. For example, a relaxed IMOD will remain in a relaxed position, and an actuated IMOD will remain in an actuated position. The hold voltages can be selected such that the pixel voltage will remain within a stability window both when the high segment voltage $VS_H$ and the low segment voltage $VS_L$ are applied along the corresponding segment line. Thus, the segment voltage swing, i.e., the difference between the high $VS_H$ and low segment voltage $VS_L$, is less than the width of either the positive or the negative stability window.

[0054] When an addressing, or actuation, voltage is applied on a common line, such as a high addressing voltage $VC_{ADD\_H}$ or a low addressing voltage $VC_{ADD\_L}$, data can be selectively written to the modulators along that line by application of segment voltages along the respective segment lines. The segment voltages may be selected such that actuation is dependent upon the segment voltage applied. When an addressing voltage is applied along a common line, application of one segment voltage will result in a pixel voltage within a stability window, causing the pixel to remain unactuated. In contrast, application of the other segment voltage will result in a pixel voltage beyond the stability window, resulting in actuation of the pixel. The particular segment voltage which causes actuation can vary depending upon which addressing voltage is used. In some implementations, when the high addressing voltage $VC_{ADD\_H}$ is applied along the common line, application of the high segment voltage $VS_H$ can cause a modulator to remain in its current position, while application of the low segment voltage $VS_L$ can cause actuation of the modulator. As a corollary, the effect of the segment voltages can be the opposite when a low addressing voltage $VC_{ADD\_L}$ is applied, with high segment voltage $VS_H$ causing actuation of the modulator, and low segment voltage $VS_L$ having no effect (i.e., remaining stable) on the state of the modulator.



IPR2026-00067
TSMC EX1002 Page 45

[0055] In some implementations, hold voltages, address voltages, and segment voltages may be used which always produce the same polarity potential difference across the modulators. In some other implementations, signals can be used which alternate the polarity of the potential difference of the modulators. Alternation of the polarity across the modulators (that is, alternation of the polarity of write procedures) may reduce or inhibit charge accumulation which could occur after repeated write operations of a single polarity.

[0056] Figure 5A shows an example of a diagram illustrating a frame of display data in the 3x3 interferometric modulator display of Figure 2. Figure 5B shows an example of a timing diagram for common and segment signals that may be used to write the frame of display data illustrated in Figure 5A. The signals can be applied to the, e.g., 3x3 array of Figure 2, which will ultimately result in the line time 60e display arrangement illustrated in Figure 5A. The actuated modulators in Figure 5A are in a dark-state, i.e., where a substantial portion of the reflected light is outside of the visible spectrum so as to result in a dark appearance to, e.g., a viewer. Prior to writing the frame illustrated in Figure 5A, the pixels can be in any state, but the write procedure illustrated in the timing diagram of Figure 5B presumes that each modulator has been released and resides in an unactuated state before the first line time 60a.

[0057] During the first line time 60a, a release voltage 70 is applied on common line 1; the voltage applied on common line 2 begins at a high hold voltage 72 and moves to a release voltage 70; and a low hold voltage 76 is applied along common line 3. Thus, the modulators (common 1, segment 1), (1,2) and (1,3) along common line 1 remain in a relaxed, or unactuated, state for the duration of the first line time 60a, the modulators (2,1), (2,2) and (2,3) along common line 2 will move to a relaxed state, and the modulators (3,1), (3,2) and (3,3) along common line 3 will remain in their previous state. With reference to Figure 4, the segment voltages applied along segment lines 1, 2 and 3 will have no effect on the state of the interferometric modulators, as none of common lines 1, 2 or 3 are being exposed to voltage levels causing actuation during line time 60a (i.e., $VC_{REL}$ – relax and $VC_{HOLD\_L}$ – stable).

[0058] During the second line time 60b, the voltage on common line 1 moves to a high hold voltage 72, and all modulators along common line 1 remain in a relaxed state regardless of the segment voltage applied because no addressing, or actuation, voltage was applied on the common line 1. The modulators along common line 2 remain in a relaxed state due to the application of the release voltage 70, and the modulators (3,1),



IPR2026-00067
TSMC EX1002 Page 46

(3,2) and (3,3) along common line 3 will relax when the voltage along common line 3 moves to a release voltage 70.

[0059] During the third line time 60c, common line 1 is addressed by applying a high address voltage 74 on common line 1. Because a low segment voltage 64 is applied along segment lines 1 and 2 during the application of this address voltage, the pixel voltage across modulators (1,1) and (1,2) is greater than the high end of the positive stability window (i.e., the voltage differential exceeded a predefined threshold) of the modulators, and the modulators (1,1) and (1,2) are actuated. Conversely, because a high segment voltage 62 is applied along segment line 3, the pixel voltage across modulator (1,3) is less than that of modulators (1,1) and (1,2), and remains within the positive stability window of the modulator; modulator (1,3) thus remains relaxed. Also during line time 60c, the voltage along common line 2 decreases to a low hold voltage 76, and the voltage along common line 3 remains at a release voltage 70, leaving the modulators along common lines 2 and 3 in a relaxed position.

[0060] During the fourth line time 60d, the voltage on common line 1 returns to a high hold voltage 72, leaving the modulators along common line 1 in their respective addressed states. The voltage on common line 2 is decreased to a low address voltage 78. Because a high segment voltage 62 is applied along segment line 2, the pixel voltage across modulator (2,2) is below the lower end of the negative stability window of the modulator, causing the modulator (2,2) to actuate. Conversely, because a low segment voltage 64 is applied along segment lines 1 and 3, the modulators (2,1) and (2,3) remain in a relaxed position. The voltage on common line 3 increases to a high hold voltage 72, leaving the modulators along common line 3 in a relaxed state.

[0061] Finally, during the fifth line time 60e, the voltage on common line 1 remains at high hold voltage 72, and the voltage on common line 2 remains at a low hold voltage 76, leaving the modulators along common lines 1 and 2 in their respective addressed states. The voltage on common line 3 increases to a high address voltage 74 to address the modulators along common line 3. As a low segment voltage 64 is applied on segment lines 2 and 3, the modulators (3,2) and (3,3) actuate, while the high segment voltage 62 applied along segment line 1 causes modulator (3,1) to remain in a relaxed position. Thus, at the end of the fifth line time 60e, the 3x3 pixel array is in the state shown in Figure 5A, and will remain in that state as long as the hold voltages are applied along the common lines, regardless of variations in the segment voltage which



IPR2026-00067
TSMC EX1002 Page 47

may occur when modulators along other common lines (not shown) are being addressed.

[0062] In the timing diagram of Figure 5B, a given write procedure (i.e., line times 60a–60e) can include the use of either high hold and address voltages, or low hold and address voltages. Once the write procedure has been completed for a given common line (and the common voltage is set to the hold voltage having the same polarity as the actuation voltage), the pixel voltage remains within a given stability window, and does not pass through the relaxation window until a release voltage is applied on that common line. Furthermore, as each modulator is released as part of the write procedure prior to addressing the modulator, the actuation time of a modulator, rather than the release time, may determine the necessary line time. Specifically, in implementations in which the release time of a modulator is greater than the actuation time, the release voltage may be applied for longer than a single line time, as depicted in Figure 5B. In some other implementations, voltages applied along common lines or segment lines may vary to account for variations in the actuation and release voltages of different modulators, such as modulators of different colors.

[0063] The details of the structure of interferometric modulators that operate in accordance with the principles set forth above may vary widely. For example, Figures 6A–6E show examples of cross-sections of varying implementations of interferometric modulators, including the movable reflective layer 14 and its supporting structures. Figure 6A shows an example of a partial cross-section of the interferometric modulator display of Figure 1, where a strip of metal material, i.e., the movable reflective layer 14 is deposited on supports 18 extending orthogonally from the substrate 20. In Figure 6B, the movable reflective layer 14 of each IMOD is generally square or rectangular in shape and attached to supports at or near the corners, on tethers 32. In Figure 6C, the movable reflective layer 14 is generally square or rectangular in shape and suspended from a deformable layer 34, which may include a flexible metal. The deformable layer 34 can connect, directly or indirectly, to the substrate 20 around the perimeter of the movable reflective layer 14. These connections are herein referred to as support posts. The implementation shown in Figure 6C has additional benefits deriving from the decoupling of the optical functions of the movable reflective layer 14 from its mechanical functions, which are carried out by the deformable layer 34. This decoupling allows the structural design and materials used for the reflective layer 14



IPR2026-00067
TSMC EX1002 Page 48

and those used for the deformable layer 34 to be optimized independently of one another.

[0064] Figure 6D shows another example of an IMOD, where the movable reflective layer 14 includes a reflective sub-layer 14a. The movable reflective layer 14 rests on a support structure, such as support posts 18. The support posts 18 provide separation of the movable reflective layer 14 from the lower stationary electrode (i.e., part of the optical stack 16 in the illustrated IMOD) so that a gap 19 is formed between the movable reflective layer 14 and the optical stack 16, for example when the movable reflective layer 14 is in a relaxed position. The movable reflective layer 14 also can include a conductive layer 14c, which may be configured to serve as an electrode, and a support layer 14b. In this example, the conductive layer 14c is disposed on one side of the support layer 14b, distal from the substrate 20, and the reflective sub-layer 14a is disposed on the other side of the support layer 14b, proximal to the substrate 20. In some implementations, the reflective sub-layer 14a can be conductive and can be disposed between the support layer 14b and the optical stack 16. The support layer 14b can include one or more layers of a dielectric material, for example, silicon oxynitride (SiON) or silicon dioxide ($SiO_2$). In some implementations, the support layer 14b can be a stack of layers, such as, for example, a $SiO_2$/SiON/$SiO_2$ tri-layer stack. Either or both of the reflective sub-layer 14a and the conductive layer 14c can include, e.g., an aluminum (Al) alloy with about 0.5% copper (Cu), or another reflective metallic material. Employing conductive layers 14a, 14c above and below the dielectric support layer 14b can balance stresses and provide enhanced conduction. In some implementations, the reflective sub-layer 14a and the conductive layer 14c can be formed of different materials for a variety of design purposes, such as achieving specific stress profiles within the movable reflective layer 14.

[0065] As illustrated in Figure 6D, some implementations also can include a black mask structure 23. The black mask structure 23 can be formed in optically inactive regions (e.g., between pixels or under posts 18) to absorb ambient or stray light. The black mask structure 23 also can improve the optical properties of a display device by inhibiting light from being reflected from or transmitted through inactive portions of the display, thereby increasing the contrast ratio. Additionally, the black mask structure 23 can be conductive and be configured to function as an electrical bussing layer. In some implementations, the row electrodes can be connected to the black mask structure 23 to reduce the resistance of the connected row electrode. The black mask structure 23 can



IPR2026-00067
TSMC EX1002 Page 49

be formed using a variety of methods, including deposition and patterning techniques. The black mask structure 23 can include one or more layers. For example, in some implementations, the black mask structure 23 includes a molybdenum-chromium (MoCr) layer that serves as an optical absorber, an $SiO_2$ layer, and an aluminum alloy that serves as a reflector and a bussing layer, with a thickness in the range of about 30–80 Å, 500–1000 Å, and 500–6000 Å, respectively. The one or more layers can be patterned using a variety of techniques, including photolithography and dry etching, including, for example, carbon tetrafluoromethane ($CF_4$) and/or oxygen ($O_2$) for the MoCr and $SiO_2$ layers and chlorine ($Cl_2$) and/or boron trichloride ($BCl_3$) for the aluminum alloy layer. In some implementations, the black mask 23 can be an etalon or interferometric stack structure. In such interferometric stack black mask structures 23, the conductive absorbers can be used to transmit or bus signals between lower, stationary electrodes in the optical stack 16 of each row or column. In some implementations, a spacer layer 35 can serve to generally electrically isolate the absorber layer 16a from the conductive layers in the black mask 23.

[0066] Figure 6E shows another example of an IMOD, where the movable reflective layer 14 is self-supporting. In contrast with Figure 6D, the implementation of Figure 6E does not include support posts 18. Instead, the movable reflective layer 14 contacts the underlying optical stack 16 at multiple locations, and the curvature of the movable reflective layer 14 provides sufficient support that the movable reflective layer 14 returns to the unactuated position of Figure 6E when the voltage across the interferometric modulator is insufficient to cause actuation. The optical stack 16, which may contain a plurality of several different layers, is shown here for clarity including an optical absorber 16a, and a dielectric 16b. In some implementations, the optical absorber 16a may serve both as a fixed electrode and as a partially reflective layer.

[0067] In implementations such as those shown in Figures 6A–6E, the IMODs function as direct-view devices, in which images are viewed from the front side of the transparent substrate 20, i.e., the side opposite to that upon which the modulator is arranged. In these implementations, the back portions of the device (that is, any portion of the display device behind the movable reflective layer 14, including, for example, the deformable layer 34 illustrated in Figure 6C) can be configured and operated upon without impacting or negatively affecting the image quality of the display device, because the reflective layer 14 optically shields those portions of the device. For example, in some implementations a bus structure (not illustrated) can be included



IPR2026-00067
TSMC EX1002 Page 50

behind the movable reflective layer 14 which provides the ability to separate the optical properties of the modulator from the electromechanical properties of the modulator, such as voltage addressing and the movements that result from such addressing. Additionally, the implementations of Figures 6A–6E can simplify processing, such as, e.g., patterning.

[0068] Figure 7 shows an example of a flow diagram illustrating a manufacturing process 80 for an interferometric modulator, and Figures 8A–8E show examples of cross-sectional schematic illustrations of corresponding stages of such a manufacturing process 80. In some implementations, the manufacturing process 80 can be implemented to manufacture, e.g., interferometric modulators of the general type illustrated in Figures 1 and 6, in addition to other blocks not shown in Figure 7. With reference to Figures 1, 6 and 7, the process 80 begins at block 82 with the formation of the optical stack 16 over the substrate 20. Figure 8A illustrates such an optical stack 16 formed over the substrate 20. The substrate 20 may be a transparent substrate such as glass or plastic, it may be flexible or relatively stiff and unbending, and may have been subjected to prior preparation processes, e.g., cleaning, to facilitate efficient formation of the optical stack 16. As discussed above, the optical stack 16 can be electrically conductive, partially transparent and partially reflective and may be fabricated, for example, by depositing one or more layers having the desired properties onto the transparent substrate 20. In Figure 8A, the optical stack 16 includes a multilayer structure having sub-layers 16a and 16b, although more or fewer sub-layers may be included in some other implementations. In some implementations, one of the sub-layers 16a, 16b can be configured with both optically absorptive and conductive properties, such as the combined conductor/absorber sub-layer 16a. Additionally, one or more of the sub-layers 16a, 16b can be patterned into parallel strips, and may form row electrodes in a display device. Such patterning can be performed by a masking and etching process or another suitable process. In some implementations, one of the sub-layers 16a, 16b can be an insulating or dielectric layer, such as sub-layer 16b that is deposited over one or more metal layers (e.g., one or more reflective and/or conductive layers). In addition, the optical stack 16 can be patterned into individual and parallel strips that form the rows of the display.

[0069] The process 80 continues at block 84 with the formation of a sacrificial layer 25 over the optical stack 16. The sacrificial layer 25 is later removed (e.g., at block 90) to form the cavity 19 and thus the sacrificial layer 25 is not shown in the resulting



IPR2026-00067
TSMC EX1002 Page 51

interferometric modulators 12 illustrated in Figure 1. Figure 8B illustrates a partially fabricated device including a sacrificial layer 25 formed over the optical stack 16. The formation of the sacrificial layer 25 over the optical stack 16 may include deposition of a xenon difluoride ($XeF_2$)-etchable material such as molybdenum (Mo) or amorphous silicon (Si), in a thickness selected to provide, after subsequent removal, a gap or cavity 19 (see also Figures 1 and 8E) having a desired design size. Deposition of the sacrificial material may be carried out using deposition techniques such as physical vapor deposition (PVD, e.g., sputtering), plasma-enhanced chemical vapor deposition (PECVD), thermal chemical vapor deposition (thermal CVD), or spin-coating.

[0070] The process 80 continues at block 86 with the formation of a support structure e.g., a post 18 as illustrated in Figures 1, 6 and 8C. The formation of the post 18 may include patterning the sacrificial layer 25 to form a support structure aperture, then depositing a material (e.g., a polymer or an inorganic material, e.g., silicon oxide) into the aperture to form the post 18, using a deposition method such as PVD, PECVD, thermal CVD, or spin-coating. In some implementations, the support structure aperture formed in the sacrificial layer can extend through both the sacrificial layer 25 and the optical stack 16 to the underlying substrate 20, so that the lower end of the post 18 contacts the substrate 20 as illustrated in Figure 6A. Alternatively, as depicted in Figure 8C, the aperture formed in the sacrificial layer 25 can extend through the sacrificial layer 25, but not through the optical stack 16. For example, Figure 8E illustrates the lower ends of the support posts 18 in contact with an upper surface of the optical stack 16. The post 18, or other support structures, may be formed by depositing a layer of support structure material over the sacrificial layer 25 and patterning to remove portions of the support structure material located away from apertures in the sacrificial layer 25. The support structures may be located within the apertures, as illustrated in Figure 8C, but also can, at least partially, extend over a portion of the sacrificial layer 25. As noted above, the patterning of the sacrificial layer 25 and/or the support posts 18 can be performed by a patterning and etching process, but also may be performed by alternative etching methods.

[0071] The process 80 continues at block 88 with the formation of a movable reflective layer or membrane such as the movable reflective layer 14 illustrated in Figures 1, 6 and 8D. The movable reflective layer 14 may be formed by employing one or more deposition processes, e.g., reflective layer (e.g., aluminum, aluminum alloy) deposition, along with one or more patterning, masking, and/or etching processes. The



IPR2026-00067
TSMC EX1002 Page 52

movable reflective layer 14 can be electrically conductive, and referred to as an electrically conductive layer. In some implementations, the movable reflective layer 14 may include a plurality of sub-layers 14a, 14b, 14c as shown in Figure 8D. In some implementations, one or more of the sub-layers, such as sub-layers 14a, 14c, may include highly reflective sub-layers selected for their optical properties, and another sub-layer 14b may include a mechanical sub-layer selected for its mechanical properties. Since the sacrificial layer 25 is still present in the partially fabricated interferometric modulator formed at block 88, the movable reflective layer 14 is typically not movable at this stage. A partially fabricated IMOD that contains a sacrificial layer 25 also may be referred to herein as an "unreleased" IMOD. As described above in connection with Figure 1, the movable reflective layer 14 can be patterned into individual and parallel strips that form the columns of the display.

[0072] The process 80 continues at block 90 with the formation of a cavity, e.g., cavity 19 as illustrated in Figures 1, 6 and 8E. The cavity 19 may be formed by exposing the sacrificial material 25 (deposited at block 84) to an etchant. For example, an etchable sacrificial material such as Mo or amorphous Si may be removed by dry chemical etching, e.g., by exposing the sacrificial layer 25 to a gaseous or vaporous etchant, such as vapors derived from solid $XeF_2$ for a period of time that is effective to remove the desired amount of material, typically selectively removed relative to the structures surrounding the cavity 19. Other combinations of etchable sacrificial material and etching methods, e.g. wet etching and/or plasma etching, also may be used. Since the sacrificial layer 25 is removed during block 90, the movable reflective layer 14 is typically movable after this stage. After removal of the sacrificial material 25, the resulting fully or partially fabricated IMOD may be referred to herein as a "released" IMOD.

[0073] Implementations described herein relate to interposers and interposers for use in compact three-dimensional (3-D) packages. In some implementations, methods of manufacturing an interposer are described. An interposer is an intermediate layer that can be used for interconnection routing or as a ground or power plane. Interposers can be incorporated within 3-D device packages, such as packages for memory, logic, EMS, MEMS, and other chip devices. In a 3-D structure, electronic components such as semiconductor chips, EMS devices, and the like can be provided in a stacked structure. Interposers can connect components in different layers of a 3-D stacked structure.



IPR2026-00067
TSMC EX1002 Page 53

[0074] In some implementations, the interposers described herein include glass or epoxy substrates having through-substrate interconnects (vias). For example, a through-glass via interposer is an interposer including electrically conductive vias that extend through a glass interposer layer and that can provide electrical interconnection between components on both sides of the layer. While portions of the discussion below refer to through-glass via interposers, it is understood that dielectric substrates other than glass may be used, such as epoxy substrates.

[0075] Through-glass via interposers may be used to provide electrical interconnections and mechanical support to electrically connect components in different layers in a stacked structure. In one implementation, two or more dies having integrated circuits may be stacked such that through-glass vias electrically connect the integrated circuits. Through-glass via interposers can provide high wiring density interconnection, reduce coefficient of thermal expansion (CTE) mismatch to the connected dies, and improve electrical performance due to shorter interconnection from the dies to a packaging substrate.

[0076] In some implementations, through-substrate via interposers, including through-glass and through-epoxy via interposers, can be formed using an additive process. An overview of an additive process according to some implementations is given in Figure 9, with examples of specific implementations described further below with reference to Figures 10–11G.

[0077] Figure 9 shows an example of a flow diagram illustrating a manufacturing process for forming an interposer. The process 900 begins at block 902 where a sacrificial layer is formed on a carrier substrate. The carrier substrate may be transparent or non-transparent. Examples of carrier substrate materials can include glass, plastic, and silicon. The sacrificial layer can be any material that can be selectively removed from the interposer layer. Examples include sputtered Cu, sputtered Al, and laser-cleavable polymers. Further examples of carrier substrates and sacrificial materials are described below with reference to Figure 11A.

[0078] The process 900 continues at block 904 where a plurality of interconnect posts are formed that are oriented substantially perpendicularly to the carrier substrate. Forming the plurality of interconnect posts can include plating a plurality of metal posts in a patterned photoresist layer. In some implementations, the metal posts can be electrically conductive vias.



IPR2026-00067
TSMC EX1002 Page 54

[0079] The process 900 continues at block 906 where one or more flowable dielectric layers are deposited and cured to cover the sacrificial layer and the plurality of interconnect posts with a solidified dielectric material. In some implementations, the one or more flowable dielectric layers can include one or more spin-on-glass layers. In some implementations, the one or more flowable dielectric layers can include one or more epoxy layers.

[0080] The process 900 continues at block 908 where the solidified dielectric material is planarized to expose the plurality of interconnect posts and to form an interposer layer releasably attached to the carrier substrate via the sacrificial layer. In some implementations, the process 900 can continue with releasing the interposer layer from the carrier substrate (not shown).

[0081] Additional operations may also be present in the process 900. For example, in some implementations, the process 900 can also include plating the plurality of interconnect posts with solderable material. In another example, in some implementations, the process 900 can include forming one or more routing layers on the solidified dielectric material. Interposers including routing layers are described below with reference to Figures 12A–12C. In yet another example, the process 900 can include forming one or more passive components on the solidified dielectric material, as described below with reference to Figure 10.

[0082] Figure 10 shows an example of a flow diagram illustrating a manufacturing process for forming an interposer. The process 1000 begins at block 1002 where an additive process is used to fabricate an interposer layer on a carrier substrate. In some implementations, the additive process includes depositing flowable dielectric material over a plurality of metal interconnect posts after forming the plurality of metal interconnect posts on the carrier substrate.

[0083] The process 1000 continues at block 1004 where one or more passive components are integrated within the interposer layer during the additive process. In some implementations, the one or more passive components include at least one of a resistor, a capacitor or an inductor. In some implementations, block 1004 can include forming one or more passive components on a surface of the interposer layer fabricated in block 1002. For example, a passive component can be vacuum deposited on a dielectric surface or a metal interconnect of the interposer layer. In some implementations, block 1004 can include forming one or more passive components on a sacrificial layer, prior to depositing and curing a flowable dielectric material over the



IPR2026-00067
TSMC EX1002 Page 55

passive components. In some implementations, block 1004 can include forming one or more passive components in between deposition of layers of a flowable dielectric material. Passive components can be formed by thin film deposition processes including CVD, atomic layer deposition (ALD), PVD or other vapor deposition technique, electrodeposition, or by ink-jet deposition.

[0084] Figures 11A–11G show examples of cross-sectional schematic illustrations of various stages in a method of manufacturing an interposer layer. Figure 11A is a cross-sectional illustration of a sacrificial layer 1104 covering a carrier substrate 1102. In subsequent operations described below, a through-substrate via interposer layer can be formed on the carrier substrate 1102.

[0085] The carrier substrate 1102 can be glass, plastic, silicon, or other appropriate material. In some implementations, the carrier substrate 1102 can be a large panel or glass plate having an area on the order of about four square meters or more. In some implementations, the carrier substrate 1102 can be provided in a roll, such as a flexible polymer or other flexible material. For example, the carrier substrate 1102 can be provided in a continuous roll of material as part of a roll-to-roll process. Fabrication of the interposer layer on such implementations of the carrier substrate 1102 can facilitate large format batch processing.

[0086] In some implementations, the carrier substrate 1102 can have a thickness of about 50 microns to about 1000 microns. In some implementations, if the carrier substrate 1102 is a large panel, the thickness can be about 300 microns to about 1000 microns. In other implementations, if the carrier substrate 1102 is a roll, the thickness can be about 50 microns to about 300 microns.

[0087] Other substrate materials and thicknesses can be used for the carrier substrate 1102 on which a sacrificial material can be formed. For example, in some implementations, the carrier substrate 1102 can be any material that is inert, has good planarity, is thermally stable at subsequent processing temperatures, and has a similar CTE match with a dielectric material such as spin-on glass. In some implementations, the carrier substrate can be thermally stable at temperatures of at least about 300°, and in some cases, at least about 400°C. The carrier substrate can be substantially planar or can include topographical features. For example, a carrier substrate can include recesses that correspond to the positions of subsequently formed interconnect posts to facilitate the formation of interconnect posts with protrusions.



IPR2026-00067
TSMC EX1002 Page 56

[0088] In some implementations, the sacrificial layer 1104 coats the surface of the carrier substrate 1102 on which the through-substrate interposer layer is formed upon, such that removal of the sacrificial layer 1104 releases the carrier substrate 1102 from the interposer layer. The sacrificial layer 1104 can be any material that can be selectively removed without damaging the interposer layer. Examples of sacrificial materials can include metals, semiconductors, and acrylics. For example, the sacrificial material can be a material removable by a wet or dry etching process such as Cu, Mo, MoCr, Al, and amorphous Si. In another example, the sacrificial material can be a material removable by exposure to radiation or thermal treatment such as a UV-removable acrylic. In some implementations, the sacrificial material can be formed from a combination of different sacrificial materials. For example, a first sacrificial material can be used to coat a surface of the carrier substrate 1102 with a second sacrificial material used to form topological features according to the desired implementation. The surface on which the sacrificial layer 1104 is deposited can be planar or include raised or recessed features according to the desired implementation. The sacrificial layer 1104 is generally conformal to the underlying carrier substrate 1102.

[0089] In some implementations, the sacrificial layer 1104 can serve as a seed layer for subsequent interconnect plating. For example, Cu can be both a seed layer and a sacrificial layer. Other examples can include Al, Cr, gold (Au), niobium (Nb), tantalum (Ta), nickel (Ni), tungsten (W), titanium (Ti), and silver (Ag). The sacrificial layer 1104 can be deposited by sputter deposition, though other conformal deposition processes, including ALD, evaporation and other CVD or PVD processes may be used. Example seed layer thicknesses range from about 800 Å to about 10,000 Å, for example from about 1000 Å to about 5000 Å.

[0090] In some other implementations, a seed layer (not shown) can be formed on the sacrificial layer 1104. As examples, a metal seed layer (for example, a Cu seed layer) can be formed on a sacrificial layer of sputtered Al, or a metal seed layer can be formed on a sacrificial layer of a laser-cleavable polymer. Also in some implementations, one or more passive components (not shown) can be fabricated on the sacrificial layer 1104 prior to photoresist deposition.

[0091] Figure 11B shows a cross-sectional illustration of a photoresist layer 1106 formed on the sacrificial layer 1104 and patterned to define interconnect post placement. The photoresist layer 1106 can be patterned by techniques including



IPR2026-00067
TSMC EX1002 Page 57

masked exposure to radiation and chemical development. The photoresist layer 1106 can include any suitable photoresist that can be applied and patterned at a desired thickness, can be stripped easily, and can withstand thermal cycles of about 150°C or more. Examples of suitable photoresists can include AZ®4562 and AZ®9260 available from AZ Electronics Materials in Branchburg, New Jersey, Dupont WBR 2000™ Series photoresists, and SU-8 and KMPR photoresists from MicroChem in Newton, Massachusetts.

[0092] The photoresist layer 1106 can have a thickness according to the desired thickness of the interposer layer. The thickness of the photoresist layer 1106 may be about 10% to about 30% greater than the desired interposer layer thickness to accommodate non-uniformity in plating and subsequent planarization. For example, to achieve an interposer thickness of between about 25 microns and about 100 microns, the photoresist thickness can be about 30 microns to about 125 microns.

[0093] Figure 11C shows a cross-sectional illustration of the plated interconnect posts 1108 in the patterned photoresist layer 1106. Any appropriate metal material may be used for the interconnect posts 1108. Examples of interconnect metals may include but are not limited to plated Ni, Ni alloys, Cu, Cu alloys, Au, Au alloys, Al, Al alloys, Ti, Ti alloys, W, W alloys, palladium (Pd), Pd alloys, tin (Sn), Sn alloys, and combinations thereof. In some other implementations, the interconnect posts 1108 can include non-metal conductive materials such as polysilicon in addition to or instead of a metal. In some implementations, the sacrificial layer 1104 has a different metallization than that used for the metal interconnect posts 1108. This is to preserve etch selectivity of the sacrificial layer 1104 with respect to the interconnect posts 1108. For example, a Ni or Ni alloy may be plated on a sputtered Cu layer that functions as sacrificial layer as well as a seed layer. In another example, a Cu or Ni alloy may be plated on a sputtered Cu seed layer, with the Cu seed layer deposited on an Al sacrificial layer. If the sacrificial layer is a laser-cleavable polymer, any appropriate seed layer and interconnect post metallization may be used.

[0094] In some implementations, a solderable material can be plated in the photoresist pattern prior to plating the interconnect posts (not shown). Examples of solderable materials include Cu, Au, Sn, Pd, Ag, and combinations thereof including Au/Sn bilayers, Sn/Ag bilayers, Ni/Pd bilayers, Ni/Au bilayers, and Ni/Pd/Au trilayers.

[0095] Figure 11D shows a cross-sectional illustration of the interconnect posts 1108 on the sacrificial layer 1104 after removal of the photoresist layer 1106. The photoresist



IPR2026-00067
TSMC EX1002 Page 58

layer 1106 can be stripped by a technique appropriate for the photoresist, with post-strip cleans of resist-related residue performed in some implementations.

[0096] Figure 11E shows a cross-sectional illustration of a dielectric layer 1110 formed around the interconnect posts 1108. Because the dielectric material of the dielectric layer 1110 is flowable when dispensed or otherwise deposited, it can conformally surround the interconnect posts 1108. The dispensed flowable dielectric material covers and conforms to the topology of the underlying sacrificial layer 1104 and the interconnect posts 1108 without significant voids. For example, the flowable dielectric material may be deposited around the interconnect posts 1108, and in some cases, extend over the tops of the posts. Suitable flowable dielectric materials can include materials with a low dielectric constant, a low loss tangent, and a CTE similar to the CTE of the carrier substrate 1102. Examples of suitable flowable dielectric materials can include epoxies and spin-on dielectrics, such as spin-on glasses.

[0097] A spin-on dielectric refers to any solid dielectric deposited by a spin-on deposition process, which also may be referred to as a spin coating process. In a spin-on deposition process, a liquid solution containing dielectric precursors in a solvent is dispensed on the sacrificial layer 1104. The carrier substrate 1102 may be rotated while or after the solution is dispensed to facilitate uniform distribution of the liquid solution during rotation by centrifugal forces. Rotation speeds of up to about 6000 rpm may be used. Spin-on dielectrics can also include dielectrics formed by dispensing, extruding or casting a liquid solution without subsequent spinning. In some implementations, for example for large panel or continuous roll processes, the spin-on glass can be dispensed with an extrusion mechanism using a blade type nozzle, with no subsequent spinning. The dispensed solution can then be subjected to one or more post-dispensation operations to remove the solvent and form the solid dielectric layer. In some implementations, the dielectric precursor is polymerized during a post-dispensation operation. A spin-on dielectric layer can be an organic or inorganic dielectric layer according to the dielectric precursor used and the desired implementation. In some implementations, multiple layers can be dispensed and cured to build up the spin-on dielectric layer. In implementations where the interposer provides an electrical connection to a glass device substrate, it can be useful to use a dielectric that, once solidified, has a CTE that is matched with the CTE of the glass device substrate. Hence, in some implementations, the dielectric layer 1110 is a spin-on glass layer.



IPR2026-00067
TSMC EX1002 Page 59

[0098] In some implementations, the dielectric layer 1110 can include an epoxy, such as a UV curable or thermally curable epoxy, that is flowable when dispensed. The epoxy can be a two-part epoxy with a resin and a hardener. In some implementations, the epoxy can have an epoxide resin and a polyamine hardener. For example, SU-8 from MicroChem in Newton, Massachusetts can be one such suitable epoxy.

[0099] A flowable dielectric material can be cured to solidify it, forming a solid dielectric layer. Figure 11E shows the dielectric layer 1110 after solidification. In some implementations, the dielectric layer 1110 can be cured through a thermal anneal at a temperature of between about 100°C and 450°C. In some implementations, a single dispensation operation can be performed to form the dielectric layer 1110. In some implementations, multiple dispensing/post-dispensing operation cycles can be performed to form the dielectric layer 1110. The dielectric layer 1110 can be dispensed to a thickness greater than the thickness of the interposer layer to accommodate shrinkage during anneal and subsequent planarization. In some implementations, after curing, the surface of a layer of the dielectric material 1110 can include bumps over the interconnect posts 1108, as illustrated in Figure 11E. After curing, the solid dielectric material 1110 can form the substrate material of a through-substrate via interposer layer 1100.

[0100] Figure 11F shows the interposer layer 1100 after planarization of the dielectric layer 1110 and the addition of an optional capping layer. The dielectric layer 1110 can be planarized such that surfaces of the interconnect posts 1108 are exposed and accessible for electrical connection. Planarizing the dielectric layer 1110 can include one or more operations, including lapping, grinding, chemical mechanical planarization (CMP), anisotropic dry etching, or another appropriate method. Furthermore, planarization of the dielectric layer 1110 can remove part of the interconnect posts 1108. In some implementations, planarization can remove between about 5% and about 25% of the interconnect posts 1108.

[0101] Also in some implementations, one or more passive components (not shown), such as capacitors, inductors and resistors, can be fabricated on the dielectric layer 1110 after planarization.

[0102] In some implementations as illustrated in Figure 11F, the interconnect posts 1108 can be capped by plating a solderable material on the exposed surfaces of the interconnect posts 1108. The interconnect caps 1112 can include solderable metallurgies such as Cu, Au, Sn, Pd, Ag, and combinations thereof including Au/Sn



IPR2026-00067
TSMC EX1002 Page 60

bilayers, Sn/Ag bilayers, Ni/Pd bilayers, Ni/Au bilayers, and Ni/Pd/Au trilayers. In some implementations, the interconnect caps 1112 have a different metallization than that used for the sacrificial layer 1104. This is to preserve etch selectivity of the sacrificial layer 1104 with respect to the interconnect caps 1112. For example, a Ni/Pd/Au interconnect cap 1112 may be plated on a Ni or Ni alloy interconnect post 1108, with a Cu seed layer serving as the sacrificial layer 1104. In another example, a Cu or Ni/Pd/Au interconnect cap 1112 may be plated on a Cu or Ni alloy interconnect post 1108, with an Al layer serving as the sacrificial the layer 1104.

[0103] In some implementations, the thickness of the plated solderable metal can be between about 0.5 microns and about 2 microns. The interconnect caps 1112 can be used to protect the interconnect posts 1108 from oxidation. In addition, the interconnect caps 1112 can be used to provide an electrical connection between materials that could not otherwise be electrically connected. While the interconnect caps 1112 depicted in Figure 11F cap the interconnect posts 1108 only on the top surface of the interposer layer 1100, in some other implementations, the interconnect posts 1108 can be capped on the bottom surface. For example, as described above with respect to Figure 11C, a solderable material can be plated in the photoresist pattern prior to plating the interconnect posts 1108. The plated solderable material can serve to cap the interconnect posts in some implementations.

[0104] In some implementations, channels 1114 can be formed in the interposer layer 1100 by dicing the dielectric layer 1110. Dicing the dielectric layer 1110 can be achieved by, for example, mechanically sawing or laser cutting the dielectric layer 1110 to form the channels 1114. The channels 1114 can be spaced apart to form the eventual die sizes. In some implementations, the pitch of the channels 1114 can vary between about every 1 mm and about every 15 mm, with the die sizes also between about 1 mm and about 15 mm. In some implementations, the channels 1114 can provide an entry point for a wet etchant that is selective to the sacrificial layer 1104. The channels 1114 may be omitted in some implementations, for example, where the sacrificial layer 1104 is removed via laser ablation.

[0105] Figure 11G shows the diced through-substrate via interposer layer 1100 after being released from the carrier substrate 1102. In some implementations, releasing the interposer layer 1100 from the carrier substrate 1102 can be achieved by etching the exposed sacrificial layer 1104 with an etchant that is selective to the sacrificial layer 1104. Selective etchants can include etchants that have a selectivity of at least about



IPR2026-00067
TSMC EX1002 Page 61

100:1 or higher for the sacrificial layer 1104. Specific examples of etchants for selective etching of copper layers include a mixture of acetic acid ($CH_3COOH$) and hydrogen peroxide ($H_2O_2$), and ammoniacal-based etchant such as BTP copper etchant from Transene Company, Inc. in Danvers, Massachusetts. Examples of etchants for selective etching of aluminum layers include sodium hydroxide (NaOH), potassium hydroxide (KOH), and alkaline solutions combined with an oxidizer. In some implementations, releasing the interposer layer 1100 from the carrier substrate 1102 can be achieved by laser ablation of the sacrificial layer 1104. The laser beam can ablate the sacrificial layer 1104 through a transparent carrier substrate 1102. The laser beam can have a selected wavelength sufficient to ablate the sacrificial layer 1104, which can be made of a laser-cleavable polymer. In some implementations, the released carrier substrate 1102 can be reused. In some implementations, the carrier substrate may be ground, etched, or otherwise removed.

[0106] In some implementations, the dielectric layer 1110 can be etched back such that interconnect posts 1108 protrude along the bottom surface of the dielectric layer 1110 (not shown). In some implementations, protruding interconnect posts 1108 can be formed without etching back the dielectric layer 1110, for example, by using a carrier substrate having topographical features.

[0107] The resulting interposer layer 1100 can be between about 10 and 100 microns thick according to various implementations. Thicker interposer layers can also be fabricated in some implementations. For example, an interposer layer of about 300 microns to 500 microns can be fabricated using a photoresist of about 400 microns to about 600 microns thick. In some implementations, if for example such thick photoresists are not available, thicker interposer layers can be fabricated using multiple cycles of lithography, plating, flowable dielectric deposition and planarization. These cycles can be performed sequentially to build up an interposer layer of desired thickness on a carrier substrate, or can be performed in parallel with the resulting interposer layers stacked to form an interposer layer of any thickness. Accordingly, single or multiple cycles can be used to fabricate interposer layers of about 10 microns to over 500 microns thick. In some implementations, thinner through-substrate via interposers can correspond to faster performance in integrated circuit systems, and to a thinner stack height when in a stacked configuration.

[0108] The interconnect posts 1108 in the interposer layer 1100 can made of any suitable electrically conductive material. As noted above, examples of interconnect post



IPR2026-00067
TSMC EX1002 Page 62

materials can include but are not limited to Ni, Ni alloy, and Cu. In some implementations, the interconnect posts 1108 can be made of Cu, which has a low resistivity.

[0109] Additionally, the interconnect posts 1108 can have any appropriate size and shape. In some implementations, the height to width aspect ratio of the interconnect posts 1108 can be greater than about 5:1. For example, the interconnect posts 1108 can have a diameter between about 5 microns and about 100 microns. The height of the interconnect posts 1108 can be between about 10 microns and 500 microns, for example between about 25 microns and 100 microns. The interconnect posts 1108 can also be configured according to various shapes, such as circular, square, octagonal, hexagonal, and rectangular.

[0110] In some implementations, fabrication of an interposer may be complete at this stage, with the interposer including the interposer layer 1100 having through-substrate interconnects posts 1108 as well as other components, if any, formed on the solidified dielectric layer 1110 and/or on the interconnect posts 1108 such as the interconnect caps 1112 or passive components (not shown). In some other implementations, an interposer may further include one or more additional layers, such as routing or redistribution layers.

[0111] Figures 12A–12C show examples of cross-sectional schematic illustrations of varying implementations of interposers with one or more routing layers. A through-substrate via interposer 1200 can have routing layers 1216 on either or both sides of a through-substrate via interposer layer 1210. The through-substrate via interposer layer 1210 can be manufactured by any of the methods described above. A routing layer 1216, otherwise referred to as a redistribution layer (RDL), can include a plurality of electrically conductive routing lines 1212 and RDL contacts 1214 embedded in a dielectric material for carrying electrical signals. RDL pads 1218 can be disposed on the routing layer 1216 to provide a point of external electrical connection. In some implementations, the routing layer 1216 can serve as an electrical interconnect between the contact points of interconnect posts 1208 in the through-substrate via interposer layer 1210 and various dies (not shown) through routing lines 1212, RDL contacts 1214, and RDL pads 1218. Although Figures 12A–12C show only one routing layer 1216 on the top and/or bottom side of the through-substrate via interposer layer 1210, in some implementations, there can be more than one routing layer 1216 on each side.



IPR2026-00067
TSMC EX1002 Page 63

[0112] Each routing layer 1216 can be formed by a series of process steps including deposition of dielectric material and conductive lines, photolithography, etching, and planarization. The dielectric material in a routing layer 1216 can be a solidified flowable dielectric material as described above or can be another dielectric material. Examples of dielectric materials include a polyimide material, a benzocyclobutene material, a polybenzoxazole material, and an ABF film available from Ajinomoto Fine-Techno. In one example, the routing lines 1212 can be about 10 microns thick, and dielectric thickness in the routing layer 1216 can be about 15 microns to 25 microns thick.

[0113] The interconnect posts 1208 and other electrical components such as the routing lines 1212, the RDL contacts 1214, and the RDL pads 1218, can be defined according to density. In some implementations, the density of one or more of the routing lines 1212, the RDL contacts 1214 and the RDL pads 1218 can be greater than the density of the interconnect posts 1208. Alternatively, the interconnect posts 1208, the routing lines 1212, the RDL contacts 1214, and the RDL pads 1218 can be defined according to pitch, where pitch defines the center-to-center spacing between electrically conductive components. In some implementations, the pitch at the top surface of the interposer 1200 can be greater than the pitch at the bottom surface of the interposer 1200. For example, the pitch of the interconnect posts 1208 can be greater than the pitch of the RDL pads 1218. In some implementations, the pitch at the top surface of the interposer 1200 can be between about 20 microns and 125 microns and the pitch at the bottom surface of the interposer 1200 can be between about 100 microns and 500 microns.

[0114] In some implementations, the routing layer 1216 can include passive components (not shown). For example, passive components such as capacitors, resistors, and/or inductors can be coupled with the routing lines 1212 in the routing layer 1216 to provide regulated power between the interconnect posts 1208 and the various dies. Examples of passive components in a routing layer are described below with respect to Figure 13.

[0115] Figure 12A shows a cross-sectional illustration of an interposer 1200 including a routing layer 1216 and a through-substrate via interposer layer 1210, with the routing layer 1216 disposed on the top surface of the through-substrate via interposer layer 1210. In some implementations, the routing layer 1216 may be manufactured after planarization of the dielectric material of the through-substrate via interposer layer



IPR2026-00067
TSMC EX1002 Page 64

1210. For example, a routing layer may be formed on the top surface of the interposer layer 1100 shown in Figure 11F or Figure 11G, or after block 908 of Figure 9. The routing layer 1216 may include passive components that electrically connect to the interconnect posts 1208.

[0116] Figure 12B shows a cross-sectional illustration of an interposer 1200 including a routing layer 1216 and a through-substrate via interposer layer 1210, with the routing layer 1216 disposed on the bottom surface of the through-substrate via interposer layer 1210. In some implementations, the routing layer 1216 may be manufactured after forming the sacrificial layer on the carrier substrate but before applying any patterned photoresist layer. For example, a routing layer may be formed on the sacrificial layer 1104 in Figure 11A or after block 902 in Figure 9. In some implementations, the routing layer 1216 may be manufactured after release of a carrier substrate. For example, a routing layer may be formed on the bottom surface of the dielectric layer 1110 in Figure 11G. The routing layer 1216 may include passive components that electrically connect to the interconnect posts 1208.

[0117] Figure 12C shows a cross-sectional illustration of an interposer 1200 with routing layers 1216a and 1216b on both the top and bottom surface of a through-substrate via interposer layer 1200. In some implementations, the routing layer 1216b may be manufactured after forming the sacrificial layer on the carrier substrate but before applying any patterned photoresist. In some implementations, one or both of the routing layers 1216a and 1216b may be manufactured after planarization of the dielectric material. The routing layers 1216a and 1216b can include passive components that electrically connect to the interconnect posts 1208.

[0118] The interposers described herein may be applied with various components in 3-D electronics packaging depending on the application. In some implementations, the interposer may be implemented in one or more application specific integrated circuits (ASICs), digital signal processors (DSPs), digital signal processing devices (DSPDs), programmable logic devices (PLDs), field programmable gate arrays (FPGAs), memory stacks, processors, controllers, microcontrollers, and other electronic devices. One example of an interposer as implemented in a 3-D device package is depicted in Figure 13, described below.

[0119] Figure 13 shows an example of a cross-sectional schematic illustration of stacked dies on an interposer according to one implementation. The packaging system includes a packaging substrate 1322, which can be a material that provides base



IPR2026-00067
TSMC EX1002 Page 65

mechanical support to the 3-D device package. In some implementations, the packaging substrate 1322 can be a metal, semiconductor, ceramic, plastic, glass, or a ceramic, organic or fiberglass printed circuit board (PCB) material.

[0120] In Figure 13, the packaging system can include electrical connectors 1320 positioned over a packaging substrate 1322. In some implementations, the electrical connectors 1320 can include under bump metallization (UBM) or solder balls in contact with the packaging substrate 1322. In some implementations, the electrical connectors 1320 may be positioned under the packaging substrate 1322. The electrical connectors 1320 can serve to electrically and physically couple components within the packaging system and can be made of electrically conductive material. As illustrated in Figure 13, the electrical connectors 1320 can connect an interposer 1300 with the packaging substrate 1322 so that the interposer 1300 is in electrical communication with the packaging substrate 1322.

[0121] The interposer 1300, such as one manufactured by any of the methods described earlier herein, can include a solidified dielectric material 1310 and one or more metal interconnect posts 1308 extending through the solidified dielectric material 1310. In some implementations, the solidified dielectric material 1310 includes spin-on glass or epoxy material. The interposer 1300 can further include routing layers 1316a and 1316b with electrically conductive routing lines 1318a and 1318b connected to the one or more metal interconnect posts 1308. In some implementations, the interposer layer 1300 can include one or more passive components such as one or more inductors, capacitors, or resistors. For example, the passive components can include an inductor electrically coupled to the routing lines 1318 to regulate electrical flow. In Figure 13, the routing layer 1316a includes a metal-insulator-metal capacitor formed by insulator layer 1342 and metal layers 1340 and a spiral inductor 1344. The conductive and insulator materials used to form passive components can be the same or different materials used to form the routing lines and main dielectric material of a routing layer.

[0122] The routing layer 1316a is a multi-layer redistribution network including alternating layers of metallization and dielectric material. In some implementations, forming the routing layer 1316a includes forming alternate layers of plated metal, such as plated Cu, and dielectric film. The uppermost layer can include UBM (not shown) for attaching dies.

[0123] The packaging system can further include electrical connectors 1326 to connect the interposer 1300 with dies 1328, 1330, 1332, and 1334 positioned over the interposer



IPR2026-00067
TSMC EX1002 Page 66

1300. The electrical connectors 1326 can be any appropriate electrically conductive material such as solder balls. In some implementations, the density of the electrical connectors 1326 from the routing layer 1316 of the interposer 1300 to the dies 1328, 1330, 1332, and 1334 can be greater than the density of the electrical connectors 1320 from the packaging substrate 1322 to the interposer 1300. In some implementations, two or more of the dies 1328, 1330, 1332, and 1334 can be stacked or mounted over one another. In some implementations, the dies 1328, 1330, 1332, and 1334 can include one of a memory, logic, or MEMS chip. It is understood that any number of dies may be mounted in various configurations over the interposer 1300 to achieve a desired implementation. In some implementations, an interposer can have a CTE between the CTE's of the dies, substrates, or layers that it connects. For example, in some implementations, an overlying silicon die may have a CTE of about 3 parts per million (ppm) and an underlying PCB may have a CTE of about 16 ppm; an interposer layer disposed between the silicon die and the PCB may have a CTE between about 3 ppm and 16 ppm, for example, between about 5 and 14 ppm.

[0124] In some implementations, an interposer can be used as part of a 3-D or other package including a display or non-display device fabricated on a glass or epoxy substrate, the combination having well-matched thermal expansion properties. In some implementations, the interposer can be used to communicate data to a processor (such as processor 21 of Figure 16B).

[0125] Figures 14A–14D show examples of cross-sectional schematic illustrations of various stages in a method of forming an interposer. The interposer 1400 is formed in a sequence of stages including forming a plurality of interconnect posts 1408 on a sacrificial layer 1404 that has been deposited on a carrier substrate 1402 such as a glass substrate or panel, as shown in Figure 14A. The sacrificial layer 1404 may also serve as a seed layer for subsequent electro- or electroless plating. An additional seed layer (not shown) may be deposited on the sacrificial layer 1404 prior to plating the interconnect posts. The interconnect posts 1408 may be formed by spinning, dispensing, or otherwise depositing a photoresist layer (not shown) on the sacrificial layer 1404; exposing and developing the photoresist layer to form holes for the interconnect posts 1408; and plating the interconnect posts 1408 through the patterned photoresist. The photoresist layer is subsequently removed. As shown in Figure 14B, one or more flowable dielectric layers 1410 may be spun, dispensed, cast, or otherwise deposited around and possibly over the interconnect posts 1408 on the sacrificial layer 1404. The



IPR2026-00067
TSMC EX1002 Page 67

dielectric layer 1410 is solidified and may be planarized to expose the interconnect posts 1408. As shown in Figure 14C, dicing streets 1414 may be cut through the dielectric layer 1410 to expose at least a portion of the sacrificial layer 1404. The cuts may extend into or through the carrier substrate 1402. As shown in Figure 14D, a sacrificial layer etchant may be used to remove the sacrificial layer 1404 and release the interposer 1400, including interconnect posts 1408, from the carrier substrate 1402.

[0126] One or more routing layers (not shown) may be formed on an upper side, lower side, or both sides of the interposer 1400 prior to depositing the flowable dielectric layer 1410 or after the planarization of the dielectric layer 1410, as described above with respect to Figures 12A–12C. One or more passive components (not shown) such as a resistor, a capacitor, an inductor, a coupling transformer, or a power combiner may be formed on an upper side or a lower side of the interposer 1400, as described above with respect to Figure 10 and Figure 13.

[0127] Figures 15A and 15B show examples of cross-sectional schematic illustrations of an interposer positioned between an integrated circuit chip and a packaging substrate. In Figure 15A, an interposer 1500 with a plurality of interconnect posts 1508 is connected between a packaging substrate 1522, such as a PCB, and an integrated circuit chip 1530, also referred to as a die that may be a memory chip, a logic device, a radio frequency (RF) chip, an ASIC, a MEMS chip, or other electronic or mechanical device. Solder bumps or balls 1520 may be used to attach the interposer 1500 to the packaging substrate 1522. Similarly, solder bumps or balls 1526 may be used to attach integrated circuit chip 1530 to corresponding interconnect posts 1508 on interposer 1500. Additional dies (not shown) may be stacked on top of integrated circuit chip 1530, or positioned laterally to integrated circuit chip 1530 and connected to other interconnect posts 1508.

[0128] The interposer 1500 may provide stress isolation and strain relief when the interposer 1500 is connected between the packaging substrate 1522 and the integrated circuit chip 1530. Strain relief may be provided, for example, when the temperature of the integrated circuit chip 1530 rises substantially with respect to the packaging substrate 1522. Alternatively, strain relief may be provided when the overall temperature of integrated circuit chip 1530, interposer 1500, and packaging substrate 1522 rise and stress is generated due to differences in the CTE between the integrated circuit chip 1530 and the packaging substrate 1522. Extra interconnect posts 1508b, as shown in Figure 15B, may be provided to enhance the strain relief due to CTE



IPR2026-00067
TSMC EX1002 Page 68

mismatches. The extra interconnect posts 1508b may be attached only to the packaging substrate 1522 as shown, attached only to the integrated circuit die 1530 (not shown), or attached to both the integrated circuit die 1530 and the packaging substrate 1522. Extra bond pads may be provided on the integrated circuit chip 1530 or the packaging substrate 1522 that are dedicated to strain relief.

[0129] Alternatively or in addition to providing electrical connections and possible strain relief between the integrated circuit chip 1530 and the packaging substrate 1522, one or more interconnect posts 1508 may be positioned to provide increased heat transfer between the integrated circuit chip 1530 and the packaging substrate 1522, so that the integrated circuit chip 130 may be kept at a lower temperature closer to that of the packaging substrate 1522 during operation.

[0130] An underfill material (not shown) such as an epoxy may be positioned between the interposer 1500 and the underlying packaging substrate 1522. The underfill material may be injected, for example, between the interposer 1500 and the packaging substrate 1522 and then cured. The underfill material may provide additional stress isolation and protection from excessive shearing forces that may develop during high temperature excursions. The underfill material may also provide additional heat transfer capability between the interposer 1500 and the packaging substrate 1522. Similarly, underfill material may be positioned between the interposer 1500 and an attached integrated circuit chip 1530. Molding compound (not shown) customary in many packaging configurations may be placed over the integrated circuit chip 1530, the interposer 1500, and portions of the packaging substrate 1522.

[0131] Figures 16A and 16B show examples of system block diagrams illustrating a display device 40 that includes a plurality of interferometric modulators. The display device 40 can be, for example, a cellular or mobile telephone. However, the same components of the display device 40 or slight variations thereof are also illustrative of various types of display devices such as televisions, e-readers and portable media players.

[0132] The display device 40 includes a housing 41, a display 30, an antenna 43, a speaker 45, an input device 48, and a microphone 46. The housing 41 can be formed from any of a variety of manufacturing processes, including injection molding, and vacuum forming. In addition, the housing 41 may be made from any of a variety of materials, including, but not limited to: plastic, metal, glass, rubber, and ceramic, or a combination thereof. The housing 41 can include removable portions (not shown) that



IPR2026-00067
TSMC EX1002 Page 69

may be interchanged with other removable portions of different color, or containing different logos, pictures, or symbols.

[0133] The display 30 may be any of a variety of displays, including a bi-stable or analog display, as described herein. The display 30 also can be configured to include a flat-panel display, such as plasma, EL, OLED, STN LCD, or TFT LCD, or a non-flat-panel display, such as a CRT or other tube device. In addition, the display 30 can include an interferometric modulator display, as described herein.

[0134] The components of the display device 40 are schematically illustrated in Figure 16B. The display device 40 includes a housing 41 and can include additional components at least partially enclosed therein. For example, the display device 40 includes a network interface 27 that includes an antenna 43 which is coupled to a transceiver 47. The transceiver 47 is connected to a processor 21, which is connected to conditioning hardware 52. The conditioning hardware 52 may be configured to condition a signal (e.g., filter a signal). The conditioning hardware 52 is connected to a speaker 45 and a microphone 46. The processor 21 is also connected to an input device 48 and a driver controller 29. The driver controller 29 is coupled to a frame buffer 28, and to an array driver 22, which in turn is coupled to a display array 30. A power supply 50 can provide power to all components as required by the particular display device 40 design.

[0135] The network interface 27 includes the antenna 43 and the transceiver 47 so that the display device 40 can communicate with one or more devices over a network. The network interface 27 also may have some processing capabilities to relieve, e.g., data processing requirements of the processor 21. The antenna 43 can transmit and receive signals. In some implementations, the antenna 43 transmits and receives RF signals according to the IEEE 16.11 standard, including IEEE 16.11(a), (b), or (g), or the IEEE 802.11 standard, including IEEE 802.11a, b, g or n. In some other implementations, the antenna 43 transmits and receives RF signals according to the BLUETOOTH standard. In the case of a cellular telephone, the antenna 43 is designed to receive code division multiple access (CDMA), frequency division multiple access (FDMA), time division multiple access (TDMA), Global System for Mobile communications (GSM), GSM/General Packet Radio Service (GPRS), Enhanced Data GSM Environment (EDGE), Terrestrial Trunked Radio (TETRA), Wideband-CDMA (W-CDMA), Evolution Data Optimized (EV-DO), 1xEV-DO, EV-DO Rev A, EV-DO Rev B, High Speed Packet Access (HSPA), High Speed Downlink Packet Access (HSDPA), High



IPR2026-00067
TSMC EX1002 Page 70

Speed Uplink Packet Access (HSUPA), Evolved High Speed Packet Access (HSPA+), Long Term Evolution (LTE), AMPS, or other known signals that are used to communicate within a wireless network, such as a system utilizing 3G or 4G technology. The transceiver 47 can pre-process the signals received from the antenna 43 so that they may be received by and further manipulated by the processor 21. The transceiver 47 also can process signals received from the processor 21 so that they may be transmitted from the display device 40 via the antenna 43.

[0136] In some implementations, the transceiver 47 can be replaced by a receiver. In addition, the network interface 27 can be replaced by an image source, which can store or generate image data to be sent to the processor 21. The processor 21 can control the overall operation of the display device 40. The processor 21 receives data, such as compressed image data from the network interface 27 or an image source, and processes the data into raw image data or into a format that is readily processed into raw image data. The processor 21 can send the processed data to the driver controller 29 or to the frame buffer 28 for storage. Raw data typically refers to the information that identifies the image characteristics at each location within an image. For example, such image characteristics can include color, saturation, and gray-scale level.

[0137] The processor 21 can include a microcontroller, CPU, or logic unit to control operation of the display device 40. The conditioning hardware 52 may include amplifiers and filters for transmitting signals to the speaker 45, and for receiving signals from the microphone 46. The conditioning hardware 52 may be discrete components within the display device 40, or may be incorporated within the processor 21 or other components.

[0138] The driver controller 29 can take the raw image data generated by the processor 21 either directly from the processor 21 or from the frame buffer 28 and can re-format the raw image data appropriately for high speed transmission to the array driver 22. In some implementations, the driver controller 29 can re-format the raw image data into a data flow having a raster-like format, such that it has a time order suitable for scanning across the display array 30. Then the driver controller 29 sends the formatted information to the array driver 22. Although a driver controller 29, such as an LCD controller, is often associated with the system processor 21 as a stand-alone Integrated Circuit (IC), such controllers may be implemented in many ways. For example, controllers may be embedded in the processor 21 as hardware, embedded in the processor 21 as software, or fully integrated in hardware with the array driver 22.



IPR2026-00067
TSMC EX1002 Page 71

[0139] The array driver 22 can receive the formatted information from the driver controller 29 and can re-format the video data into a parallel set of waveforms that are applied many times per second to the hundreds, and sometimes thousands (or more), of leads coming from the display's x-y matrix of pixels.

[0140] In some implementations, the driver controller 29, the array driver 22, and the display array 30 are appropriate for any of the types of displays described herein. For example, the driver controller 29 can be a conventional display controller or a bi-stable display controller (e.g., an IMOD controller). Additionally, the array driver 22 can be a conventional driver or a bi-stable display driver (e.g., an IMOD display driver). Moreover, the display array 30 can be a conventional display array or a bi-stable display array (e.g., a display including an array of IMODs). In some implementations, the driver controller 29 can be integrated with the array driver 22. Such an implementation is common in highly integrated systems such as cellular phones, watches and other small-area displays

[0141] In some implementations, the input device 48 can be configured to allow, e.g., a user to control the operation of the display device 40. The input device 48 can include a keypad, such as a QWERTY keyboard or a telephone keypad, a button, a switch, a rocker, a touch-sensitive screen, or a pressure- or heat-sensitive membrane. The microphone 46 can be configured as an input device for the display device 40. In some implementations, voice commands through the microphone 46 can be used for controlling operations of the display device 40.

[0142] The power supply 50 can include a variety of energy storage devices as are well known in the art. For example, the power supply 50 can be a rechargeable battery, such as a nickel-cadmium battery or a lithium-ion battery. The power supply 50 also can be a renewable energy source, a capacitor, or a solar cell, including a plastic solar cell or solar-cell paint. The power supply 50 also can be configured to receive power from a wall outlet.

[0143] In some implementations, control programmability resides in the driver controller 29 which can be located in several places in the electronic display system. In some other implementations, control programmability resides in the array driver 22. The above-described optimization may be implemented in any number of hardware and/or software components and in various configurations.

[0144] The various illustrative logics, logical blocks, modules, circuits and algorithm steps described in connection with the implementations disclosed herein may be



IPR2026-00067
TSMC EX1002 Page 72

implemented as electronic hardware, computer software, or combinations of both. The interchangeability of hardware and software has been described generally, in terms of functionality, and illustrated in the various illustrative components, blocks, modules, circuits and steps described above. Whether such functionality is implemented in hardware or software depends upon the particular application and design constraints imposed on the overall system.

[0145] The hardware and data processing apparatus used to implement the various illustrative logics, logical blocks, modules and circuits described in connection with the aspects disclosed herein may be implemented or performed with a general purpose single- or multi-chip processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general purpose processor may be a microprocessor, or, any conventional processor, controller, microcontroller, or state machine. A processor also may be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration. In some implementations, particular steps and methods may be performed by circuitry that is specific to a given function

[0146] In one or more aspects, the functions described may be implemented in hardware, digital electronic circuitry, computer software, firmware, including the structures disclosed in this specification and their structural equivalents thereof, or in any combination thereof. Implementations of the subject matter described in this specification also can be implemented as one or more computer programs, i.e., one or more modules of computer program instructions, encoded on a computer storage media for execution by, or to control the operation of, data processing apparatus.

[0147] Various modifications to the implementations described in this disclosure may be readily apparent to those having ordinary skill in the art, and the generic principles defined herein may be applied to other implementations without departing from the spirit or scope of this disclosure. Thus, the claims are not intended to be limited to the implementations shown herein, but are to be accorded the widest scope consistent with this disclosure, the principles and the novel features disclosed herein. The word "exemplary" is used exclusively herein to mean "serving as an example, instance, or



IPR2026-00067
TSMC EX1002 Page 73

illustration." Any implementation described herein as "exemplary" is not necessarily to be construed as preferred or advantageous over other implementations. Additionally, a person having ordinary skill in the art will readily appreciate, the terms "upper" and "lower" are sometimes used for ease of describing the figures, and indicate relative positions corresponding to the orientation of the figure on a properly oriented page, and may not reflect the proper orientation of the IMOD as implemented.

[0148] Certain features that are described in this specification in the context of separate implementations also can be implemented in combination in a single implementation. Conversely, various features that are described in the context of a single implementation also can be implemented in multiple implementations separately or in any suitable subcombination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a subcombination or variation of a subcombination.

[0149] Similarly, while operations are depicted in the drawings in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. Further, the drawings may schematically depict one more example processes in the form of a flow diagram. However, other operations that are not depicted can be incorporated in the example processes that are schematically illustrated. For example, one or more additional operations can be performed before, after, simultaneously, or between any of the illustrated operations. In certain circumstances, multitasking and parallel processing may be advantageous. Moreover, the separation of various system components in the implementations described above should not be understood as requiring such separation in all implementations, and it should be understood that the described program components and systems can generally be integrated together in a single software product or packaged into multiple software products. Additionally, other implementations are within the scope of the following claims. In some cases, the actions recited in the claims can be performed in a different order and still achieve desirable results.



IPR2026-00067
TSMC EX1002 Page 74

## CLAIMS

What is claimed is:

1. A method of forming an interposer comprising:

forming a sacrificial layer on a carrier substrate;

forming a plurality of interconnect posts on the sacrificial layer, the interconnect posts oriented substantially perpendicularly to the carrier substrate;

depositing and solidifying one or more flowable dielectric layers to cover the sacrificial layer and the plurality of interconnect posts with a dielectric material; and

planarizing the solidified dielectric material to expose the plurality of interconnect posts and to form an interposer layer releasably attached to the carrier substrate via the sacrificial layer.

2. The method of claim 1, wherein the one or more flowable dielectric layers include one or more spin-on dielectric layers.

3. The method of claim 1 or 2, wherein the one or more flowable dielectric layers include one or more epoxy layers.

4. The method of any of claims 1-3, wherein forming a plurality of interconnect posts includes plating a plurality of metal posts in a patterned photoresist layer.

5. The method of any of claims 1-4, further comprising forming one or one more passive components on the solidified dielectric material.

6. The method of claim 5, wherein forming the one or more passive components is performed after planarizing the solidified dielectric material.

7. The method of claim 5 or 6, wherein forming the one or more passive components is performed after forming the sacrificial layer on the carrier substrate but before depositing any flowable dielectric layers.

8. The method of any of claims 1-7, further comprising forming one or more routing layers on the solidified dielectric material.



IPR2026-00067
TSMC EX1002 Page 75

9. The method of any of claims 1-8, further comprising plating the plurality of interconnect posts with solderable material.

10. An interposer comprising:

an additive glass interposer layer; and

one or more metal interconnect posts extending through the glass interposer layer.

11. The interposer of claim 10, further comprising one or more passive components on the glass interposer layer.

12. The interposer of claim 11, wherein the one or more passive components include at least one of a resistor, a capacitor, and an inductor.

13. The interposer of any of claims 10-12, wherein the one or more metal interconnect posts include at least one of nickel, a nickel alloy, and copper.

14. The interposer of any of claims 10-13, wherein the one or more metal interconnect posts have a height to width aspect ratio of greater than about 5:1.

15. The interposer of any of claims 10-14, wherein the one or more metal interconnect posts have a height of from about 10 microns to about 500 microns and a width of from about 5 microns to about 100 microns.

16. The interposer of any of claims 10-15, wherein the glass interposer layer has a thickness between about 10 and 500 microns.

17. The interposer of any of claims 10-16, wherein the one or more interconnect posts include an interconnect cap that protrudes from the glass interposer layer.

18. The interposer of claim 17, wherein the interconnect cap includes a solderable material.

19. The interposer of any of claims 10-18, further comprising a routing layer including electrically conductive routing lines connected to the one or more metal interconnect posts.



IPR2026-00067
TSMC EX1002 Page 76

20. The interposer of claim 19, wherein the density of the routing lines is greater than the density of the metal interconnect posts.

21. A method of forming an interposer, comprising:

using an additive process to fabricate an additive glass interposer layer on a carrier substrate; and

integrating one or more passive components within the interposer layer during the additive process.

22. The method of claim 21, wherein the one or more passive components include at least one of a resistor, a capacitor and an inductor.

23. The method of claim 21 or 22, wherein using the additive process includes depositing flowable dielectric material around a plurality of metal interconnect posts and the carrier substrate after forming the plurality of metal interconnect posts on the carrier substrate.

24. An apparatus, comprising:

a packaging substrate;

an interposer layer in electrical communication with the packaging substrate, wherein the interposer layer includes:

a solidified dielectric material;

one or more metal interconnect posts extending through the solidified dielectric material;

a routing layer including electrically conductive routing lines connected to the one or more metal interconnect posts; and

one or more dies positioned over the interposer layer, wherein the density of electrical connections from the routing layer to the one or more dies is greater than the density of electrical connections from the interposer layer to the packaging substrate.

25. The apparatus of claim 24, wherein the one or more dies include at least one of memory, logic, radio frequency (RF), ASIC or MEMS chips.

26. The apparatus of claim 24 or 25, wherein the one or more dies includes a plurality of stacked dies.



IPR2026-00067
TSMC EX1002 Page 77

27. The apparatus of any of claims 24-26, further comprising one or more passive components within the interposer layer.

28. The apparatus of any of claims 24-27, wherein the solidified dielectric material includes spin-on-glass or epoxy.

29. The apparatus of any of claims 24-28, further comprising:
a display;
a processor that is configured to communicate with the display, the processor being configured to process image data; and
a memory device that is configured to communicate with the processor.

30. The apparatus of claim 29, further comprising:
a driver circuit configured to send at least one signal to the display; and
a controller configured to send at least a portion of the image data to the driver circuit.

31. The apparatus of claim 29 or 30, further comprising:
an image source module configured to send the image data to the processor.

32. The apparatus of claim 31, wherein the image source module includes at least one of a receiver, transceiver, and transmitter.

33. The apparatus of any of claims 29-32, further comprising:
an input device configured to receive input data and to communicate the input data to the processor.

34. An apparatus, comprising:
an interposer, wherein the interposer is formed by forming a plurality of interconnect posts on a sacrificial layer, the sacrificial layer formed on a carrier substrate; depositing and solidifying one or more flowable dielectric layers around the interconnect posts; planarizing the solidified dielectric material to expose the interconnect posts; and releasing the interposer from the carrier substrate by sacrificially etching the sacrificial layer.



IPR2026-00067
TSMC EX1002 Page 78

35. The apparatus of claim 34, wherein at least one interconnect post provides strain relief when the interposer is connected between a packaging substrate and an integrated circuit chip.

36. The apparatus of claim 34 or 35, wherein at least one interconnect post allows heat transfer between an integrated circuit chip and a packaging substrate, the interposer connected between the packaging substrate and the integrated circuit chip.

37. The apparatus of any of claims 34-36, further comprising one or more routing layers on an upper side or a lower side of the interposer.

38. The apparatus of any of claims 34-37, further comprising at least one passive component formed on an upper side or a lower side of the interposer.

39. The apparatus of any of claims 34-38, further comprising at least one integrated circuit chip attached to the interposer.

40. The apparatus of any of claims 34-39, further comprising a packaging substrate attached to the interposer.

41. The apparatus of any of claims 34-40, wherein the packaging substrate is a printed circuit board.

42. The apparatus of any of claims 34-41, wherein the interposer provides stress isolation between the packaging substrate and an integrated circuit chip attached to the interposer.



IPR2026-00067
TSMC EX1002 Page 79

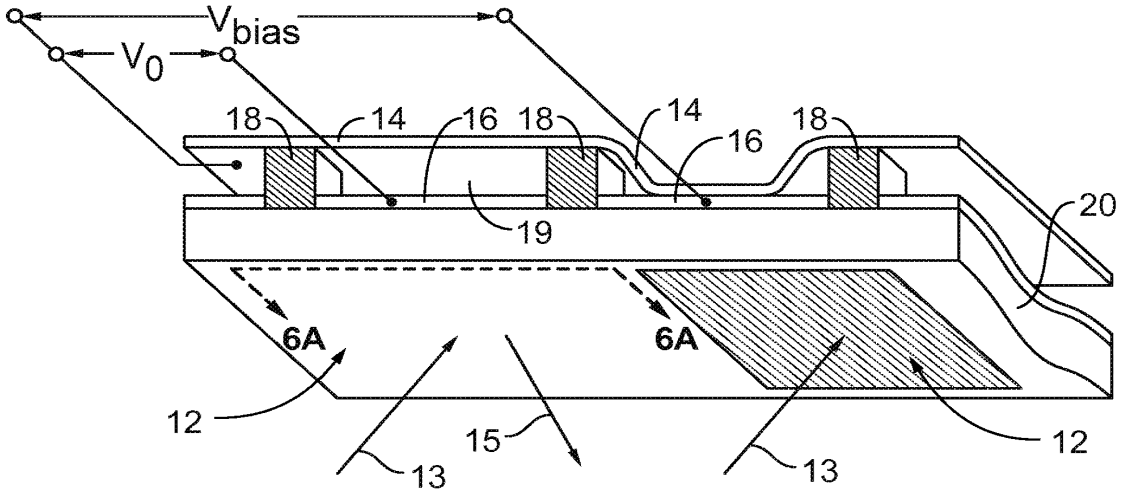



**Figure 1**

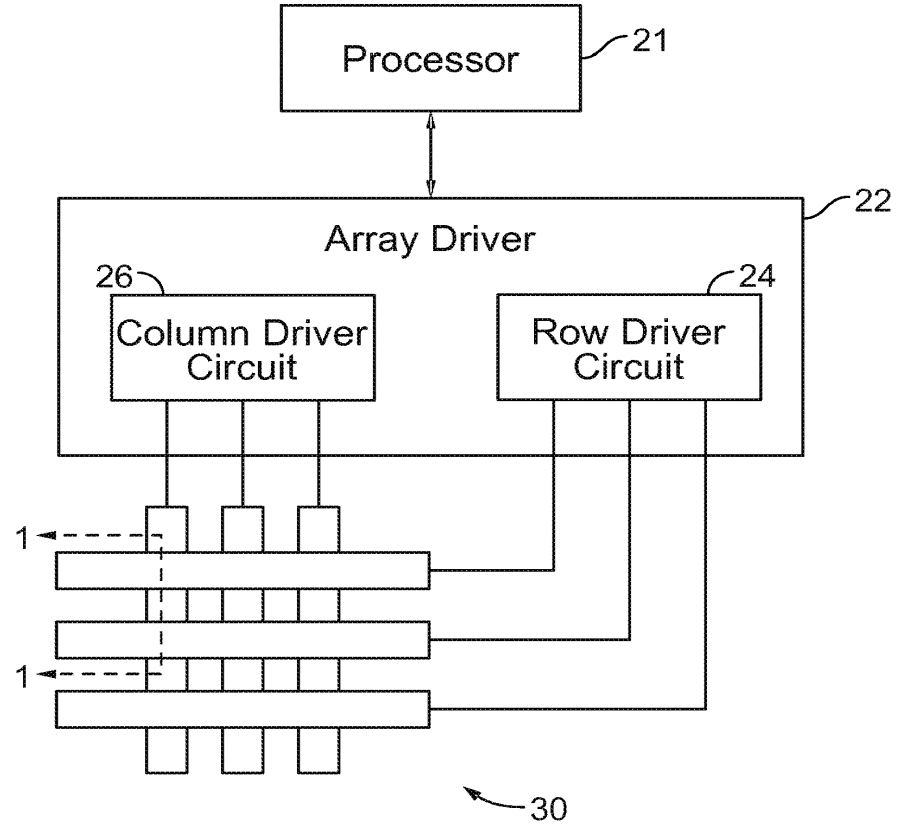



**Figure 2**

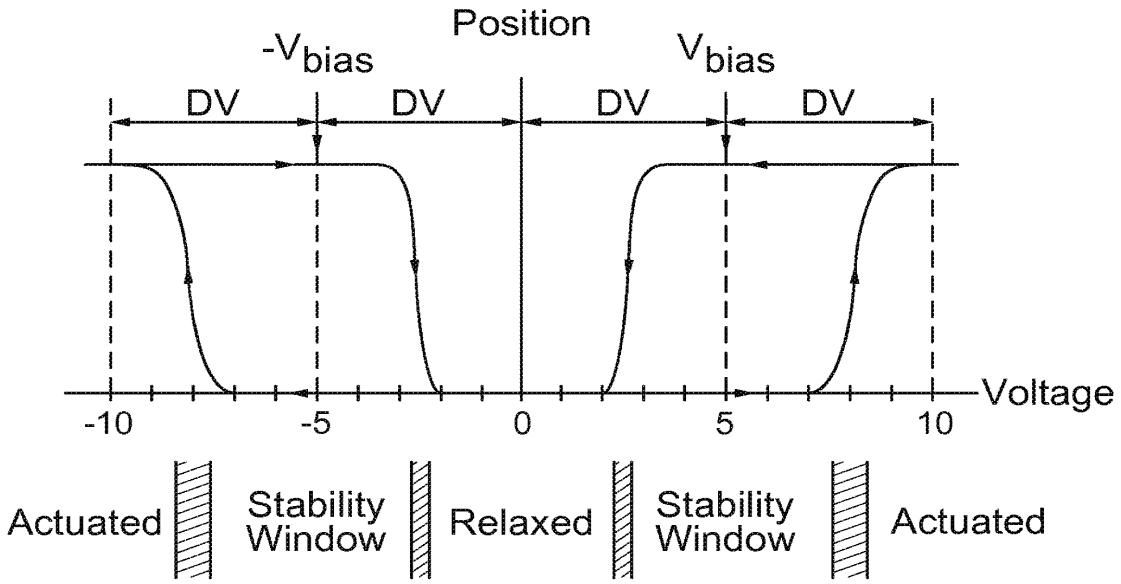



**Figure 3**

| Segment Voltages | Common Voltages: $VC_{ADD\_H}$ | $VC_{HOLD\_H}$ | $VC_{REL}$ | $VC_{HOLD\_L}$ | $VC_{ADD\_L}$ |
|---|---|---|---|---|---|
| $VS_H$ | Stable | Stable | Relax | Stable | Actuate |
| $VS_L$ | Actuate | Stable | Relax | Stable | Stable |

**Figure 4**

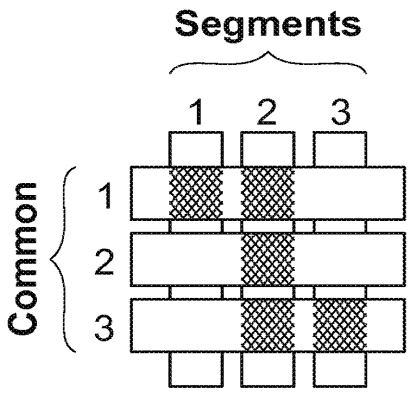



Figure 5A

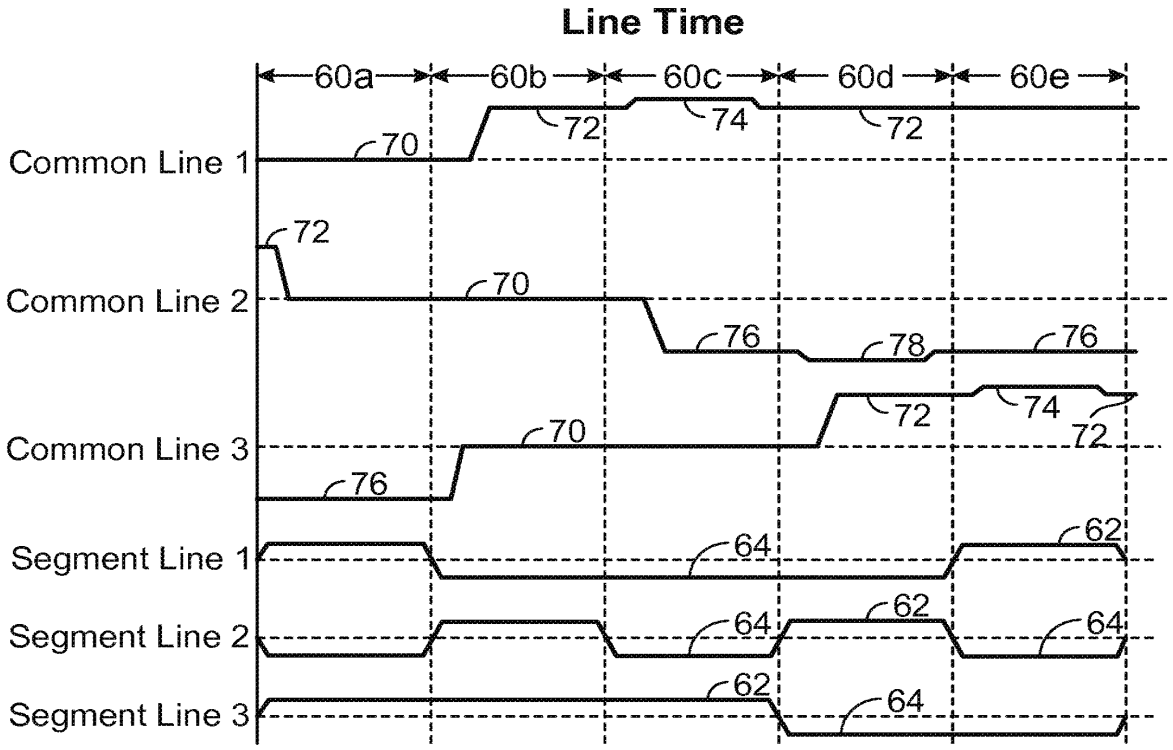



Figure 5B

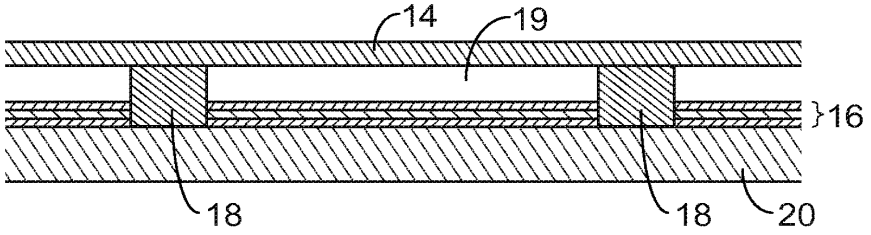



Figure 6A

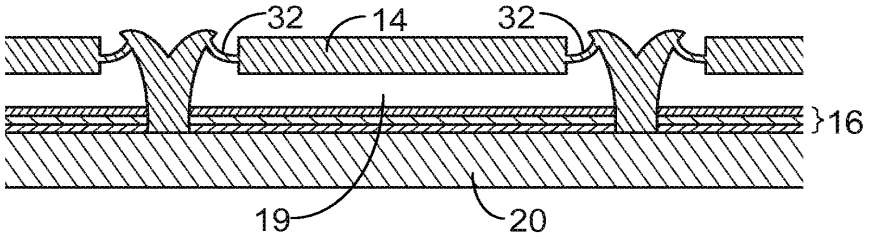



Figure 6B

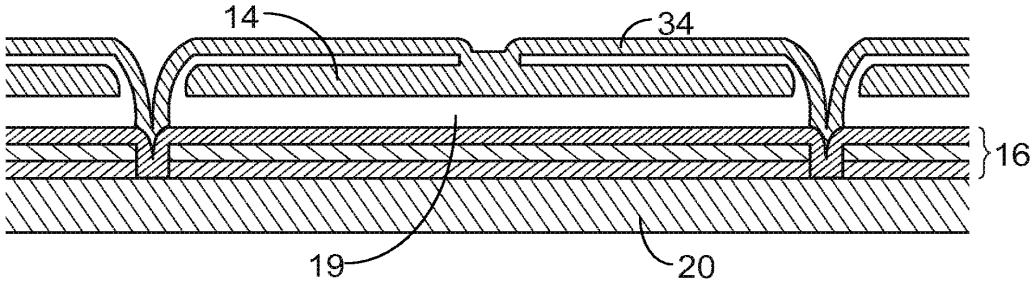



Figure 6C

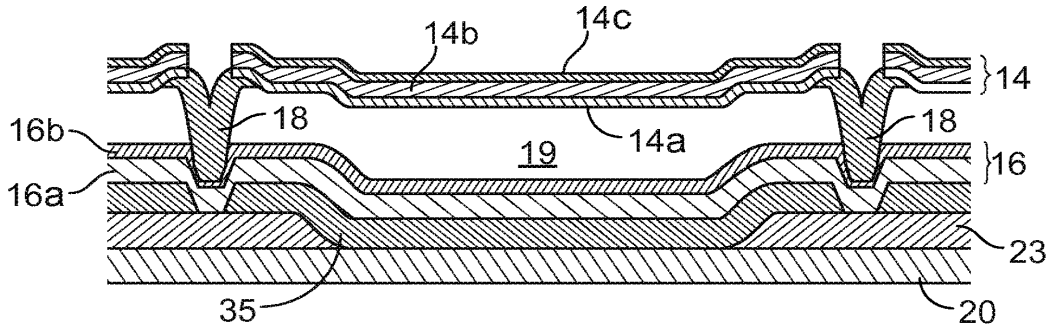



Figure 6D

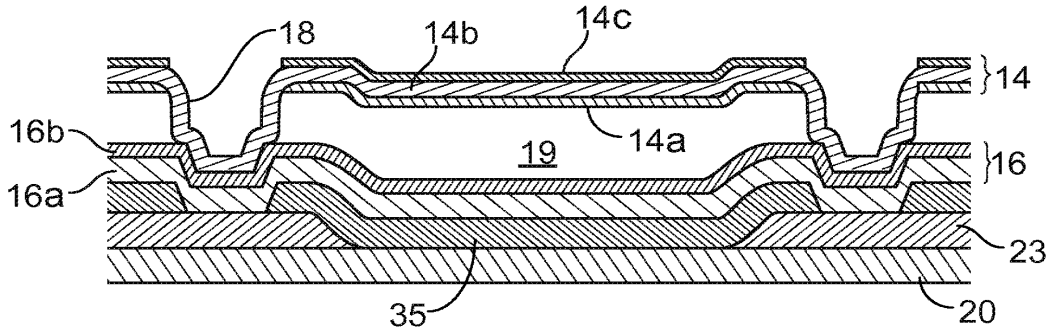



Figure 6E

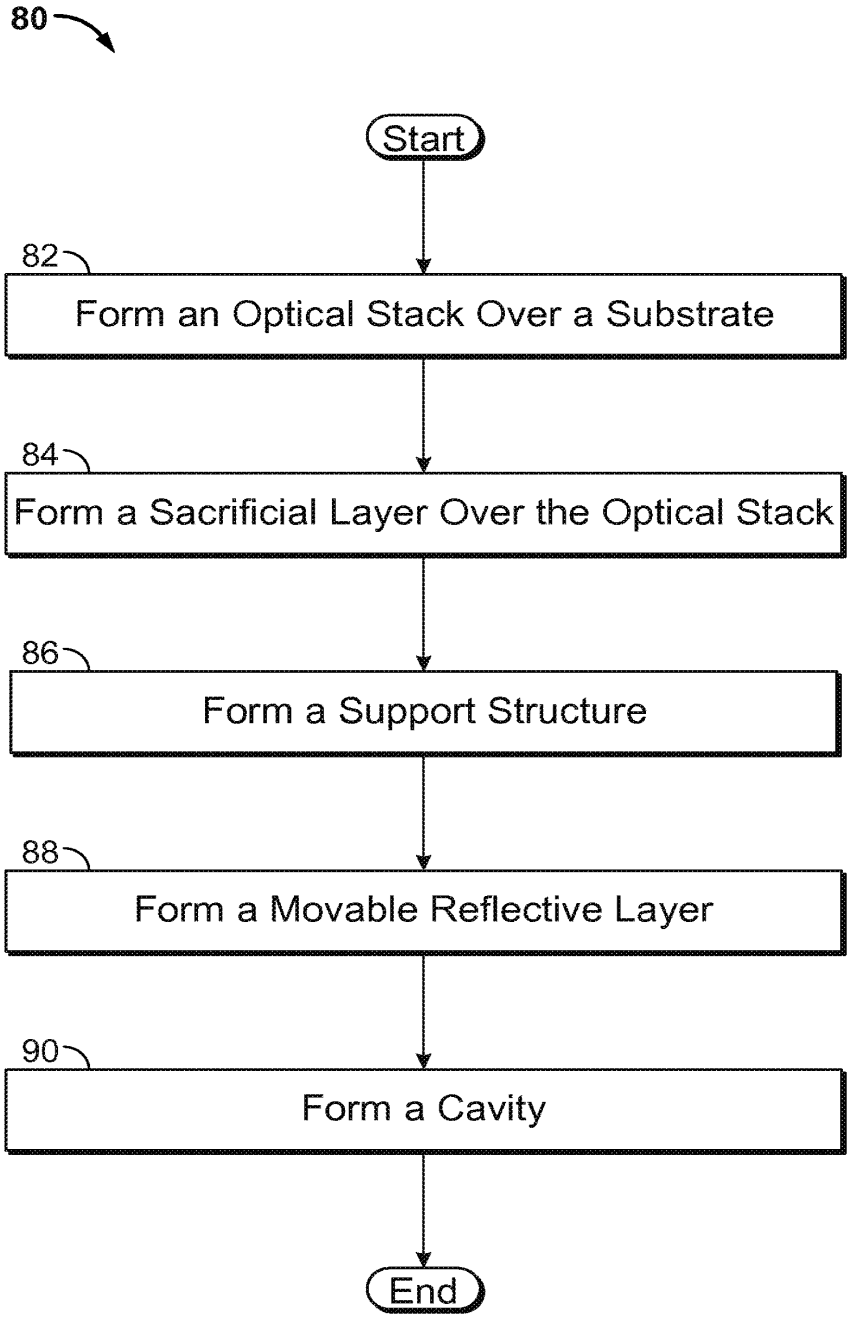

80
Start
82
Form an Optical Stack Over a Substrate
84
Form a Sacrificial Layer Over the Optical Stack
86
Form a Support Structure
88
Form a Movable Reflective Layer
90
Form a Cavity
End

**Figure 7**

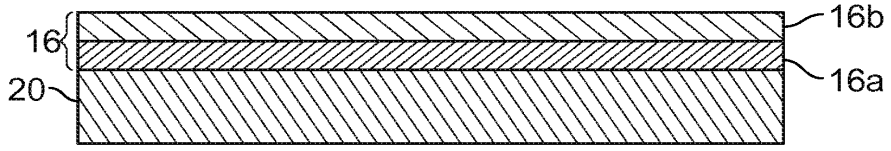



Figure 8A

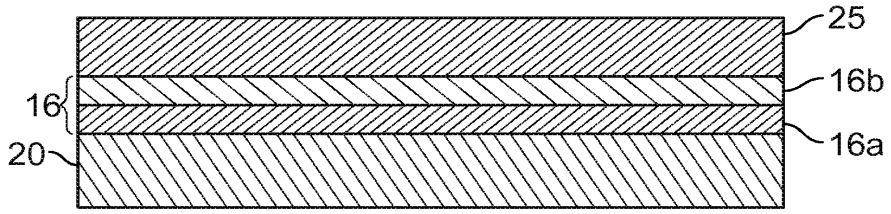



Figure 8B

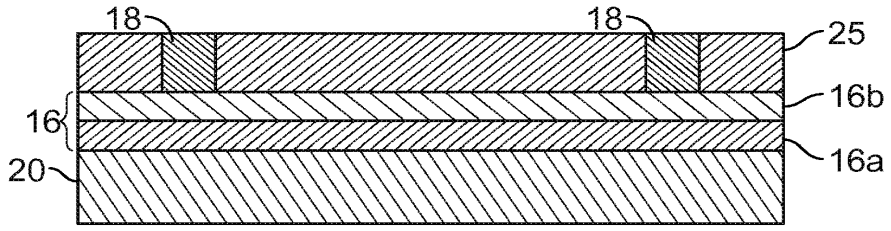



Figure 8C

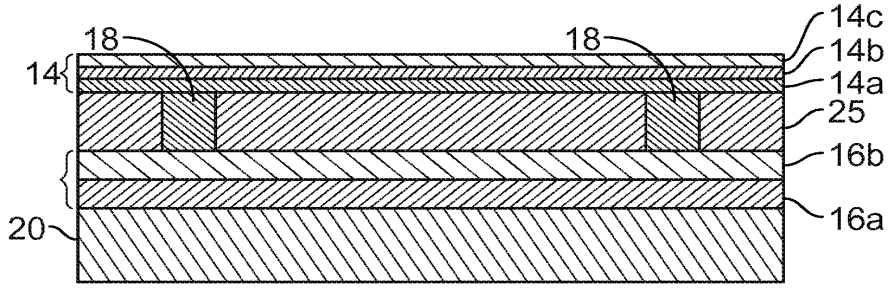



Figure 8D

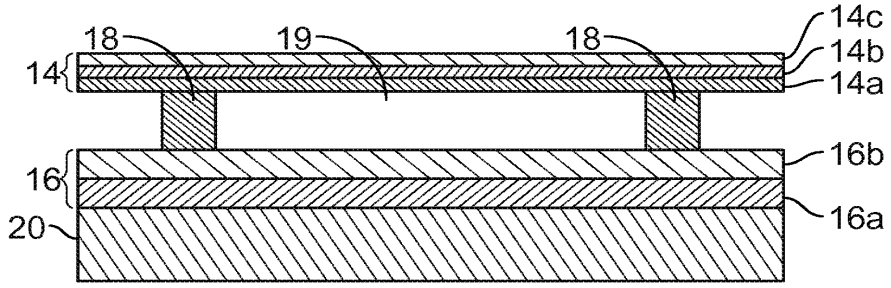



Figure 8E

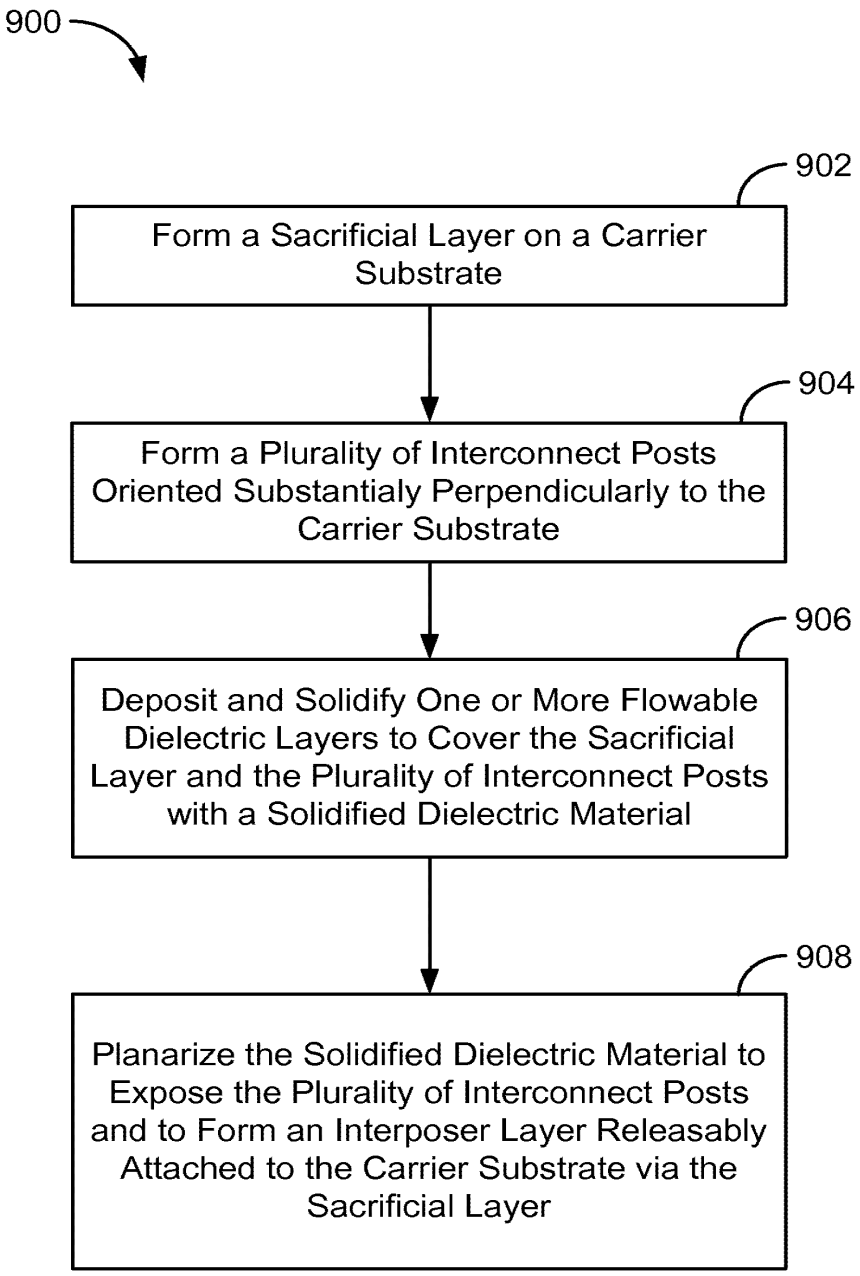

900
902
Form a Sacrificial Layer on a Carrier Substrate
904
Form a Plurality of Interconnect Posts Oriented Substantialy Perpendicularly to the Carrier Substrate
906
Deposit and Solidify One or More Flowable Dielectric Layers to Cover the Sacrificial Layer and the Plurality of Interconnect Posts with a Solidified Dielectric Material
908
Planarize the Solidified Dielectric Material to Expose the Plurality of Interconnect Posts and to Form an Interposer Layer Releasably Attached to the Carrier Substrate via the Sacrificial Layer

**Figure 9**

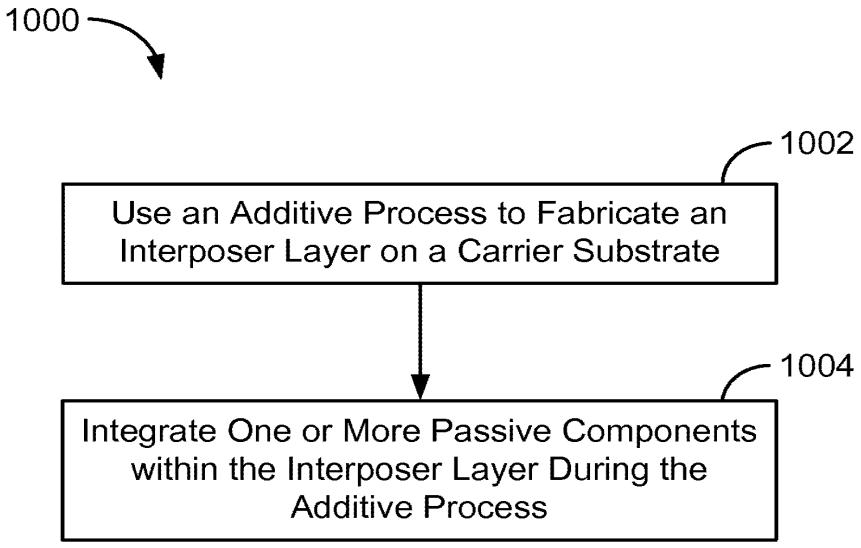

1000
1002
Use an Additive Process to Fabricate an Interposer Layer on a Carrier Substrate
1004
Integrate One or More Passive Components within the Interposer Layer During the Additive Process

**Figure 10**

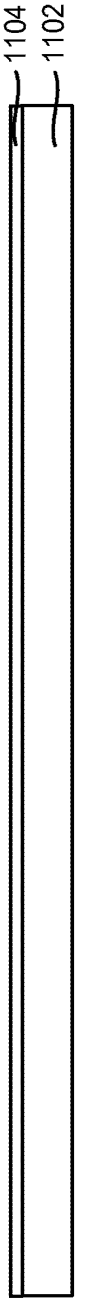



Figure 11A

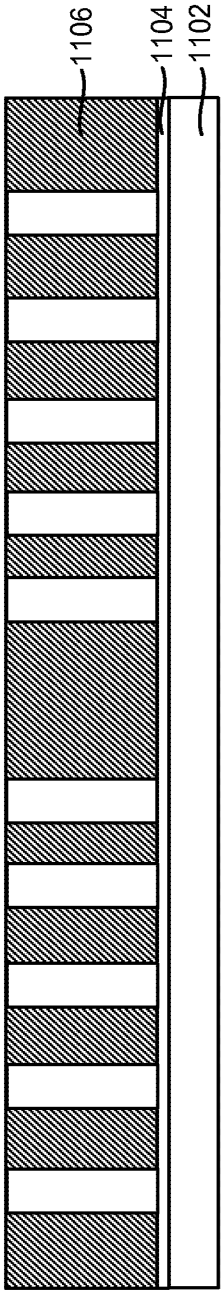



Figure 11B

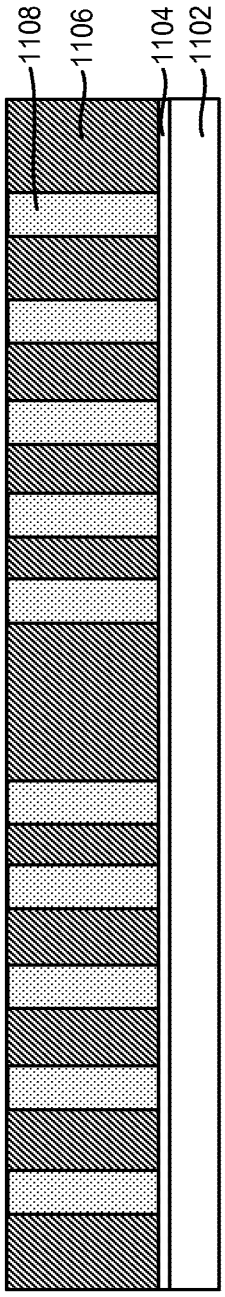



Figure 11C

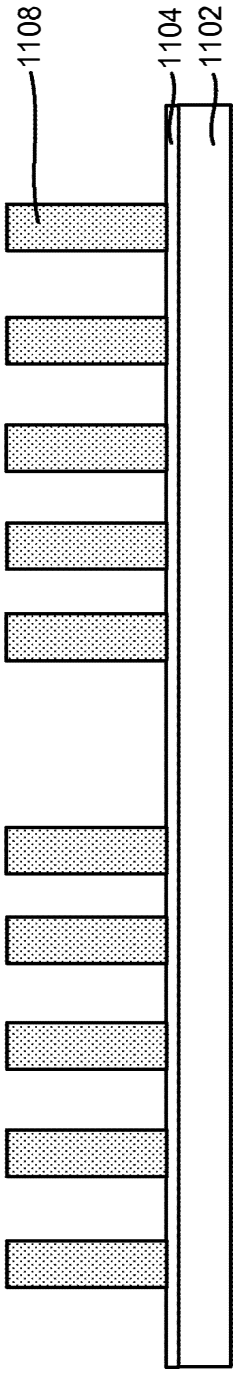



Figure 11D

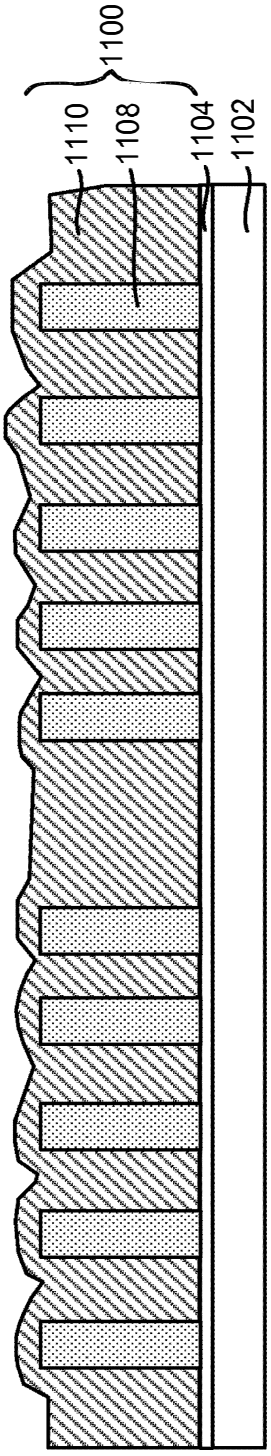



Figure 11E

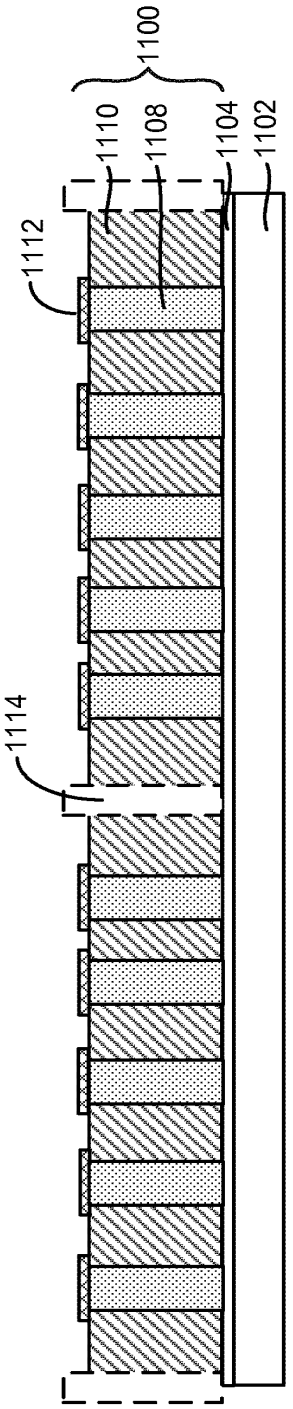



Figure 11F

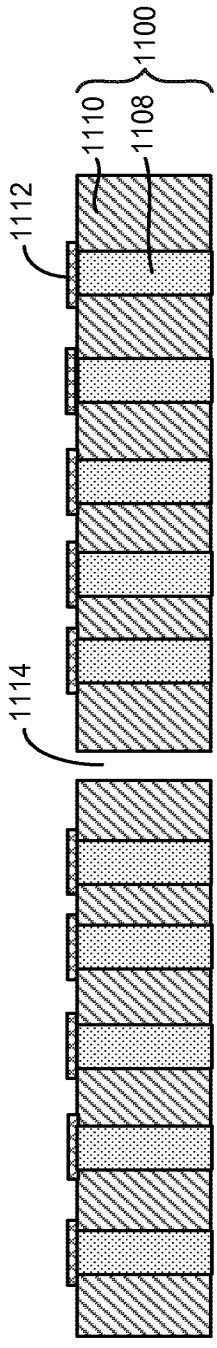



Figure 11G

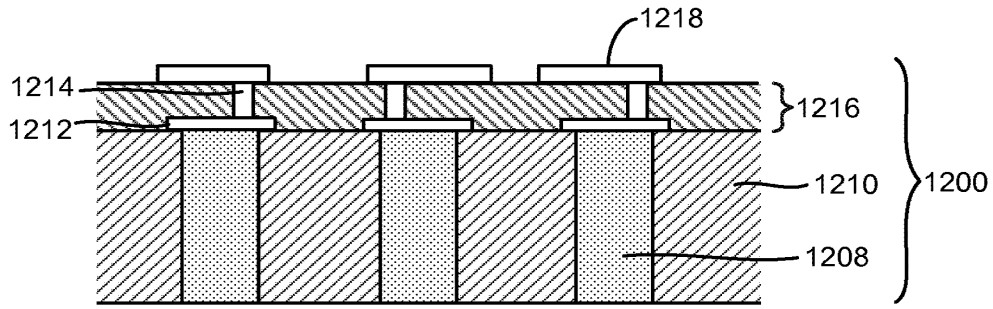



Figure 12A

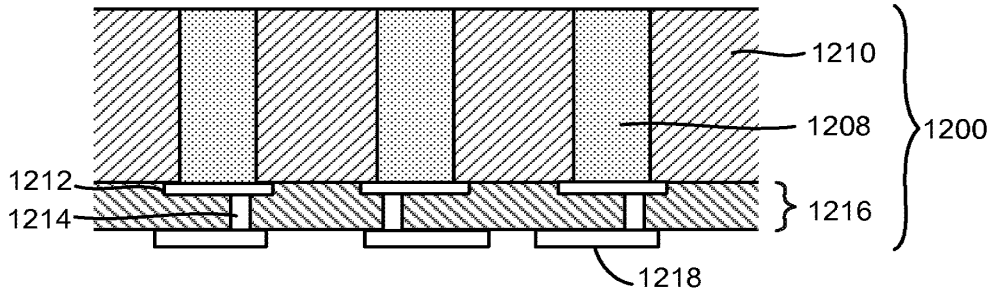



Figure 12B

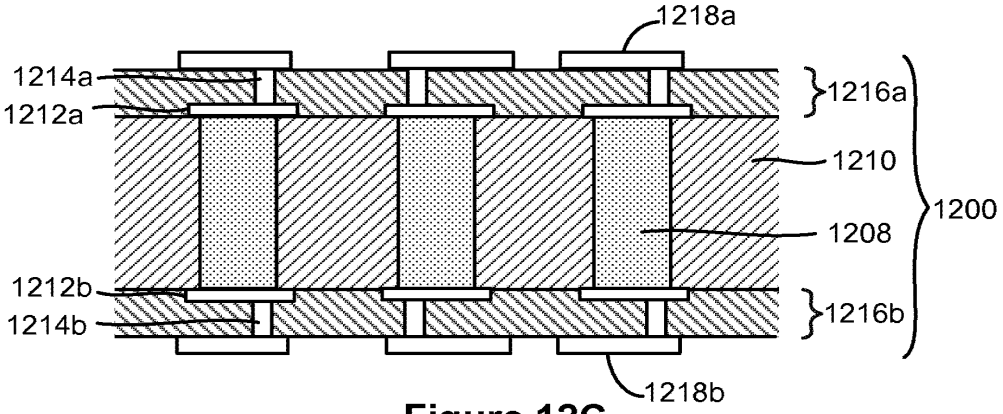



Figure 12C

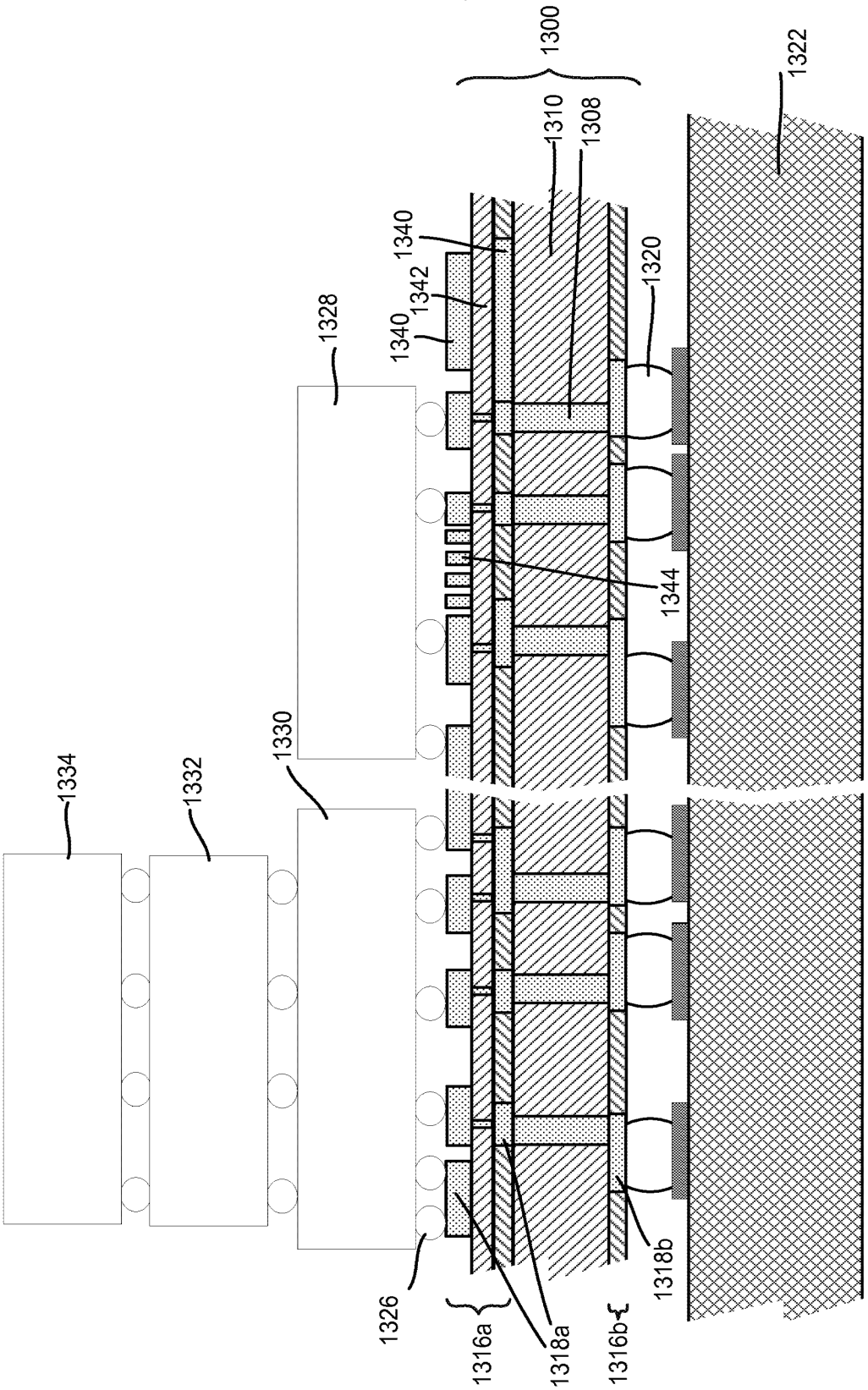

1300
1322
1310
1308
1340
1342
1340
1320
1328
1344
1330
1334
1332
1326
1316a
1318a
1316b
1318b

Figure 13

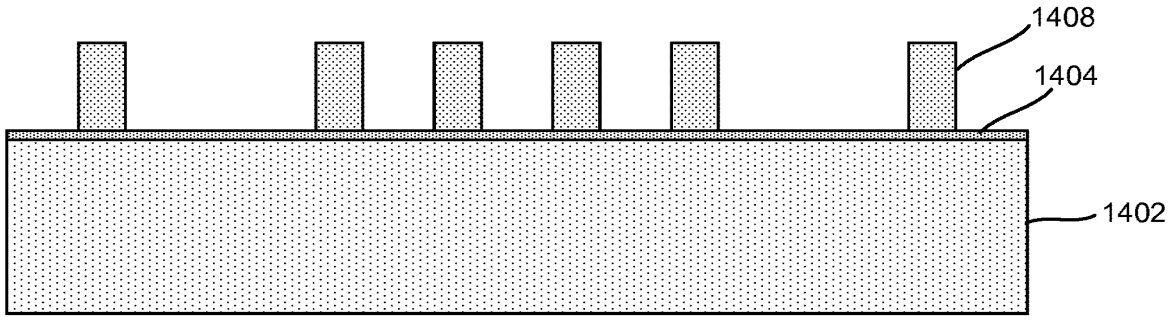



Figure 14A

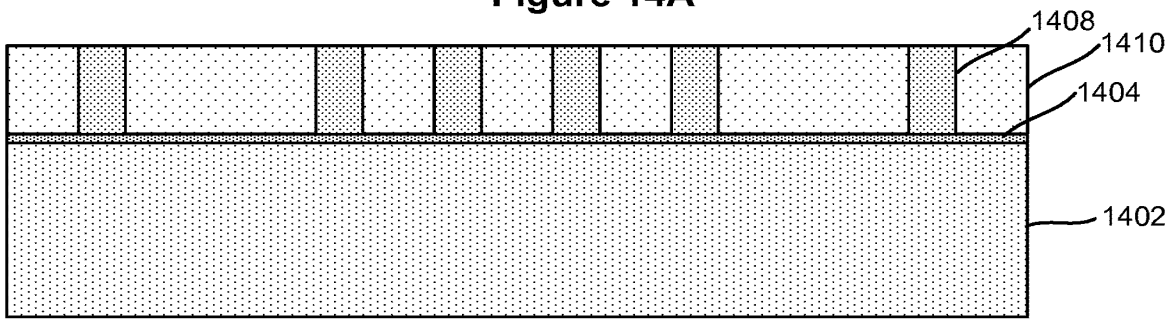



Figure 14B

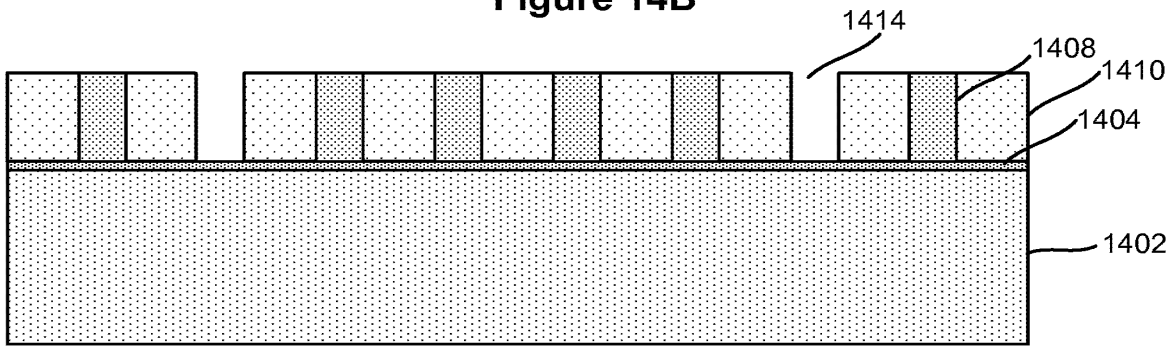



Figure 14C

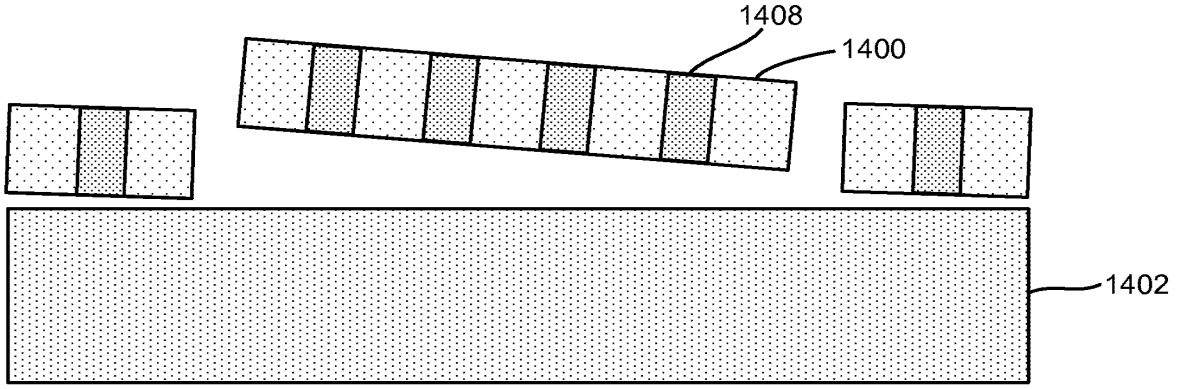



Figure 14D

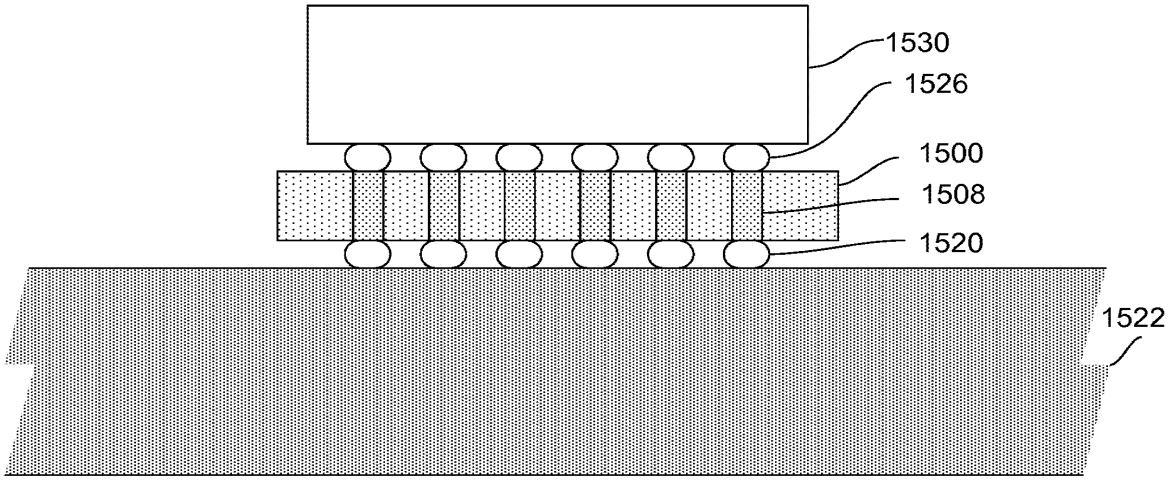



**Figure 15A**

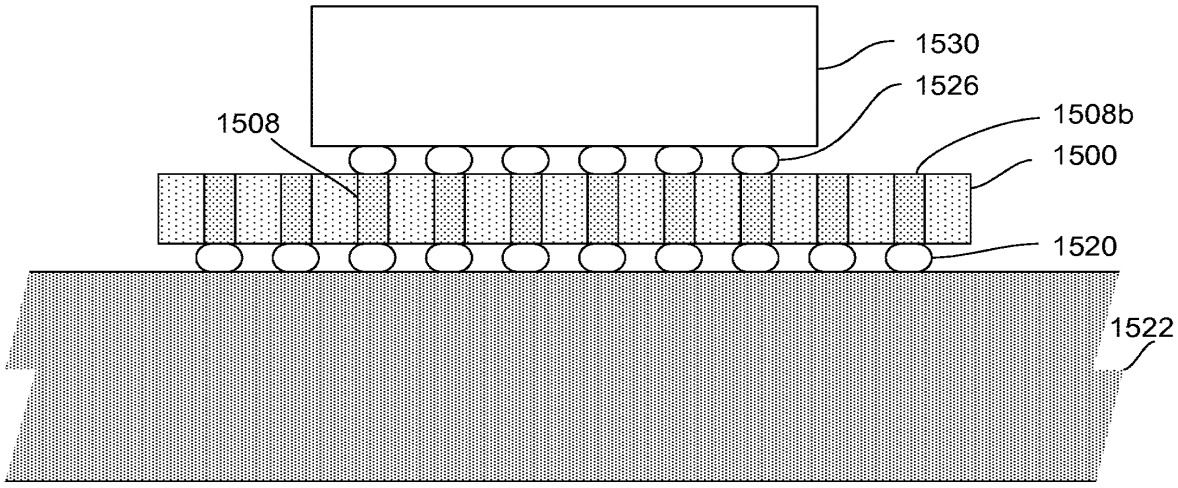



**Figure 15B**

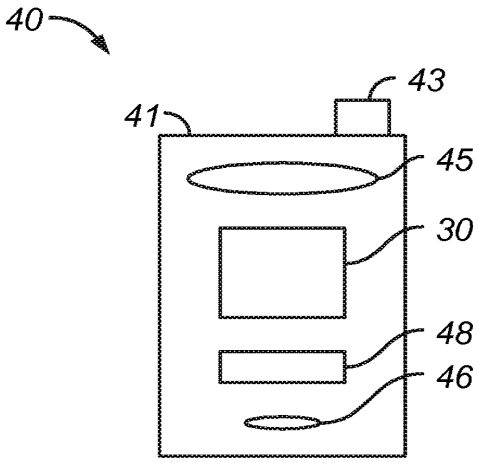



Figure 16A

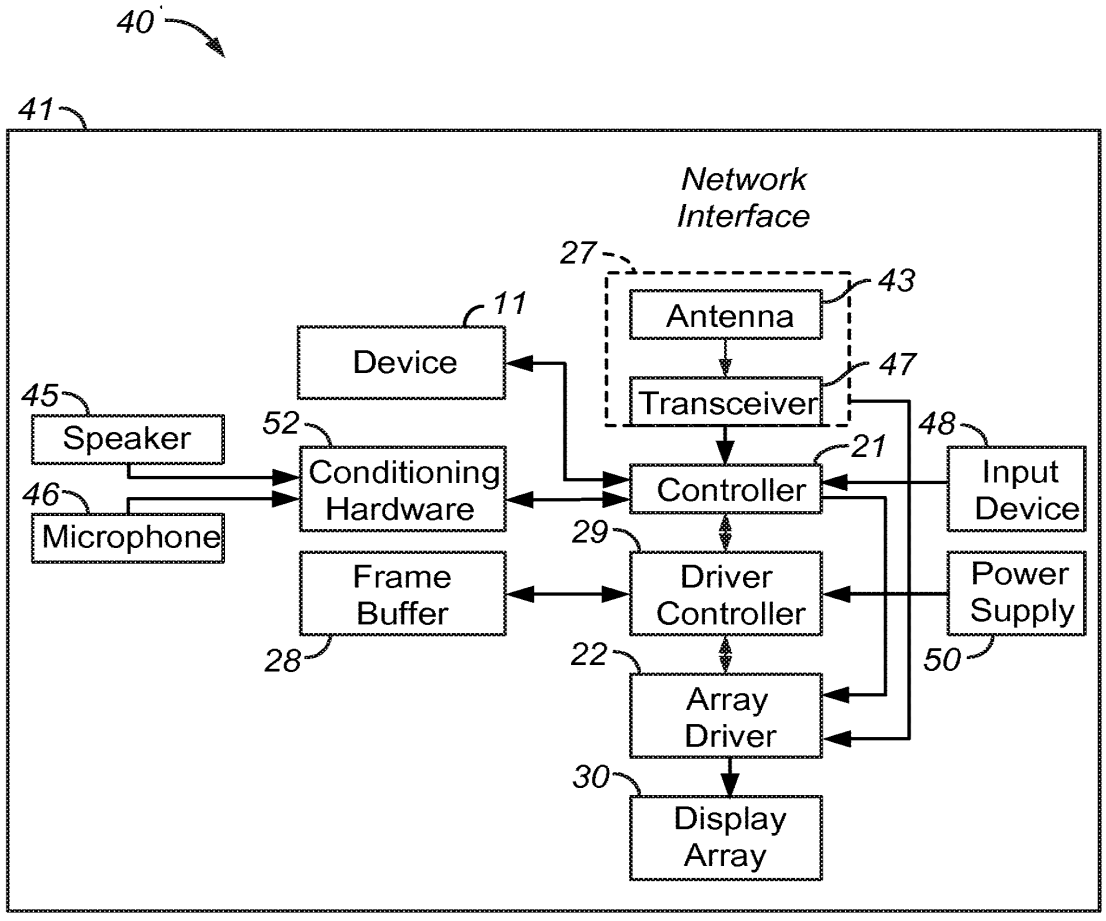



Figure 16B

# INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/030831

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01L23/498 H01L21/48
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | JP 2002 368368 A (HITACHI CHEMICAL CO LTD) 20 December 2002 (2002-12-20) | 1-9, 11-20, 22,23, 27-33, 35-38 |
| Y | figures 2, 4 | 4-7,21 |
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| Y | EP 1 643 819 A2 (SHINKO ELECTRIC IND CO [JP]) 5 April 2006 (2006-04-05) figures 1E, 1F | 4 |
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| | ----- | |
| | -/-- | |

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 9 August 2013 | 16/08/2013 |

| Name and mailing address of the ISA/ | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040,<br>Fax: (+31-70) 340-3016 | Kästner, Martin |

2

Form PCT/ISA/210 (second sheet) (April 2005)



IPR2026-00067
TSMC EX1002 Page 97

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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| Y | figures 1j, 8 | 5-7,21 |
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## INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2013/030831

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
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(P2009-170941A)
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| H01L 23/12 | (2006.01) | H01L | 25/00 | B | |
| | | H01L | 23/12 | N | |

審査請求 有　請求項の数 1　ＯＬ　（全 18 頁）

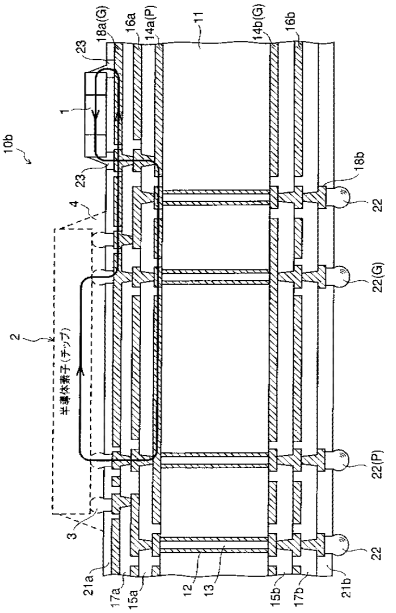
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(22)出願日　平成21年5月1日 (2009.5.1)
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原出願日　平成16年3月31日 (2004.3.31)

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最終頁に続く

(54)【発明の名称】キャパシタ実装配線基板

(57)【要約】
【課題】実装するキャパシタのＥＳＬを低減して効果的なデカップリングを行えるようにし、搭載する半導体素子等の動作信頼性の向上に寄与すること。
【解決手段】キャパシタ実装配線基板１０ｂにおいて、それぞれ所要の形状にパターン形成された複数の配線層１４ａ，１４ｂ，１６ａ，１６ｂ，１８ａ，１８ｂが、絶縁層１５ａ，１５ｂ，１７ａ，１７ｂを介して積層されると共に、該絶縁層を厚さ方向に貫通して形成された導体を介して相互に接続されている。デカップリング用のキャパシタ１は、電源ライン又はグランドラインとして供される最表層の配線層１８ａに近接して当該配線層に電気的に接続されると共に、該キャパシタ１に電流を流したときにその電流の向きと当該配線層１８ａに流れる電流の向きが逆方向となり、かつ、該キャパシタに流れる電流の経路が当該配線層に流れる電流の経路と略平行となるように、表面実装されている。
【選択図】図３




IPR2026-00067
TSMC EX1002 Page 100

【特許請求の範囲】
【請求項１】
それぞれ所要の形状にパターン形成された複数の配線層が、絶縁層を介して積層されると共に、該絶縁層を厚さ方向に貫通して形成された導体を介して相互に接続され、
キャパシタが、半導体素子や電子部品等が搭載される側と同じ面及びその反対側の面の少なくとも一方の面に設けられ、前記複数の配線層のうち電源ライン又はグランドラインとして供される最表層の配線層に近接して当該配線層に電気的に接続されると共に、該キャパシタに電流を流したときにその電流の向きと当該配線層に流れる電流の向きが逆方向となり、かつ、該キャパシタに流れる電流の経路が当該配線層に流れる電流の経路と略平行となるように、表面実装されていることを特徴とするキャパシタ実装配線基板。
【発明の詳細な説明】
【技術分野】
【０００１】
本発明は、キャパシタを実装した配線基板に関し、より詳細には、高速のスイッチング動作が要求される半導体素子（チップ）や電子部品等を搭載するための、デカップリング用のキャパシタを表面実装した配線基板（キャパシタ実装配線基板）に関する。
【０００２】
この明細書では、配線基板は半導体素子等を搭載するパッケージとしての役割を果たす意味で、便宜上「半導体パッケージ」ともいう。また、半導体素子等を搭載した状態にある配線基板（半導体パッケージ）を「半導体装置」と呼ぶことにする。
【背景技術】
【０００３】
近年、プリント配線基板は軽量化が要求され、かつ、小型・多ピン化されたＢＧＡ（ボール・グリッド・アレイ）やＰＧＡ（ピン・グリッド・アレイ）、ＣＳＰ（チップ・サイズ・パッケージ）等を搭載するため、配線の微細化及び高密度化が要求されている。しかし、従来のプリント配線基板はビアホールの形成に多くの面積を必要としていたため、設計の自由度が制限され、配線の微細化が困難であった。そこで、近年実用化が進んできたのが、ビルドアップ法を用いたプリント配線基板（ビルドアップ多層配線基板）である。このビルドアップ多層配線基板は、層間絶縁層の材料とビアホール形成のプロセスの組合せにより多種類のものが作製可能であり、その基本的なプロセスは、絶縁層の形成、絶縁層における層間接続のためのビアホールの形成、ビアホールの内部を含めた導体層（パターン形成された配線、パッド等）の形成を順次繰り返しながら導体層を積み上げていくものである。このようなビルドアップ法によって得られた多層配線基板では、集積度等が進展した半導体素子（チップ）でも搭載することが可能である。
【０００４】
しかしその反面、かかる多層配線基板（半導体パッケージ）では各配線パターンが互いに近接しているため、配線間でクロストークノイズが生じたり、また電源ラインやグランドライン等の電位が変動したりする等の問題が起こり得る。特に、高速のスイッチング動作が要求される半導体素子や電子部品等を搭載する半導体パッケージでは、周波数の上昇に伴いクロストークノイズが発生し易くなり、またスイッチング素子が高速にオン／オフすることでスイッチングノイズが発生し、これによって電源ライン等の電位が変動し易くなる。これは、搭載する半導体素子等の動作信頼性の低下につながり、好ましくない。
【０００５】
そこで、電源電圧を安定させ、かつスイッチングノイズ等を低減させる目的で、従来より、半導体素子を搭載した半導体パッケージにチップキャパシタ等の容量素子を付設して電源ライン等を「デカップリング」することが行われている。典型的な手法としては、半導体パッケージの半導体素子等が搭載される側と同じ面又はその反対側の面に、チップキャパシタをはんだ付け等により表面実装する方法がある。
【０００６】
しかしこの場合、半導体パッケージの表面にキャパシタを設けた分だけ当該パッケージ

IPR2026-00067
TSMC EX1002 Page 101

全体の厚みが大きくなってしまい、また、キャパシタと半導体素子の間を接続する配線の引き回し距離が長くなってインダクタンスの増大を招くことがある。インダクタンスが大きいと、効果的な「デカップリング」を行うことができないので、インダクタンスは出来るだけ小さい方が望ましい。このためには、キャパシタは出来るだけ半導体素子の近傍に配置することが望ましい。また、このようにキャパシタを半導体素子の近くに配置するのが従来の技術常識であった。

【０００７】

上記の従来技術に関連する技術としては、例えば、特許文献１に記載されるように、ビルドアップ法によって得られた樹脂の多層回路基板にデカップリング用のキャパシタを内装し、該キャパシタを構成する２層の導体パターンによって挟まれた誘電体層を、所定値以上の比誘電率を有する材料（樹脂）によって形成するようにしたものがある。

【先行技術文献】

【特許文献】

【０００８】

【特許文献１】特開平１１－６８３１９号公報

【発明の概要】

【発明が解決しようとする課題】

【０００９】

上述したように従来の技術では、デカップリング用キャパシタのインダクタンスを出来るだけ小さくするために、当該キャパシタを半導体素子に近づけて配設することで両者間の配線距離を出来るだけ短くするようにしていた。この際、キャパシタに流れる電流とその近傍のプレーン（平面）状の配線パターン、特に、電源プレーン又はグランドプレーンの磁気的な結合に関する配慮はなされていなかった。

【００１０】

このため、キャパシタと半導体素子を接続したときに両者間の配線距離が単に短いというだけでは、当該キャパシタが有する等価直列インダクタンス（ＥＳＬ）を必ずしも小さくできない場合も起こり得る。例えば、長手の板状のチップキャパシタの近傍で当該キャパシタに接続されるプレーン（平面）状の配線パターンがあり、しかもその配線パターンが当該キャパシタの長手方向に平行な状態で、当該キャパシタに流れる電流とその配線パターンに流れる電流の方向が同じ向きの場合、当該キャパシタに流れる電流によって生じる磁界と配線パターンに流れる電流によって生じる磁界の方向が同じ向きとなるため、当該キャパシタのＥＳＬは、配線パターンからの磁界の影響を受けてそのインダクタンスが見かけ上大きくなってしまう。

【００１１】

つまり、キャパシタの配置とその近傍の配線パターンの配置や流れる電流の向きとの関係によっては、当該キャパシタのＥＳＬを必ずしも満足に小さくできないといった課題があった。

【００１２】

本発明は、かかる従来技術における課題に鑑み創作されたもので、実装するキャパシタの等価直列インダクタンス（ＥＳＬ）を低減して効果的なデカップリングを行えるようにし、ひいては搭載する半導体素子等の動作信頼性の向上に寄与することができるキャパシタ実装配線基板を提供することを目的とする。

【課題を解決するための手段】

【００１３】

上記の従来技術の課題を解決するため、本発明によれば、それぞれ所要の形状にパターン形成された複数の配線層が、絶縁層を介して積層されると共に、該絶縁層を厚さ方向に貫通して形成された導体を介して相互に接続され、キャパシタが、半導体素子や電子部品等が搭載される側と同じ面及びその反対側の面の少なくとも一方の面に設けられ、前記複数の配線層のうち電源ライン又はグランドラインとして供される最表層の配線層に近接して当該配線層に電気的に接続されると共に、該キャパシタに電流を流したときにその電流

IPR2026-00067
TSMC EX1002 Page 102

の向きと当該配線層に流れる電流の向きが逆方向となり、かつ、該キャパシタに流れる電流の経路が当該配線層に流れる電流の経路と略平行となるように、表面実装されていることを特徴とするキャパシタ実装配線基板が提供される。

【発明の効果】

【００１４】

本発明に係るキャパシタ実装配線基板の構成によれば、キャパシタが、電源用（又はグランド用）として供される最表層の配線層に近接配置され、キャパシタに流れる電流の経路と当該配線層に流れる電流の経路が略平行となるように表面実装されているので、キャパシタに流れる電流と当該配線層に流れる電流の磁気的な結合が強化される。また、双方の電流の向きが互いに逆方向となっているので、各々の電流によって生じる磁界が互いに打ち消される。その結果、当該キャパシタの等価直列インダクタンス（ＥＳＬ）は、当該配線層からの磁界（自己が発生する磁界を打ち消す方向に作用する磁界）の影響を受けて見かけ上小さくなる。つまり、当該キャパシタのＥＳＬを低減することができる。これによって、効果的なデカップリングを行うことが可能となり、また、搭載する半導体素子等の動作信頼性の向上に寄与することができる。

【図面の簡単な説明】

【００１５】

【図１】本発明の第１の実施形態に係るキャパシタ実装配線基板の構成を示す断面図である。

【図２】本発明の第２の実施形態に係るキャパシタ実装配線基板の構成を示す断面図である。

【図３】本発明の第３の実施形態に係るキャパシタ実装配線基板の構成を示す断面図である。

【図４】本発明の第４の実施形態に係るキャパシタ実装配線基板の構成を示す断面図である。

【図５】本発明の第５の実施形態に係るキャパシタ実装配線基板の構成を示す断面図である。

【図６】本発明の第６の実施形態に係るキャパシタ実装配線基板の構成を示す断面図である。

【図７】本発明の第７の実施形態に係るキャパシタ実装配線基板の構成を示す断面図である。

【図８】本発明の第８の実施形態に係るキャパシタ実装配線基板の構成を示す断面図である。

【図９】図７の実施形態に係るキャパシタ実装配線基板の要部（チップキャパシタの接続形態に係る部分）の製造工程（その１）を示す断面図である。

【図１０】図９の製造工程に続く製造工程（その２）を示す断面図である。

【図１１】図８の実施形態に係るキャパシタ実装配線基板の要部（チップキャパシタの接続形態に係る部分）の製造工程（その１）を示す断面図である。

【図１２】図１１の製造工程に続く製造工程（その２）を示す断面図である。

【図１３】チップキャパシタを表面実装した場合と埋め込み実装した場合にそれぞれ得られる等価直列インダクタンス（ＥＳＬ）を対比させて示した図である。

【図１４】図６の実施形態の一変形例に係るキャパシタ実装配線基板におけるキャパシタ部分の構成を示す断面図である。

【発明を実施するための形態】

【００１６】

図１は本発明の第１の実施形態に係るキャパシタ実装配線基板（半導体パッケージ）の構成を断面図の形態で模式的に示したものである。図示の例では、チップキャパシタ１を半導体パッケージ１０の裏面（半導体素子２が搭載される側と反対側の面）に表面実装した場合の構成を示している。

【００１７】

IPR2026-00067
TSMC EX1002 Page 103

本実施形態に係る半導体パッケージ１０において、１１は本パッケージのコア基板としての絶縁性基材（例えば、ガラス布にエポキシ樹脂やポリイミド樹脂等の熱硬化性樹脂を含浸させたもの）、１２はコア基板１１の所要箇所に厚さ方向に貫通して形成されたスルーホールの内壁に形成された導体（例えば、銅（Ｃｕ）等の金属）、１３は導体１２の内側に充填された絶縁体（例えば、エポキシ樹脂等）、１４ａ，１４ｂはそれぞれコア基板１１の両面に所要の形状にパターン形成された配線層（例えば、Ｃｕ）、１５ａ，１５ｂはそれぞれコア基板１１及び配線層１４ａ，１４ｂ上に形成された層間絶縁層としての樹脂層（例えば、エポキシ樹脂層）、１６ａ，１６ｂはそれぞれ配線層１４ａ，１４ｂの一部に電気的に接続されて樹脂層１５ａ，１５ｂ上に所要の形状にパターン形成された配線層、１７ａ，１７ｂはそれぞれ樹脂層１５ａ，１５ｂ及び配線層１６ａ，１６ｂ上に形成された樹脂層、１８ａ，１８ｂはそれぞれ配線層１６ａ，１６ｂの一部に電気的に接続されて樹脂層１７ａ，１７ｂ上に所要の形状にパターン形成された配線層、１９ａ，１９ｂはそれぞれ樹脂層１７ａ，１７ｂ及び配線層１８ａ，１８ｂ上に形成された樹脂層、２０ａ，２０ｂはそれぞれ配線層１８ａ，１８ｂの一部に電気的に接続されて樹脂層１９ａ，１９ｂ上に所要の形状にパターン形成された配線層を示す。

【００１８】

また、２１ａ，２１ｂはそれぞれ所定の部分に開口部を有して配線層２０ａ，２０ｂ及び樹脂層１９ａ，１９ｂ上に形成された保護膜としてのソルダレジスト層、２２は下側のソルダレジスト層２１ｂの開口部から露出している各パッド部（配線層２０ｂの一部）に接合された外部接続端子としてのはんだバンプ、２３は同じくソルダレジスト層２１ｂの開口部から露出している２箇所のパッド部（配線層２０ｂの一部）にチップキャパシタ１を接続するはんだを示す。このとき、はんだの接着性を高めるために、ソルダレジスト層２１ｂの開口部から露出しているパッド部（配線層２０ｂの一部）上にニッケル（Ｎｉ）／金（Ａｕ）のめっきによる導体層を被着させておくのが望ましい。これは、上側のソルダレジスト層２１ａの開口部から露出しているパッド部（配線層２０ａの一部）に対しても同様である。

【００１９】

なお、図示の例ではバンプ（外部接続端子）２２を設けているが、これは必ずしも設ける必要はない。要は、必要なときに外部接続端子を接合できるように下側のソルダレジスト層２１ｂの開口部からパッド部（配線層２０ｂの一部）が露出していれば十分である。また、チップキャパシタ１は、パッケージ１０に表面実装されるので、パッケージ全体の厚みを抑えるためにもその厚さが可及的に薄いものを用いるのが望ましい。また、後述するようにチップキャパシタ１を埋め込み実装する実施形態においても、パッケージ中に埋め込むためその厚さは出来るだけ薄い方が望ましい。よって、本実施形態を含めて以下に記述する各実施形態では、チップキャパシタ１として厚さが１００μｍ程度の薄いものを使用している。

【００２０】

各配線層１４ａ，１４ｂ，１６ａ，１６ｂ，１８ａ，１８ｂ，２０ａ及び２０ｂはそれぞれ所要の形状にパターン形成されるが、その際、それぞれ要求されるパターンの信号ライン、電源ライン（Ｐ）又はグランドライン（Ｇ）と、層間接続用のパッド部とを含むように形成される。最外層の配線層２０ａ，２０ｂ以外の配線層については、各々のパッド部は、それぞれ対応する樹脂層に形成される上下接続用のビアホール（このビアホールには導体（例えば、Ｃｕ）が充填されている）の位置に対応してパターン形成されている。一方、最外層の配線層２０ａ，２０ｂの各パッド部は、それぞれ搭載する半導体素子（チップ）２の電極の位置、外部接続端子２２の接合位置、及びチップキャパシタ１の実装位置に対応するようにパターン形成されている。また、図示の例では、上側の配線層１８ａと下側の配線層１４ｂが電源ラインとして供され、上側の配線層１４ａと下側の配線層１８ｂがグランドラインとして供されている。本実施形態を含めて以下に記述する各実施形態では、便宜上、電源ラインとして供される配線層を「電源プレーン」、グランドラインとして供される配線層を「グランドプレーン」ともいう。

IPR2026-00067
TSMC EX1002 Page 104

【００２１】
本実施形態に係るキャパシタ実装配線基板（半導体パッケージ）１０は、後述するように、デカップリング用として実装するチップキャパシタ１を、電源プレーン（図１の例では、電源用の配線層１４ｂにビアホール（に充填された導体）を介して接続された最下層の配線層２０ｂ）に近接して当該プレーンに電気的に接続すると共に、チップキャパシタ１に電流を流したときにその電流の向き（図１の例では、右から左に向かう方向）と当該プレーン（配線層２０ｂ）に流れる電流の向き（図１の例では、左から右に向かう方向）が逆方向となるように実装したことを特徴としている。このような特徴的な構成は、チップキャパシタ１に近接配置される当該プレーンが電源プレーンであるか、グランドプレーンであるかの違いはあるにせよ、後述する他の実施形態についても共通している。

【００２２】
本実施形態に係る半導体パッケージ１０は、ビルドアップ法などの周知の技術を用いて製造することができる。よって、その製造方法の工程については図示を省略するが、簡単に説明すると以下の通りである。例えばビルドアップ法を用いた場合、先ず、コア基板１１（所要箇所にスルーホールを形成し、その内部に導体１２及び絶縁体１３を充填したもの）の両面に所要のパターン形状に配線層１４ａ，１４ｂを形成し、次に、樹脂層（層間絶縁層）の形成→樹脂層における層間接続のためのビアホールの形成→ビアホールの内部を含めた配線層の形成を順次繰り返しながら上下各４層となるまで配線層を積み上げていき、さらに、最外層の配線層２０ａ，２０ｂのパッド部が露出するように全面を覆ってソルダレジスト層２１ａ，２１ｂを形成した後、基板実装側のソルダレジスト層２１ｂからそれぞれ露出している各パッド部に、はんだバンプ（外部接続端子）２２を接合すると共に、チップキャパシタ１をはんだ付け（２３）により表面実装することで、本実施形態の半導体パッケージ１０（図１）を得ることができる。

【００２３】
また、本パッケージ１０に半導体素子（チップ）２を搭載して半導体装置を得る場合には、例えば、上側のソルダレジスト層２１ａの開口部から露出しているパッド部（配線層２０ａの一部）に、半導体チップ２のパッド上に接合された電極３（例えば、はんだバンプ）が電気的に接続されるように当該チップ２をフリップチップ接続し、さらに、ソルダレジスト層２１ａとの間にアンダーフィル樹脂４を充填し、熱硬化させて接着する。あるいは、このアンダーフィル樹脂４の代わりに、あらかじめノン・コンダクティブ・ペースト（ＮＣＰ）を塗布し、又はノン・コンダクティブ・フィルム（ＮＣＦ）を貼り付けておき、フリップチップ接続と同時にアンダーフィル樹脂４と同等の形状に成形するようにしてもよい。

【００２４】
本実施形態に係る半導体パッケージ１０（図１）の構成によれば、チップキャパシタ１と電源プレーン（配線層２０ｂ）が近接配置されると共に、当該キャパシタ１に流れる電流と当該プレーンに流れる電流の向きが互いに逆方向となっているので、双方の電流の磁気的な結合が強化されると共に、各々の電流によって生じる磁界が互いに打ち消される。その結果、チップキャパシタ１のＥＳＬは、当該電源プレーン（配線層２０ｂ）から及ぼされる磁界（つまり、当該キャパシタ１が発生する磁界を打ち消す方向に作用する磁界）の影響を受けて見かけ上小さくなる。つまり、チップキャパシタ１のＥＳＬを低減することができ、これによって、効果的なデカップリングを行うことが可能となり、また、搭載する半導体素子（チップ）２の動作信頼性の向上に寄与することができる。

【００２５】
図２は本発明の第２の実施形態に係るキャパシタ実装配線基板（半導体パッケージ）の構成を断面図の形態で模式的に示したものである。

【００２６】
本実施形態に係る半導体パッケージ１０ａは、上述した第１の実施形態に係る半導体パッケージ１０（図１）と比べて、チップキャパシタ１を本パッケージ１０ａの表面（半導体素子２が搭載される側と同じ面）の半導体素子搭載領域の周囲（図示の例では、右側）

IPR2026-00067
TSMC EX1002 Page 105

の領域に表面実装した点で相違する。他の構成及びその機能については、第１の実施形態の場合と基本的に同じであるので、その説明は省略する。

【００２７】

この第２の実施形態によれば、第１の実施形態の場合と比べて、搭載する半導体素子２のより近傍にチップキャパシタ１を実装しており、インダクタンスの大きなスルーホールを介さないので、半導体装置（半導体素子２を搭載した状態の半導体パッケージ１０ａ）全体として見たときの電気的特性をより向上させることができる。

【００２８】

図３は本発明の第３の実施形態に係るキャパシタ実装配線基板（半導体パッケージ）の構成を断面図の形態で模式的に示したものである。

【００２９】

本実施形態に係る半導体パッケージ１０ｂは、上述した第２の実施形態に係る半導体パッケージ１０ａ（図２）と比べて、チップキャパシタ１の直下にグランドプレーン（すなわち、キャパシタ１に流れる電流によって生じる磁界を打ち消す方向に磁界を発生させる電流が流れるグランド用の配線層１８ａ）を配置した点で相違する。この配置の違いにより、キャパシタ１を流れる電流の経路上に存在するビアホールの段数（長さ）は、第２の実施形態の場合と比べて減少しており、当該キャパシタを流れる電流の経路上に発生するインダクタンスは小さくなるため、半導体装置（半導体素子２を搭載した状態の半導体パッケージ１０ｂ）全体として見たときの電気的特性が向上する。他の構成及びその機能については、第２の実施形態の場合と基本的に同じであるので、その説明は省略する。

【００３０】

図３の例では、チップキャパシタ１の直下の配線層１８ａはグランド用として供されているが、これは、電源用として供されている場合（電源プレーン）でも同様である。この場合には、電源用として供されている配線層１４ａはグランド用に変更され、この配線層１４ａはグランド用の外部接続端子２２（Ｇ）に接続されるようにパターン変更され、一方、配線層１８ａは電源用の外部接続端子２２（Ｐ）に接続されるようにパターン変更される。

【００３１】

この第３の実施形態によれば、チップキャパシタ１の直下にグランドプレーン（又は電源プレーン）を配置しているので、第２の実施形態の場合と比べて、当該キャパシタ１に流れる電流によって生じる磁界と当該プレーン（配線層１８ａ）に流れる電流によって生じる磁界との結合がより一層強化される。その結果、チップキャパシタ１のＥＳＬをより一層効果的に低減することができる。

【００３２】

図４は本発明の第４の実施形態に係るキャパシタ実装配線基板（半導体パッケージ）の構成を断面図の形態で模式的に示したものである。図示の例では、チップキャパシタ１を半導体パッケージ１０ｃに埋め込み実装した場合の構成を示している。

【００３３】

本実施形態に係る半導体パッケージ１０ｃは、上述した第１の実施形態に係る半導体パッケージ１０（図１）と比べて、本パッケージを構成するビルドアップ層のうちコア基板１１の下側（半導体素子２が搭載される側と反対側）に積層されたビルドアップ層（樹脂層１７ｂ）中にチップキャパシタ１を埋設した点で相違する。チップキャパシタ１は、その一方の電極が、樹脂層１５ｂを厚さ方向に貫通して形成されたビアホールに充填された導体（配線層１６ｂの一部）を介して電源用の配線層１４ｂに接続され、他方の電極が、樹脂層１７ｂを厚さ方向に貫通して形成されたビアホールに充填された導体（配線層１８ｂの一部）を介してグランド用の配線層１８ｂに接続されている。他の構成及びその機能については、第１の実施形態の場合と基本的に同じであるので、その説明は省略する。

【００３４】

この第４の実施形態によれば、チップキャパシタ１を電源プレーン（配線層１４ｂ）とグランドプレーン（配線層１８ｂ）の間に挟み込むようにしているので、上述した各実施

IPR2026-00067
TSMC EX1002 Page 106

形態（図１～図３）のようにチップキャパシタ１を表面実装する場合（すなわち、チップキャパシタ１の一方の側にのみ電源プレーン（例えば、図１の配線層２０ｂ）又はグランドプレーン（例えば、図３の配線層１８ａ）を配置する場合）と比べて、チップキャパシタ１に流れる電流に対する対抗電流（各プレーン１４ｂ，１８ｂに流れる電流）は相対的に増大する。その結果、チップキャパシタ１のＥＳＬをより一層効果的に低減することができる。

【００３５】

また、チップキャパシタ１を半導体パッケージ１０ｃに埋め込み実装しているので、第１～第３の各実施形態（図１～図３）の場合と比べて、半導体パッケージ１０ｃ全体の厚みを小さくすることができる。さらに、チップキャパシタ１は半導体素子搭載領域の下方の領域に埋め込まれているので、第２、第３の各実施形態（図２、図３）のようにチップキャパシタ１を半導体素子搭載領域の周囲の領域に表面実装する場合と比べて、半導体パッケージ１０ｃのサイズを小さくすることができる。

【００３６】

図５は本発明の第５の実施形態に係るキャパシタ実装配線基板（半導体パッケージ）の構成を断面図の形態で模式的に示したものである。

【００３７】

本実施形態に係る半導体パッケージ１０ｄは、上述した第４の実施形態に係る半導体パッケージ１０ｃ（図４）と比べて、本パッケージを構成するビルドアップ層のうちコア基板１１の上側（半導体素子２が搭載される側と同じ側）に積層されたビルドアップ層（樹脂層１７ａ）中にチップキャパシタ１を埋設した点で相違する。このチップキャパシタ１は、その一方の電極が、樹脂層１７ａを厚さ方向に貫通して形成されたビアホールに充填された導体（配線層１８ａの一部）を介して電源用の配線層１８ａに接続され、他方の電極が、樹脂層１５ａを厚さ方向に貫通して形成されたビアホールに充填された導体（配線層１６ａの一部）を介してグランド用の配線層１４ａに接続されている。他の構成及びその機能については、第４の実施形態の場合と基本的に同じであるので、その説明は省略する。

【００３８】

この第５の実施形態によれば、第４の実施形態の場合と比べて、搭載する半導体素子２のより近傍にチップキャパシタ１を埋め込み実装しており、インダクタンスの大きなスルーホールを介さないので、半導体装置（半導体素子２を搭載した状態の半導体パッケージ１０ｄ）全体として見たときの電気的特性をより向上させることができる。

【００３９】

図６は本発明の第６の実施形態に係るキャパシタ実装配線基板（半導体パッケージ）の構成を断面図の形態で模式的に示したものである。

【００４０】

本実施形態に係る半導体パッケージ１０ｅは、上述した第５の実施形態に係る半導体パッケージ１０ｄ（図５）と比べて、搭載する半導体素子２の直下にグランドプレーン（グランド用の配線層１８ａ）を配置した点で相違する。この配置の違いにより、キャパシタ１を流れる電流の経路上に存在するビアホールの段数（長さ）は、第５の実施形態の場合よりも減少しており、当該キャパシタを流れる電流の経路上に発生するインダクタンスは小さくなるため、半導体装置（半導体素子２を搭載した状態の半導体パッケージ１０ｅ）全体として見たときの電気的特性が向上する。また、チップキャパシタ１は、その一方の電極が、樹脂層１７ａを厚さ方向に貫通して形成されたビアホールに充填された導体（配線層１８ａの一部）を介してグランド用の配線層１８ａに接続され、他方の電極が、樹脂層１５ａを厚さ方向に貫通して形成されたビアホールに充填された導体（配線層１６ａの一部）を介して電源用の配線層１４ａに接続されている。他の構成及びその機能については、第５の実施形態の場合と基本的に同じであるので、その説明は省略する。

【００４１】

図６の例では、搭載する半導体素子２の直下の配線層１８ａはグランド用として供され

IPR2026-00067
TSMC EX1002 Page 107

ているが、これは、電源用として供されている場合（電源プレーン）でも同様である。この場合には、電源用として供されている配線層１４ａはグランド用に変更され、この配線層１４ａはグランド用の外部接続端子２２（Ｇ）に接続されるようにパターン変更され、一方、配線層１８ａは電源用の外部接続端子２２（Ｐ）に接続されるようにパターン変更される。

【００４２】

図７は本発明の第７の実施形態に係るキャパシタ実装配線基板（半導体パッケージ）の構成を断面図の形態で模式的に示したものである。

【００４３】

本実施形態に係る半導体パッケージ１０ｆは、上述した第５の実施形態に係る半導体パッケージ１０ｄ（図５）と比べて、チップキャパシタ１の接続形態において相違する。すなわち、図７において本パッケージ１０ｆ中の破線で囲んだ部分ＣＰ１に示すように、チップキャパシタ１は、グランド用の配線層１４ａに接着剤３０を介して実装されており、その一方の電極（少なくとも端部）は、断面的に見て略Ｌ字形状に形成された配線層１６ａ（これは、配線層１４ａに接続されている）に係止されて接続されている。また、チップキャパシタ１の他方の電極は、別の部分の配線層１６ａの一部及び樹脂層１７ａを厚さ方向に貫通して形成されたビアホールに充填された導体（配線層１８ａの一部）を介して電源用の配線層１８ａに接続されている。他の構成及びその機能については、第５の実施形態の場合と基本的に同じであるので、その説明は省略する。

【００４４】

この第７の実施形態によれば、基本的には第５の実施形態に係るパッケージ構造と同等であるので、第５の実施形態の場合と同様の効果を奏することができる。更に、上記の構成上の特徴（チップキャパシタ１の一方の電極が略Ｌ字形状の配線層１６ａに係止されている点）に基づいて、当該電極とグランドプレーン（配線層１４ａ）との電気的な接続の信頼性を高めることができる。

【００４５】

図８は本発明の第８の実施形態に係るキャパシタ実装配線基板（半導体パッケージ）の構成を断面図の形態で模式的に示したものである。

【００４６】

本実施形態に係る半導体パッケージ１０ｇは、上述した第５の実施形態に係る半導体パッケージ１０ｄ（図５）と比べて、チップキャパシタ１の接続形態において相違する。すなわち、図８において本パッケージ１０ｇ中の破線で囲んだ部分ＣＰ２に示すように、チップキャパシタ１は、樹脂層１５ａ中に接着剤３０を介して実装されており、その一方の電極（少なくとも端部）は、断面的に見てＬ字形状に形成された配線層１６ａ（これは、樹脂層１５ａを厚さ方向に貫通して形成されたビアホールに充填された導体（配線層１６ａの一部）を介してグランド用の配線層１４ａに接続されている）に係止されて接続されている。また、チップキャパシタ１の他方の電極は、別の部分の配線層１６ａの一部及び樹脂層１７ａを厚さ方向に貫通して形成されたビアホールに充填された導体（配線層１８ａの一部）を介して電源用の配線層１８ａに接続されている。他の構成及びその機能については、第５の実施形態の場合と基本的に同じであるので、その説明は省略する。

【００４７】

この第８の実施形態においても、基本的には第５の実施形態に係るパッケージ構造と同等であるので、第５の実施形態の場合と同様の効果を奏することができる。更に、上記の構成上の特徴（チップキャパシタ１の一方の電極がＬ字形状の配線層１６ａに係止されている点）に基づいて、第７の実施形態の場合と同様に、当該電極とグランドプレーン（配線層１４ａ）との電気的な接続の信頼性を高めることができる。

【００４８】

なお、第７，第８の各実施形態に係る半導体パッケージ１０ｆ，１０ｇ（図７、図８）では、第５の実施形態に係る半導体パッケージ１０ｄ（図５）に対し、チップキャパシタ１の接続形態に係る部分ＣＰ１，ＣＰ２を置き換えた場合を例にとって説明したが、これ

IPR2026-00067
TSMC EX1002 Page 108

は、第４の実施形態に係る半導体パッケージ１０ｃ（図４）又は第６の実施形態に係る半導体パッケージ１０ｅ（図６）に対しても同様に置き換え可能であることはもちろんである。

【００４９】

また、第７，第８の各実施形態に係る半導体パッケージ１０ｆ，１０ｇ（図７、図８）は、チップキャパシタ１の接続形態に係る部分ＣＰ１，ＣＰ２以外の部分については、当業者には周知のビルドアップ法により製造することができる。よって、当該部分ＣＰ１，ＣＰ２以外の部分については記述の簡略化のためその説明を省略し、当該部分ＣＰ１，ＣＰ２の製造工程についてのみ、以下、図９～図１２を参照しながら説明する。

【００５０】

（第７の実施形態に係る当該部分ＣＰ１の製造工程：図９及び図１０参照）

先ず最初の工程では（図９（ａ）参照）、コア基板１１上にグランドプレーン（配線層１４ａ）を形成する。この配線層１４ａは、図示の例ではコア基板１１上の全面に形成されているが、図７に示すように所要のパターン形状に形成される。例えば、コア基板１１上に銅（Ｃｕ）の薄膜を形成し、その薄膜を種としてサブトラクティブ法により所要のパターンを形成する。

【００５１】

次の工程では（図９（ｂ）参照）、パターン形成された配線層１４ａ上に層間絶縁層としての樹脂層１５ａを形成する。例えば、エポキシ樹脂やポリイミド樹脂等の熱硬化性樹脂を配線層１４ａ上にラミネートし、平坦化及びプレス処理を施し、さらにキュア処理を施して樹脂層１５ａを形成する。

【００５２】

次の工程では（図９（ｃ）参照）、樹脂層１５ａの特定の位置（後述するチップキャパシタが実装される部分に対応する位置）に、ルータ加工により、凹部（キャビティ）ＲＰを形成する。このルータ加工に代えて、サンドブラストやエッチング等により凹部ＲＰを形成するようにしてもよい。

【００５３】

次の工程では（図９（ｄ）参照）、樹脂層１５ａに形成された凹部（キャビティ）ＲＰ内の配線層１４ａ上に、厚さが１００μｍ程度の薄いチップキャパシタ１を実装する。この場合、接着剤３０を配線層１４ａに貼り付けた後、その接着剤３０の位置に合わせて当該キャパシタ１を搭載するようにしてもよいし、又は、接着剤３０を当該キャパシタ１に貼り付けた後、その接着剤３０の付いたキャパシタ１を配線層１４ａ上に搭載するようにしてもよい。チップキャパシタ１の実装に際しては、凹部ＲＰ内で一方の側（図示の例では左側）の隙間が相対的に大きくなるように位置決めされる。本実施形態では、左側の隙間は１００μｍ～２００μｍ程度に選定されている。このとき、右側の隙間は５０μｍ～１００μｍ程度に選定されている。

【００５４】

次の工程では（図９（ｅ）参照）、全面に、無電解Ｃｕめっきにより、後の工程で行う電解めっきの際のめっきベース膜となるシード層３１を厚さ１μｍ程度に形成する。無電解めっきに代えて、スパッタリングによりシード層３１を形成するようにしてもよい。

【００５５】

次の工程では（図９（ｆ）参照）、シード層３１によって覆われた配線層１４ａ、樹脂層１５ａ及びチップキャパシタ１のうち特定の部分が露出するように全面を覆ってめっきレジスト（レジスト層３２）を形成する。ここでいう「特定の部分」は、チップキャパシタ１の一方の電極（図示の例では、左側の電極）及び同じ側にある配線層１４ａの位置に対応する部分と、チップキャパシタ１の他方の電極（図示の例では、右側の電極）の位置に対応する部分に相当する。レジスト層３２の形成は、例えば、全面に感光性のドライフィルム（厚さ２５μｍ程度）をラミネートし、上記の「特定の部分」の形状に従うように露光及び現像（ドライフィルムのパターニング）を行い、その特定の部分の領域に対応する部分のドライフィルムを開口する。これによって、上記の特定の部分が露出したレジス

IPR2026-00067
TSMC EX1002 Page 109

ト層３２が形成されたことになる。

【００５６】

次の工程では（図１０（ａ）参照）、レジスト層３２から露出しているシード層３１上に、当該シード層を給電層として電解Ｃｕめっきを施し、配線層１６ａを形成する。これによって、チップキャパシタ１の両側の電極上にそれぞれ配線層１６ａが形成され、この時点で、一方の側の配線層１６ａは、シード層３１を介してグランドプレーン（配線層１４ａ）に接続されたことになる。

【００５７】

次の工程では（図１０（ｂ）参照）、ドライフィルム３２を剥離除去し、さらに、露出している部分のシード層３１（Ｃｕ）を、ウエットエッチングにより除去する。

【００５８】

次の工程では（図１０（ｃ）参照）、樹脂層１５ａ、配線層１４ａ，１６ａ、及びチップキャパシタ１上に、図９（ｂ）の工程で行った処理と同様にして、層間絶縁層としての樹脂層１７ａを形成する。

【００５９】

次の工程では（図１０（ｄ）参照）、樹脂層１７ａの特定の位置（チップキャパシタ１の他方の電極上の配線層１６ａが形成されている部分に対応する位置）に、当該配線層１６ａに達するようにビアホールＶＨ１を形成する。例えば、樹脂層１７ａの対応する部分をＣＯ２ レーザ、ＵＶ－ＹＡＧレーザ等により除去することで、ビアホールＶＨ１を形成する。

【００６０】

最後の工程では（図１０（ｅ）参照）、ビアホールＶＨ１の内部を含めて樹脂層１７ａ上に、配線層１６ａを給電層として電解Ｃｕめっきを施し、セミアディティブ法により所要のパターン形状に電源プレーン（配線層１８ａ）を形成する。これによって、チップキャパシタ１の他方の電極が配線層１６ａ（シード層を含む）を介して電源プレーン（配線層１８ａ）に接続され、チップキャパシタ１の接続形態に係る部分ＣＰ１が作製されたことになる。

【００６１】

（第８の実施形態に係る当該部分ＣＰ２の製造工程：図１１及び図１２参照）

先ず最初の工程では（図１１（ａ）参照）、図９（ａ）の工程で行った処理と同様にして、コア基板１１上にグランドプレーン（配線層１４ａ）を形成する。

【００６２】

次の工程では（図１１（ｂ）参照）、図９（ｂ）の工程で行った処理と同様にして、パターン形成された配線層１４ａ上に層間絶縁層としての樹脂層１５ａを形成する。

【００６３】

次の工程では（図１１（ｃ）参照）、樹脂層１５ａの特定の位置（チップキャパシタ１の一方の電極の端部が位置する部分に対応する位置）に、配線層１４ａに達するようにビアホールＶＨ２を形成する。例えば、樹脂層１５ａの対応する部分をＣＯ２ レーザ、ＵＶ－ＹＡＧレーザ等により除去することで、ビアホールＶＨ２を形成する。

【００６４】

次の工程では（図１１（ｄ）参照）、チップキャパシタ１の一方の電極が、樹脂層１５ａに形成されたビアホールＶＨ２の開口領域を部分的に覆うようにして当該キャパシタ１を実装する。この場合、接着剤３０を樹脂層１５ａに貼り付けた後、その接着剤３０の位置に合わせて当該キャパシタ１を搭載するようにしてもよいし、又は、接着剤３０を当該キャパシタ１に貼り付けた後、その接着剤３０の付いたキャパシタ１を樹脂層１５ａ上に搭載するようにしてもよい。

【００６５】

次の工程では（図１１（ｅ）参照）、図９（ｅ）の工程で行った処理と同様にして、全面に、無電解Ｃｕめっきにより、シード層３３を厚さ１μｍ程度に形成する。

【００６６】

IPR2026-00067
TSMC EX1002 Page 110

次の工程では（図１１（ｆ）参照）、シード層３３によって覆われた配線層１４ａ、樹脂層１５ａ及びチップキャパシタ１のうち特定の部分が露出するように全面を覆ってめっきレジスト（レジスト層３４）を形成する。ここでいう「特定の部分」は、チップキャパシタ１の一方の電極がビアホールＶＨ２の開口領域を部分的に覆っている位置に対応する部分と、チップキャパシタ１の他方の電極の位置に対応する部分に相当する。レジスト層３４の形成は、図９（ｆ）の工程で行った処理と同様にして行うことができる。

【００６７】

次の工程では（図１２（ａ）参照）、図１０（ａ）の工程で行った処理と同様にして、レジスト層３４から露出しているシード層３３上に配線層１６ａを形成する。これによって、チップキャパシタ１の両側の電極上に配線層１６ａが形成され、この時点で、一方の側の配線層１６ａは、シード層３３を介してグランドプレーン（配線層１４ａ）に接続されたことになる。

【００６８】

次の工程では（図１２（ｂ）参照）、ドライフィルム３４を剥離除去し、さらに、露出している部分のシード層３３（Ｃｕ）を、ウエットエッチングにより除去する。

【００６９】

次の工程では（図１２（ｃ）参照）、樹脂層１５ａ、配線層１６ａ、及びチップキャパシタ１上に、図１１（ｂ）の工程で行った処理と同様にして、層間絶縁層としての樹脂層１７ａを形成する。

【００７０】

次の工程では（図１２（ｄ）参照）、図１０（ｄ）の工程で行った処理と同様にして、樹脂層１７ａの特定の位置（チップキャパシタ１の他方の電極上の配線層１６ａが形成されている部分に対応する位置）に、当該配線層１６ａに達するようにビアホールＶＨ３を形成する。

【００７１】

最後の工程では（図１２（ｅ）参照）、ビアホールＶＨ３の内部を含めて樹脂層１７ａ上に、配線層１６ａを給電層として電解Ｃｕめっきを施し、セミアディティブ法により所要のパターン形状に電源プレーン（配線層１８ａ）を形成する。これによって、チップキャパシタ１の他方の電極が配線層１６ａ（シード層を含む）を介して電源プレーン（配線層１８ａ）に接続され、チップキャパシタ１の接続形態に係る部分ＣＰ２が作製されたことになる。

【００７２】

図１３は、チップキャパシタを表面実装した場合と埋め込み実装した場合の各々のパッケージ構造について評価したときに得られたデータ（当該キャパシタのＥＳＬ）を対比させて示したものである。図示の例では、２種類のチップキャパシタＡ、Ｂ（Ａは３個、Ｂは２個）について、搭載する半導体素子との接続を考慮しないで、単に表面実装したらどうなるか、また埋め込み実装したらどうなるかを評価したときのデータを示している。埋め込み実装した場合については、チップキャパシタをグランドライン上に位置するように絶縁層中に埋め込み、当該キャパシタに電流を流したときにその電流の向きとグランドラインに流れる電流の向きが逆方向となるようにして、評価を行っている。チップキャパシタＡ，Ｂは容量が異なり、それぞれ１０ｎＦ、５ｎＦである。また、サイズは両方とも、縦（１．０ｍｍ）×横（０．５ｍｍ）×高さ（０．１ｍｍ）である。チップキャパシタＡについて、表面実装した場合のＥＳＬ（ｐＨ）は、平均値が２０９．０、最大値と平均値の差が３９．０、最小値と平均値の差が４６．０であり、埋め込み実装した場合のＥＳＬ（ｐＨ）は、平均値が８４．０、最大値と平均値の差が１２．３、最小値と平均値の差が１０．５であった。チップキャパシタＢについては、表面実装した場合のＥＳＬ（ｐＨ）は、平均値が１８９．５、最大値と平均値の差が１８．５、最小値と平均値の差が１８．５であり、埋め込み実装した場合のＥＳＬ（ｐＨ）は、平均値が１２８．５、最大値と平均値の差が４．５、最小値と平均値の差が４．５であった。ここで得られた知見を元に、実際の製品に適用したらどのようなパッケージ構造を実現できるかを案出したものが、上

IPR2026-00067
TSMC EX1002 Page 111

述した各実施形態（図１～図８）の構造である。

【００７３】

上述した各実施形態（図１～図８）では、電子部品としてのチップキャパシタを当該パッケージに表面実装した場合又は埋め込み実装した場合を例にとって説明したが、本発明の要旨からも明らかなように、キャパシタに相当する構造を当該パッケージの内部や表面に作り込むようにしてもよい。その場合の構成例を図１４に示す。

【００７４】

図１４に示す構成例では、第６の実施形態に係る半導体パッケージ１０ｅ（図６）において、チップキャパシタ１の代わりに、キャパシタに相当する構造（キャパシタ部分）を当該パッケージの内部に作り込んだ場合を示している。図示の構成において、キャパシタ部分は、一方の電極（下側電極）を構成する配線層１６ａと、他方の電極（上側電極）を構成する配線層１６ａと、上下各電極間に挟まれて形成された誘電体膜ＤＦとから構成されており、下側電極は電源プレーン（配線層１４ａ）に接続され、上側電極はグランドプレーン（配線層１８ａ）に接続されている。キャパシタを配線基板（パッケージ）内に作り込む方法については、従来より知られている各種の方法を用いることができる。その一例としては、例えば特開平６－２５２５２８号公報に記載されるように、配線層の一部である電極上に、スパッタリングや蒸着によりタンタルやアルミニウム等の膜を形成し、次いでこの膜を陽極酸化して、キャパシタの誘電体膜とする方法が知られている。

【００７５】

また、上述した各実施形態では、一つのパッケージに１個のキャパシタを表面実装した場合又は埋め込み実装した場合を例にとって説明したが、当該パッケージに搭載される半導体素子等に要求される機能に応じて適宜２個以上のキャパシタを表面実装又は埋め込み実装するようにしてもよい。あるいは、必要に応じてキャパシタの表面実装と埋め込み実装を併用するようにしてもよい。

【００７６】

また、図１～図３に示した各実施形態では、当該パッケージの半導体素子等が搭載される側と同じ面又はその反対側の面にキャパシタを表面実装した場合を例にとって説明したが、必要に応じて当該パッケージの両面にそれぞれ表面実装するようにしてもよい。

【００７７】

さらに、上述した各実施形態では、当該パッケージをマザーボード等に実装するための外部接続端子としてはんだバンプ２２を接合した場合を例にとって説明したが、外部接続端子の形態はこれに限定されないことはもちろんであり、例えば、ＰＧＡ等において用いられているようなピンの形態とすることも可能である。

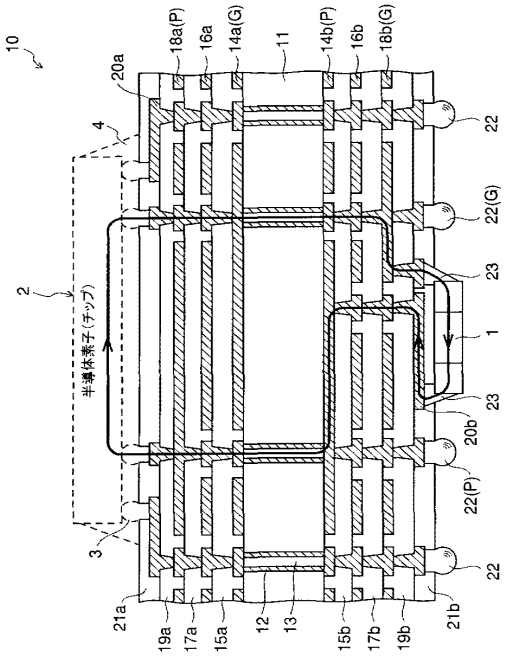
【符号の説明】

【００７８】

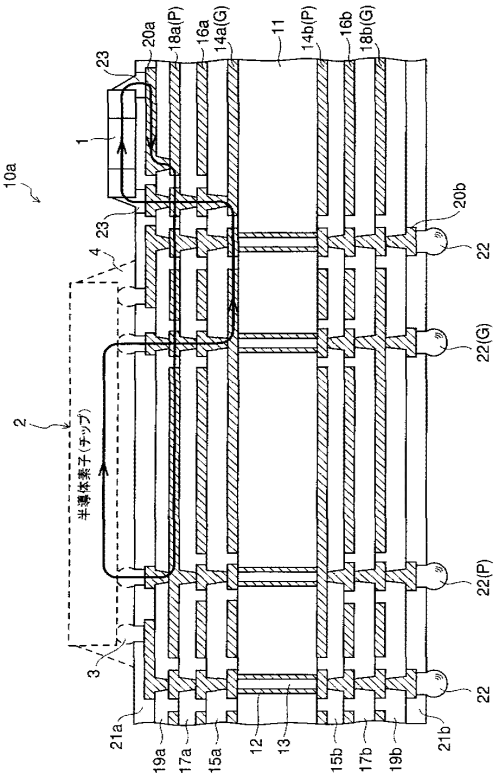
１…キャパシタ（チップキャパシタ）、
２…半導体素子（チップ）、
１０，１０ａ，１０ｂ，１０ｃ，１０ｄ，１０ｅ，１０ｆ，１０ｇ…キャパシタ実装配線基板（半導体パッケージ）、
１１…絶縁性基材（コア基板）、
１４ａ，１４ｂ，１６ａ，１６ｂ，１８ａ，１８ｂ，２０ａ，２０ｂ…配線層、
１５ａ，１５ｂ，１７ａ，１７ｂ，１９ａ，１９ｂ…層間絶縁層（樹脂層）、
２１ａ，２１ｂ…保護膜（ソルダレジスト層）、
２２…外部接続端子（はんだバンプ）、
２３…はんだ、
ＲＰ…凹部（キャビティ）、
ＶＨ１，ＶＨ２，ＶＨ３…ビアホール。

IPR2026-00067
TSMC EX1002 Page 112

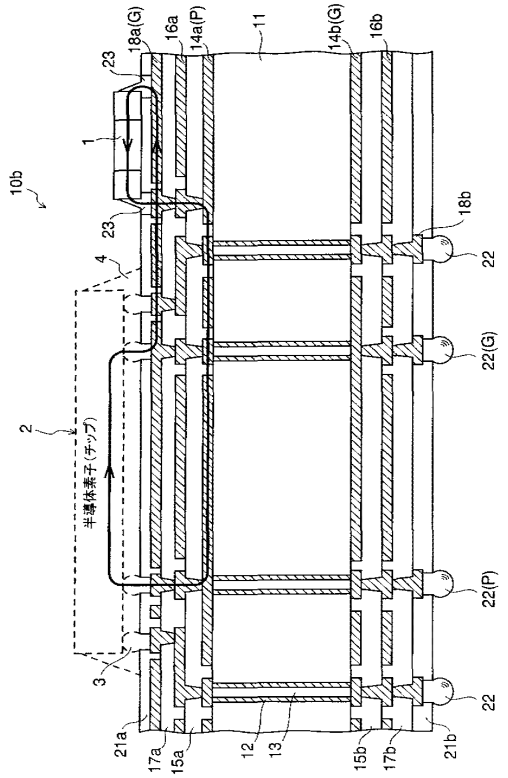
【図１】


10
20a
18a(P)
16a
14a(G)
11
14b(P)
16b
18b(G)
4
22
22(G)
23
2
半導体素子（チップ）
1
23
20b
22(P)
3
22
21a
19a
17a
15a
12
13
15b
17b
19b
21b

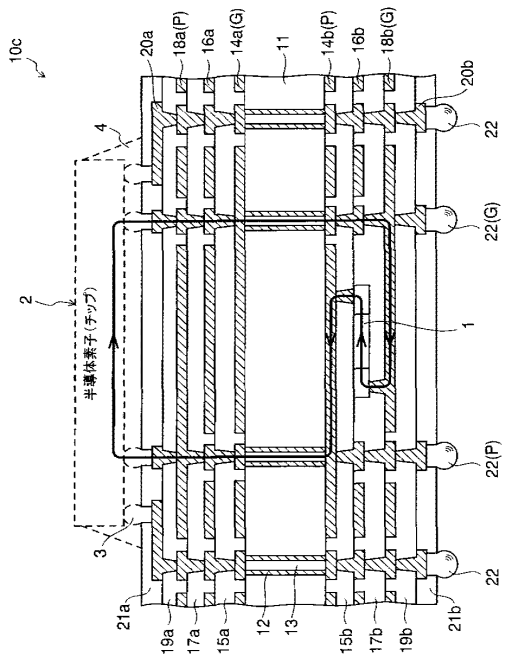
【図２】


10a
23
20a
18a(P)
16a
14a(G)
11
14b(P)
16b
18b(G)
1
20b
22
4
23
22(G)
2
半導体素子（チップ）
22(P)
3
22
21a
19a
17a
15a
12
13
15b
17b
19b
21b

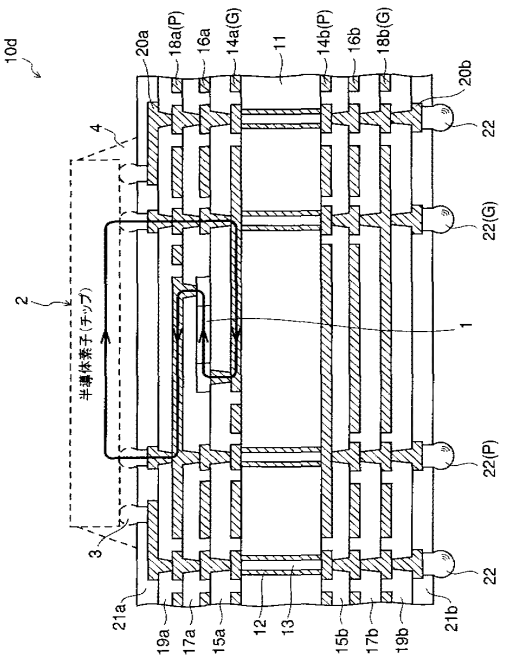
【図３】


10b
23
18a(G)
16a
14a(P)
11
14b(G)
16b
1
18b
23
22
4
22(G)
2
半導体素子（チップ）
22(P)
3
22
21a
17a
15a
12
13
15b
17b
21b

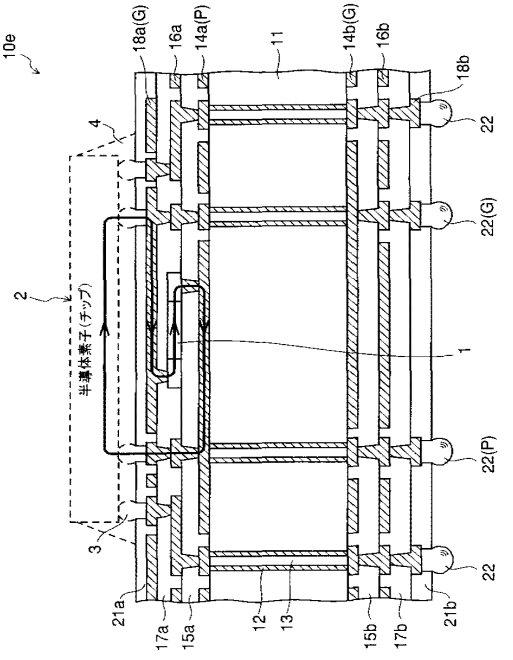
【図４】


10c
20a
18a(P)
16a
14a(G)
11
14b(P)
16b
18b(G)
20b
22
4
22(G)
2
半導体素子（チップ）
1
22(P)
3
22
21a
19a
17a
15a
12
13
15b
17b
19b
21b

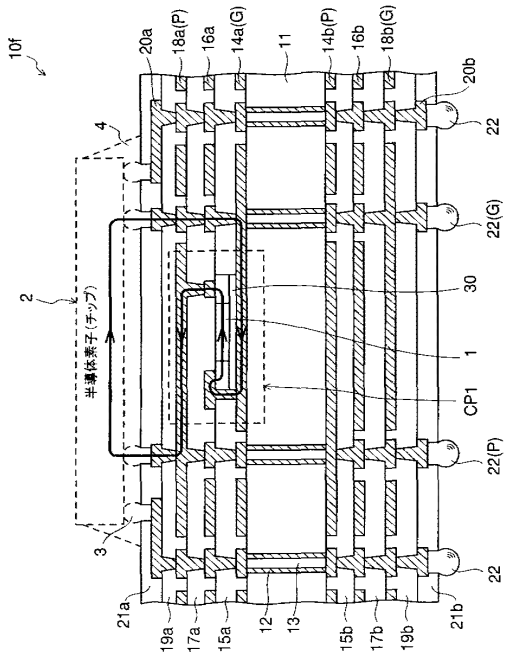
【図５】


10d
20a
18a(P)
16a
14a(G)
11
14b(P)
16b
18b(G)
20b
22
4
22(G)
2
半導体素子(チップ)
1
22(P)
3
22
21a
19a
17a
15a
12
13
15b
17b
19b
21b

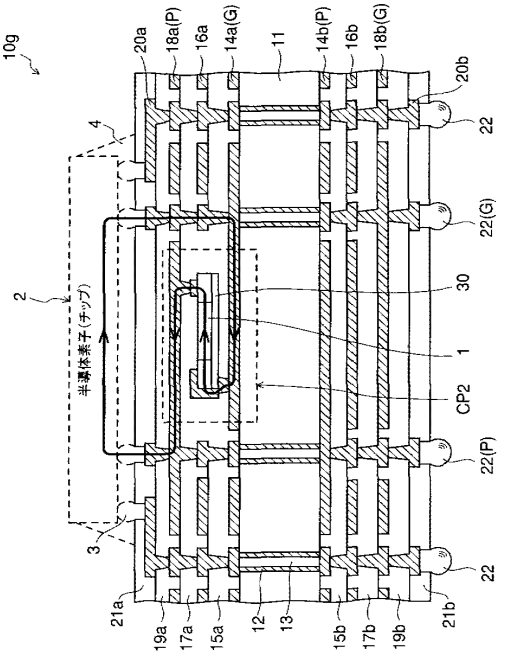
【図６】


10e
18a(G)
16a
14a(P)
11
14b(G)
16b
18b
22
4
22(G)
2
半導体素子(チップ)
1
22(P)
3
22
21a
17a
15a
12
13
15b
17b
21b

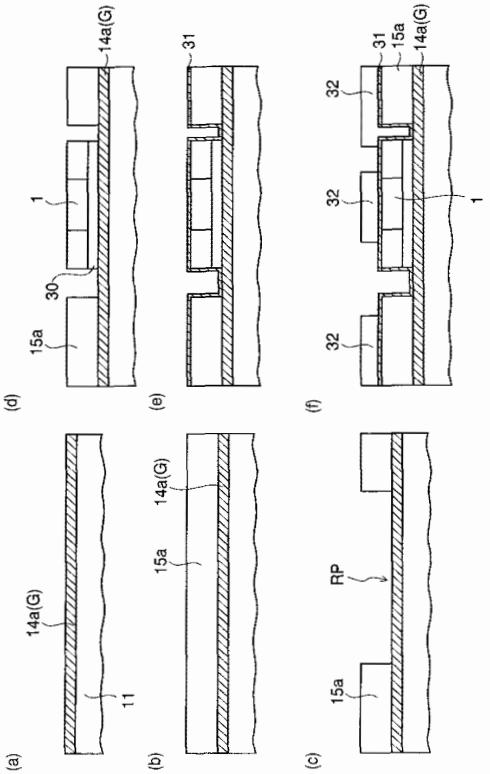
【図７】


10f
20a
18a(P)
16a
14a(G)
11
14b(P)
16b
18b(G)
20b
22
4
22(G)
2
半導体素子(チップ)
30
1
CP1
22(P)
3
22
21a
19a
17a
15a
12
13
15b
17b
19b
21b

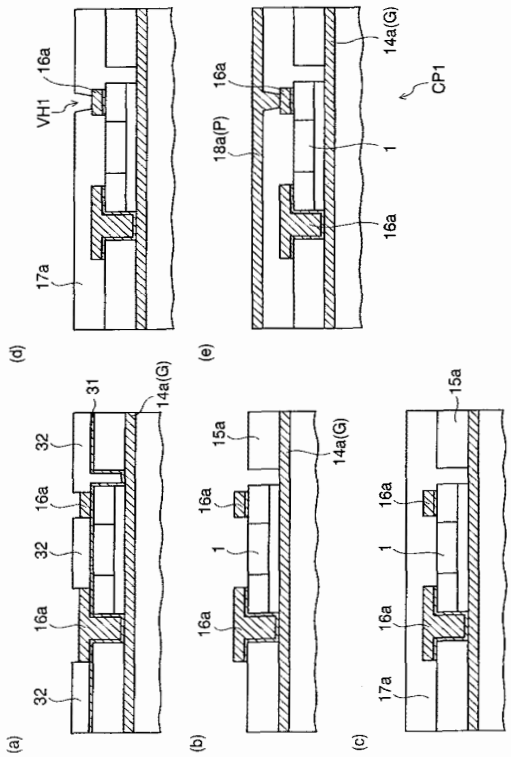
【図８】


10g
20a
18a(P)
16a
14a(G)
11
14b(P)
16b
18b(G)
20b
22
4
22(G)
2
半導体素子(チップ)
30
1
CP2
22(P)
3
22
21a
19a
17a
15a
12
13
15b
17b
19b
21b

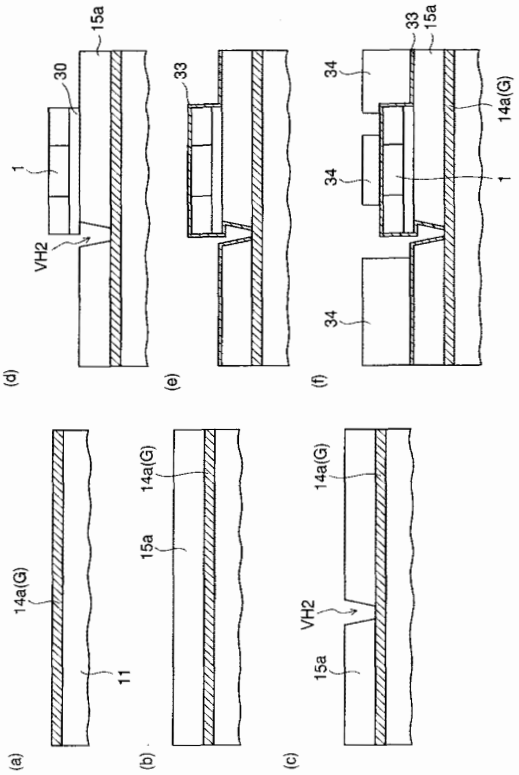
【図９】



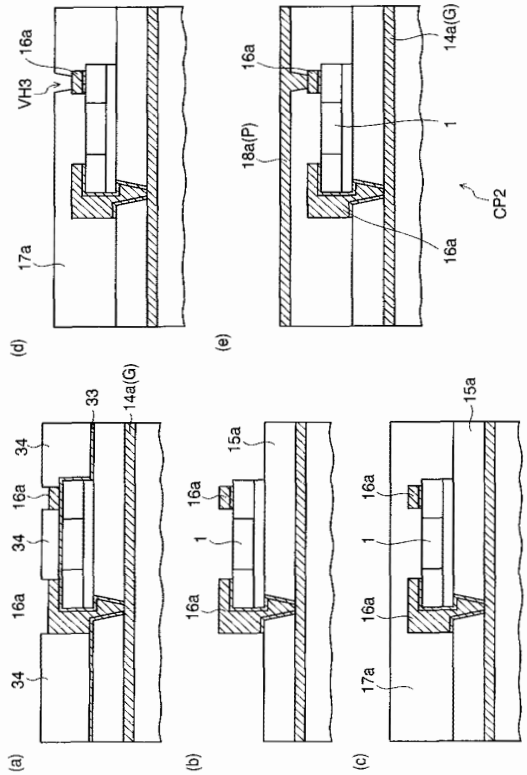

【図１０】



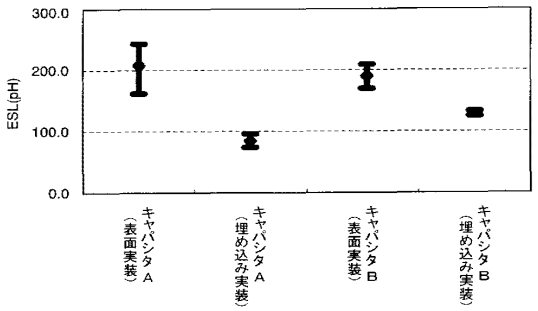

【図１１】



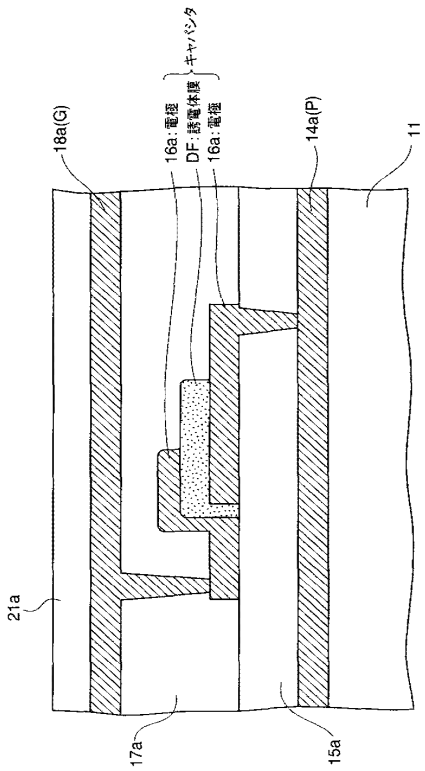

【図１２】



【図１３】


300.0
200.0
100.0
0.0
ESL(pH)
キャパシタA（表面実装）
キャパシタA（埋め込み実装）
キャパシタB（表面実装）
キャパシタB（埋め込み実装）

【図１４】


18a(G)
16a:電極
DF:誘電体層
16a:電極
キャパシタ
14a(P)
11
21a
17a
15a

フロントページの続き

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Ｆターム(参考) 5E346 AA12 AA15 AA35 AA43 BB01 BB11 BB20 CC08 CC32 EE31
FF45 HH01

| Electronic Patent Application Fee Transmittal | | | | |
|---|---|---|---|---|
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| **Filing Date:** | | | | |
| **Title of Invention:** | CHIP PACKAGE | | | |
| **First Named Inventor/Applicant Name:** | Ping-Jung Yang | | | |
| **Filer:** | Ping-Jung. Yang | | | |
| **Attorney Docket Number:** | Mars16-001-US-C03 | | | |
| Filed as Small Entity | | | | |
| **Filing Fees for Utility under 35 USC 111(a)** | | | | |
| **Description** | **Fee Code** | **Quantity** | **Amount** | **Sub-Total in USD($)** |
| **Basic Filing:** | | | | |
| UTILITY FILING FEE (ELECTRONIC FILING) | 4011 | 1 | 80 | 80 |
| UTILITY SEARCH FEE | 2111 | 1 | 350 | 350 |
| UTILITY EXAMINATION FEE | 2311 | 1 | 400 | 400 |
| **Pages:** | | | | |
| **Claims:** | | | | |
| **Miscellaneous-Filing:** | | | | |
| **Petition:** | | | | |
| **Patent-Appeals-and-Interference:** | | | | |

| Description | Fee Code | Quantity | Amount | Sub-Total in USD($) |
|---|---|---|---|---|
| **Post-Allowance-and-Post-Issuance:** | | | | |
| **Extension-of-Time:** | | | | |
| **Miscellaneous:** | | | | |
| | | **Total in USD ($)** | | **830** |

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| **EFS ID:** | 47011710 |
| **Application Number:** | 17985827 |
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| **Confirmation Number:** | 1762 |
| **Title of Invention:** | CHIP PACKAGE |
| **First Named Inventor/Applicant Name:** | Ping-Jung Yang |
| **Customer Number:** | 102851 |
| **Filer:** | Ping-Jung. Yang |
| **Filer Authorized By:** | |
| **Attorney Docket Number:** | Mars16-001-US-C03 |
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| **Time Stamp:** | 10:24:09 |
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| Authorized User | |
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| Document Number | Document Description | File Name | File Size(Bytes)/ Message Digest | Multi Part /.zip | Pages (if appl.) |
|---|---|---|---|---|---|
| 1 | | Mars-16-001-US-C03-SPEC-11122022.pdf | 314116<br>8d8fed493475d616ab6295a8f8421027b27f0aa1 | yes | 46 |
| | **Multipart Description/PDF files in .zip description** | | | | |
| | **Document Description** | | **Start** | **End** | |
| | Specification | | 1 | 40 | |
| | Claims | | 41 | 45 | |
| | Abstract | | 46 | 46 | |
| **Warnings:** | | | | | |
| **Information:** | | | | | |
| 2 | Drawings-only black and white line drawings | Mars-16-001-US-C02-drawings-07082021.pdf | 8121130<br>4ef9e4f7b1acfdb5d884b9a1c3a3e1429130a4ac | no | 64 |
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| 3 | Application Data Sheet | Mars16-001-US-C03-ADS-11120222.pdf | 1561746<br>f767c45789b8fee789e0947fff406edccb93408a | no | 7 |
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| 4 | Oath or Declaration filed | Mars-16-001-US-C03-DECLARATION-11122022.pdf | 983857<br>bf16f09a6f4e374d3b28cf2c0c3e6fd8378d4173 | no | 2 |
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| **Information:** | | | | | |
| 5 | Information Disclosure Statement (IDS) Form (SB08) | Mars16-001-C03-IDS-11122022.pdf | 616099<br>b8804344b9558bf73a219849626d751f269d046b | no | 17 |

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| 6 | Foreign Reference | EP1026744A1.pdf | 328917<br>cb6e554fbaee112c93380d14f08c7de579d2a0b6 | no | 13 |
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| 7 | Foreign Reference | WO2013138452.pdf | 3880918<br>9f62132f9733d2fabeccec10fe48aa8b9e86213f | no | 69 |
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| 8 | Foreign Reference | JP2009170941A.pdf | 7419563<br>dcf77a1fea3380bea6394b2f40c1b45d5e990e9b | no | 18 |
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**If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.**
**National Stage of an International Application under 35 U.S.C. 371**
**If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.**
**New International Application Filed with the USPTO as a Receiving Office**
**If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.**

Mars 16-001-US-C03

# CHIP PACKAGE

**[0001]** This patent application is a continuation of application No. 17372459, filed July 11, 2021, now pending, which is a continuation of application No. 16752650, filed Jan. 26, 2020, now patent No. 11107768, which is a continuation of application No. 15261956, filed Sept. 11, 2016, now patent No. 10622310, which claims priority benefits from U.S. provisional patent application No. 62/219249, filed Sept. 16, 2015. This patent application of application No. 15261956 is a continuation-in-part of application No. 14/036256, filed Sept. 25, 2013, now patent No. 9615453, which claims the benefit of priority from U.S. provisional patent application No. 61/705,649, filed Sept. 26, 2012, all of which is incorporated herein by reference in their entirety.

## BACKGROUND OF THE DISCLOSURE

### Field of the Disclosure

**[0002]** The patent disclosure a method and structure to manufacture a glass substrate, and disclosed embodiments relate to one or more chip building a system on the glass substrate.

### Brief Description of the Related Art

**[0003]** As is well known, microelectronic devices have a tendency to be minimized and thinned with its functional development and a semiconductor package mounted on a mother board is also



IPR2026-00067
TSMC EX1002 Page 123

following the tendency in order to realize a mounting of high integration.

**[0004]** When the geometric dimensions of the Integrated Circuits are scaled down, the cost per die is decreased while some aspects of performance are improved. The metal connections which connect the Integrated Circuit to other circuit or system components become of relative more importance and have, with the further miniaturization of the IC, an increasingly negative impact on the circuit performance. The parasitic capacitance and resistance of the metal interconnections increase, which degrades the chip performance significantly. Of most concern in this respect is the voltage drop along the power and ground buses and the RC delay of the critical signal paths. Attempts to reduce the resistance by using wider metal lines result in higher capacitance of these wires.

**[0005]** To solve this problem, the approach has been taken to develop low resistance metal (such as copper) for the wires while low dielectric materials are used in between signal lines.

**[0006]** Increased Input-Output (IO) combined with increased demands for high performance, and then IC's has led to the development of flip-chip Packages. Flip-chip technology fabricates bumps (typically Pb/Sn solders) on Al pads of chip and interconnects the bumps directly to the package media, which are usually ceramic or plastic based. The flip-chip is bonded face down to the package medium through the shortest path. These technologies can be applied not only to single-chip packaging, but also to higher or integrated levels of packaging in which the packages are larger and to more sophisticated substrates that accommodate several chips to form larger functional units.

**[0007]** The flip-chip technique, using an area array, has the advantage of achieving the highest density of interconnection to the device and a very low inductance interconnection to the package. However, pre-testability, post-bonding visual inspection, and TCE (Temperature Coefficient of Expansion) matching to avoid solder bump fatigue are still challenges.



IPR2026-00067
TSMC EX1002 Page 124

**[0008]** Glass can be used as an interposer to bridge between one or more IC chips and a printed circuit board. In many respects, when used as an interposer / substrate and without the requirement for active devices, glass can be a good substitute for a silicon interposer. The advantages of glass in comparison to silicon as an interposer lie in its much lower material cost. Glass also has a CTE closely matched to silicon, so that reliability of interconnects, especially micro-bonds, can be expected to be quite good. Glass has some disadvantages in comparison to silicon – notably its lower thermal conductivity and the difficulty in forming Through Glass Vias (TGV's). Both of these topics are discussed elsewhere in this patent.

## SUMMARY OF THE DISCLOSURE

**[0009]** Embodiments of the present disclosure provide A display device comprises a display panel substrate and a glass substrate over said display panel substrate, wherein said display panel substrate comprises multiple contact pads, a display area, a first boundary, a second boundary, a third boundary and a fourth boundary, wherein said display area comprises a first edge, a second edge, a third edge and a fourth edge, wherein said first boundary is parallel to said third boundary and said first and third edges, wherein said second boundary is parallel to said fourth boundary and said second and fourth edges, wherein a first least distance between said first boundary and said first edge, wherein a second least distance between said second boundary and said second edge, a third least distance between said third boundary and said third edge, a fourth distance between said fourth boundary and said fourth edge, and wherein said first, second, third and fourth least distances are smaller than 100 micrometers, and wherein said glass substrate comprising multiple metal conductors through in said glass substrate and multiple metal bumps are between said glass substrate and said display panel substrate, wherein said one of said metal conductors is connected to one of said contact pads through one of said metal bumps.



IPR2026-00067
TSMC EX1002 Page 125

**[0010]** These, as well as other components, steps, features, benefits, and advantages of the present disclosure, will now become clear from a review of the following detailed description of illustrative embodiments, the accompanying drawings, and the claims.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0011]** The drawings disclose illustrative embodiments. They do not set forth all embodiments. Other embodiments may be used in addition or instead. Details that may be apparent or unnecessary may be omitted to save space or for more effective illustration. Conversely, some embodiments may be practiced without all of the details that are disclosed. When the same numeral appears in different drawings, it refers to the same or like components or steps.

**[0012]** Aspects of the disclosure may be more fully understood from the following description when read together with the accompanying drawings, which are to be regarded as illustrative in nature, and not as limiting. The drawings are not necessarily to scale, emphasis instead being placed on the principles of the disclosure.

**[0013]** Figs. 1 illustrates a three-dimensional view of a X-axis nets and a Y-axis nets, in accordance with the present disclosure.

**[0014]** Fig. 2 illustrates a cross-section view of the X-axis nets and the Y-axis nets, in accordance with the present disclosure.

**[0015]** Fig. 3 illustrates a cross-section view of the Z-axis traces crossed to the X-axis nets and the Y-axis nets, in accordance with the present disclosure.

**[0016]** Fig. 4 illustrates a three-dimensional view of the Z-axis traces, X-axis nets and the Y-axis nets, in accordance with the present disclosure.



IPR2026-00067
TSMC EX1002 Page 126

**[0017]** Figs. 5a-5i illustrate the shape and structure of the Z-axis traces, in accordance with the present disclosure.

**[0018]** Figs. 6a-6j illustrate a 1st process of forming a glass substrate, in accordance with the present disclosure.

**[0019]** Figs. 6k-6n illustrate a top views of the 1st process of forming the glass substrate, in accordance with the present disclosure.

**[0020]** Figs. 7a-7o illustrate a 2nd process of forming the glass substrate, in accordance with the present disclosure.

**[0021]** Figs. 7p-7r illustrate a top views of the 2nd process of forming the glass substrate, in accordance with the present disclosure.

**[0022]** Figs. 8a-8d illustrate cross-section views of the glass substrate and the metal plug, in accordance with the present disclosure.

**[0023]** Figs. 9a-9s illustrate a process to form multiple traces on a top surface and a bottom surface of the glass substrate, in accordance with the present disclosure.

**[0024]** Figs. 9t-9u illustrate cross-section views of multiple chips formed on the glass substrate, in accordance with the present disclosure.

**[0025]** Fig. 9v illustrates a cross-section view of the metal bump, in accordance with the present disclosure.

**[0026]** Fig. 9w illustrates a cross-section view of multiple chips formed on a top surface and bottom surface of the glass substrate, in accordance with the present disclosure.



IPR2026-00067
TSMC EX1002 Page 127

**[0027]** Fig. 9x illustrates a cross-section view of multiple chips and a 3D-IC package formed on a top surface and bottom surface of the glass substrate, in accordance with the present disclosure.

**[0028]** Fig. 9y illustrates a top views of the multiple chips on the glass substrate, in accordance with the present disclosure.

**[0029]** Figs. 10a-10j illustrate a damascene process to form the metal layer on the glass substrate, in accordance with the present disclosure.

**[0030]** Figs. 11a-11i illustrate an embossing process to form the metal layer on the glass substrate, in accordance with the present disclosure.

**[0031]** Fig. 12 illustrates a cross-section view of the glass substrate of the first application formed on an OLED display substrate, in accordance with the present disclosure.

**[0032]** Fig. 13 illustrates a cross-section view of the glass substrate of the second application formed on a MEMs display substrate, in accordance with the present disclosure.

**[0033]** Fig. 14 illustrates a cross-section view of the glass substrate of the third application formed on a LCD display substrate, in accordance with the present disclosure.

**[0034]** Fig. 15 illustrates a cross-section view of the glass substrate of the fourth application formed on an another LCD display substrate, in accordance with the present disclosure.

**[0035]** Fig. 16 illustrates a cross-section view of the glass substrate of the fifth application formed on an OLED display substrate, in accordance with the present disclosure.

**[0036]** Fig. 17a illustrates a cross-section view of the glass substrate of the sixth application formed on an OLED display substrate, in accordance with the present disclosure.



IPR2026-00067
TSMC EX1002 Page 128

**[0037]** Fig. 17b illustrates a cross-section view of the structure of the OLED display substrate, in accordance with the present disclosure.

**[0038]** Fig. 18 illustrates a three-dimensional view of the display device, in accordance with the present disclosure.

**[0039]** Fig. 19 illustrates a big display device combined from multiple display device, in accordance with the present disclosure.

**[0040]** While certain embodiments are depicted in the drawings, one skilled in the art will appreciate that the embodiments depicted are illustrative and that variations of those shown, as well as other embodiments described herein, may be envisioned and practiced within the scope of the present disclosure.

## DETAILED DESCRIPTION OF THE DISCLOSURE

**[0041]** Fig. 1 illustrates a three-dimensional view of a net 2, 4, wherein the net 4 is under the net 2, wherein the net 2 comprises multiple Y-axis traces 2a and multiple X-axis traces 2b under the Y-axis traces 2a, and wherein the net 4 comprises multiple Y-axis traces 4a and multiple X-axis traces 4b under the Y-axis traces 4a. Multiple gaps 3and 5 are formed in the net 2 and 4. Each of the traces 2a, 2b, 4a and 4b is easily moved to change the size of gaps 3 and gaps 5. The diameter (or width) of traces 2a, 2b, 4a and 4b are the same, such as between 10 and 30 micrometers, between 20 and 100 micrometers, between 40 and 150 micrometers, between 50 and 200 micrometers, between 200 and 1000 micrometers or between 500 and 10000 micrometers. The traces 2a, 2b, 4a and 4b may be metal traces or polymer traces, such as copper traces, copper-gold alloy traces, copper-gold-palladium alloy traces, copper-gold-silver alloy traces, copper-platinum alloy traces, copper-iron alloy traces, copper-nickel alloy traces, copper-tungsten traces, tungsten traces, brass wires, zinc



IPR2026-00067
TSMC EX1002 Page 129

plated brass wires, stainless wires, nickel plated stainless wires, phosphor bronze wires, copper plated the aluminum wires, aluminum traces, phenolic resin traces, epoxy resin traces, melamine-formaldehyde resin traces or polysiloxanes resin traces. The cross-section shape of traces 2a, 2b, 4a and 4b may be a circular shape, a Square shape, an oblong shape, a rectangle shape or a flat shape.

**[0042]** Fig. 2 illustrates a cross-section view of the net 2 and the net 4. The gaps 3 and gaps 5 are aligned with each other.

**[0043]** Next, referring to Fig. 3, multiple metal traces 6 are crossed the net 2 and the net 4 through the gaps 3 and gaps 5. The diameter (or width) of metal traces 6 is between 10 and 30 micrometers, between 20 and 100 micrometers, between 40 and 150 micrometers, between 50 and 200 micrometers, between 200 and 1000 micrometers or between 500 and 10000 micrometers. The traces 6 may be metal traces, such as copper traces, copper-gold alloy traces, copper-gold-palladium alloy traces, copper-gold-silver alloy traces, copper-platinum alloy traces, copper-iron alloy traces, copper-nickel alloy traces, copper-tungsten traces, tungsten traces, brass wires, zinc plated brass wires, stainless wires, nickel plated stainless wires, phosphor bronze wires, copper plated the aluminum wires, aluminum traces, titanium-containing layer plated the copper wires, tantalum-containing layer plated the copper wires. The cross-section shape of traces 6 may be a circular shape, a square shape, an oblong shape, a rectangle shape or a flat shape. The diameter (or width) of traces 6 may be the same with the traces 2a, 2b, 4a and 4b or different with the traces 2a, 2b, 4a and 4b.

**[0044]** Furthermore, we proposed the material of the traces 6 is copper-tungsten alloy, wherein the copper in the copper-tungsten alloy is 50 percent and the tungsten in the copper-tungsten alloy is 50 percent, the copper in the copper-tungsten alloy is 60 percent and the tungsten in the copper-tungsten alloy is 40 percent, the copper in the copper-tungsten alloy is 70 percent and the tungsten in the copper-tungsten alloy is 30 percent, the copper in the copper-tungsten alloy is 80 percent and the



IPR2026-00067
TSMC EX1002 Page 130

tungsten in the copper-tungsten alloy is 20 percent, the copper in the copper-tungsten alloy is 90 percent and the tungsten in the copper-tungsten alloy is 10 percent, the copper in the copper-tungsten alloy is 40 percent and the tungsten in the copper-tungsten alloy is 60 percent, the copper in the copper-tungsten alloy is 30 percent and the tungsten in the copper-tungsten alloy is 70 percent.

**[0045]** Fig. 4 illustrates a three-dimensional view of a net 2, 4 and traces 6.

**[0046]** Fig. 5a-5i illustrate the shape and structure of the traces 6. In Fig. 5a, the cross-section shape of traces 6 is a circular shape. In Fig. 5d, the cross-section shape of traces 6 is a square shape. In Fig. 5g, the cross-section shape of traces 6 is a rectangle shape. In Fig. 5b, the cross-section shape of traces 6 is a circular shape and a first covering layer 6a is cover on the traces 6, wherein the first covering layer 6a may be a metal layer, such as a nickel-containing layer, a zinc-containing layer, a titanium-containing layer, a tantalum-containing layer, a silver-containing layer, a chromium-containing layer and wherein the first covering layer 6a may be an anti-oxidation layer, such as an oxide-containing layer. In Fig. 5e, the cross-section shape of traces 6 is a square shape and a first covering layer 6a is cover on the traces 6, wherein the first covering layer 6a may be a metal layer, such as a nickel-containing layer, a zinc-containing layer, a titanium-containing layer, a tantalum-containing layer, a silver-containing layer, a chromium-containing layer and wherein the first covering layer 6a may be an anti-oxidation layer, such as an oxide-containing layer. In Fig. 5h, the cross-section shape of traces 6 is a rectangle shape and a first covering layer 6a is cover on the traces 6, wherein the first covering layer 6a may be a metal layer, such as a nickel-containing layer, a zinc-containing layer, a titanium-containing layer, a tantalum-containing layer, a silver-containing layer, a chromium-containing layer and wherein the first covering layer 6a may be an anti-oxidation layer, such as an oxide-containing layer. In Fig. 5c, the cross-section shape of traces 6 is a circular shape and a second covering layer 6b is cover on the first covering layer 6a, wherein the second covering layer 6b may be an adhesion layer, such as a nickel-containing layer, a zinc-containing layer, a



IPR2026-00067
TSMC EX1002 Page 131

titanium-containing layer, a tantalum-containing layer, a silver-containing layer, a chromium-containing layer and wherein the first covering layer 6a may be an anti-oxidation layer, such as an oxide-containing layer. In Fig. 5f, the cross-section shape of traces 6 is a square shape and a second covering layer 6b is cover on the first covering layer 6a, wherein the second covering layer 6b may be an adhesion layer, such as a nickel-containing layer, a zinc-containing layer, a titanium-containing layer, a tantalum-containing layer, a silver-containing layer, a chromium-containing layer and wherein the first covering layer 6a may be an anti-oxidation layer, such as an oxide-containing layer. In Fig. 5i, the cross-section shape of traces 6 is an oblong shape and a second covering layer 6b is cover on the first covering layer 6a, wherein the second covering layer 6b may be an adhesion layer, such as a nickel-containing layer, a zinc-containing layer, a titanium-containing layer, a tantalum-containing layer, a silver-containing layer, a chromium-containing layer and wherein the first covering layer 6a may be an anti-oxidation layer, such as an oxide-containing layer.

**[0047]** Next, Figs. 6a-6j are illustrated a 1st process of forming a glass substrate of the invention. Please referring to Fig. 6a, the traces 6 are stretched to a suitable length L1, e.g., smaller than 5 meters, such as between 0.5 and 1 meter, or between 1 and 3 meters. At the same time, the net 4 is moved down to a suitable location. The pitch t1 between the traces 2a, 2b, 4a, 4b is greater than the diameter (or width) of traces 6.

**[0048]** Next, referring to Fig. 6b, the traces 2a, 2b, 4a and 4b are moved to change the pitch t1 to a pitch t2, then the traces 6 are closed up to a pitch t3. The pitch t3 substantially the same with the diameter (or width) of the traces 2a, 2b, 4a and 4b, such as between 5 and 20 micrometers, between 20 and 50 micrometers, between 30 and 80 micrometers, between 20 and 100 micrometers, between 40 and 150 micrometers, between 50 and 200 micrometers, between 200 and 1000 micrometers or between 500 and 10000 micrometers. At the same time, maybe applied a force to stretch the traces 6, 2a, 2b, 4a and 4b and make the traces 6 keep strength and keep the pitch t3 fixed.



IPR2026-00067
TSMC EX1002 Page 132

**[0049]** Next, referring to Fig. 6c, a thermal resistance layer 8 is formed on surfaces of the net 4. The thermal resistance layer 8 may be a polymer layer, such as a thermosetting resin, phenolic resin, epoxy resin, melamine-formaldehyde resin, polysiloxanes resin, plaster layer, wherein the thermal resistance layer 8 has a heat deflection temperature between 400 and 900 ℃. When a liquid thermal resistance layer 8 formed on the net 4 and the thermal resistance layer 8 permeated the net 4 through the gaps 5, wherein the thermal resistance layer 8 covers the gaps 5 between traces 4a, traces 4b and traces 6, then curing the thermal resistance layer 8. The thermal resistance layer 8 has a thickness between 0.05 and 1 meter.

**[0050]** Next, referring to Fig. 6d, a mold 10 is provided between the net 2 and the net 4, wherein the mold 10 surrounds the traces 6 and on the thermal resistance layer 8. The mold 10 is held up by a machine or a device. The mold 10 may be a metal mold, a ceramics mold or a polymer mold, which has a heat deflection temperature between 400 ℃ and 900 ℃ or between 800 ℃ and 1300 ℃.

**[0051]** Next, referring to Fig. 6e, a fixed layer 12 is formed on the thermal resistance layer 8, wherein the fixed layer 12 may be a glass layer or a polymer layer. When the material of the fixed layer 12 is glass, the fixed layer 12 is a high temperature liquid to form on the thermal resistance layer 8, and then the fixed layer 12 down to a suitable temperature becomes a solid state. The fixed layer 12 has a thickness between 0.01 and 1 meter. The bottom of traces 6 is fixed by the fixed layer 12.

**[0052]** Next, referring to Fig. 6f, the traces 6 under the net 4 are cut. A tank 14 carries the mold 10, net 4 and the fixed layer 12.

**[0053]** Next, referring to Fig. 6g, a glass layer (liquid form) 16 is formed on the fixed layer 12. The glass layer 16 is a high temperature liquid to form on the fixed layer 12 and fill in the mold 10, and then the glass layer 16 down to a suitable temperature becomes a solid state, wherein the glass



IPR2026-00067
TSMC EX1002 Page 133

layer 16 has a glass transition temperature between 300°C and 900°C, between 500°C and 800°C, between 900°C and 1200°C or between 1000°C and 1800°C. The glass layer 16 is a low melting point glass material, wherein the glass layer 16 has a melting point between 300°C and 900°C, 800°C and 1300°C, between 900°C and 1600°C, between 1000°C and 1850°C, or between 1000°C and 2000°C, wherein the melting point may smaller than 1500°C. The glass layer 16 has a thickness greater than 0.5 meters or greater than 0.1 meter. Furthermore, there is a few bubbles or no bubble in glass layer 16, for example, there is zero to 3 bubbles in one cubic meter of the glass layer 16, 1 to 10 bubbles in one cubic meter of the glass layer 16, 5 to 30 bubbles in one cubic meter of the glass layer 16 or 20 to 60 bubbles in one cubic meter of the glass layer 16, wherein the bubble has a diameter between 0.0001 and 0.001 centimeters, between 0.001 and 0.05 centimeters, between 0.05 and 0.1 centimeters or between 0.05 and 0.5 centimeters. The glass layer 16 may be removed bubbles through multiple processes of a laminating process, a squeezing process and a heating process.

**[0054]** The glass layer 16 refers to an amorphous solid. The material of the glass layer 16 may be included soda-lime glass, boro-silicate glass, alumo-silicate glass, fluoride glasses, phosphate glasses or chalcogen glasses. For example, the composition of the soda-lime glass comprises $SiO_2$ (74%), $Na_2O$ (13%), CaO (10.5%), $Al_2O_3$ (1.3%), $K_2O$ (0.3%), SO3 (0.2%), MgO (0.2%), Fe2O3 (0.04%), TiO2 (0.01%), the composition of the boro-silicate glass comprises $SiO_2$ (81%), $B_2O_3$ (12%), $Na_2O$ (4.5%), $Al_2O_3$ (2.0%), the composition of the phosphate glasses comprises a percentage of the $P_2O_5$ material between 3% and 10% or between 5% and 20%.

**[0055]** A glass, once formed into a solid body, is capable of being softened and perhaps remitted into a liquid form. The "glass transition temperature" of a glass material is a temperature below which the physical properties of the glass are similar to those of a solid and above which the glass material behaves like a liquid.



IPR2026-00067
TSMC EX1002 Page 134

**[0056]** If a glass is sufficiently below the glass transition temperature, molecules of the glass may have little relative mobility. As a glass approaches the glass transition temperature, the glass may begin to soften and with increasing temperature, the glass will ultimately melt into the liquid state. Thus, a glass body may be softened to an extent sufficient to enable manipulation of the body's shape, allowing for the formation of holes or other features in the glass body. Once the desired form is obtained, glass is usually annealed for the removal of stresses. Surface treatments, coatings or lamination may follow to improve the chemical durability (glass container coatings, glass container internal treatment), strength (toughened glass, bulletproof glass, windshields), or optical properties (insulated glazing, anti-reflective coating).

**[0057]** Furthermore, the glass layer 16 may be replaced by a polymer layer. When the polymer layer cured to a solid state, then the polymer layer has a coefficient of expansion between 3 and 10 ppm/°C.

**[0058]** Next, referring to Fig. 6h, the mold 10 and the tank 14 are removed and cut the traces 6 from net 2.

**[0059]** Next, referring to Fig. 6i, the net 4 and the thermal resistance layer 8 are removed, and then a column 25 is produced.

**[0060]** Next, referring to Fig. 6j, the traces 6 out of the column 25 are removed and cutting the column 25 to produce multiple first substrates 20, wherein the first substrate 20 has a thickness between 20 and 100 micrometers, between 50 and 150 micrometers, between 100 and 300 micrometers or between 150 and 2000 micrometers or greater than 1000 micrometers. The first substrates 20 may be made a planarization process using a suitable process, such as a chemical mechanical polishing (CMP) procedure, mechanical grinding, or laser drilling



IPR2026-00067
TSMC EX1002 Page 135

**[0061]** Next, referring to Fig. 6k, the first substrate 20 comprises multiple second substrates 22. The second substrates 22 are well-regulated an array in the first substrate 20. Each of the second substrates22 has multiple metal plugs 21, wherein the metal plug 21 is formed from metal traces 6. The metal plug 21 has the same material and structure with metal trace 6.

**[0062]** Next, referring to Figs. 6l-6n, the metal plugs 21 may be arranged in different types, such as Fig. 6l, the metal plugs 21 are arranged on the side portions of the second substrate 22, or such as Fig. 6m, the metal plugs 21 are arranged on the side portions and center portion of the second substrate 22, or such as Fig. 6n, some portions of the second substrate 22 are not arranged the metal plugs 21.

**[0063]** Figs. 7a-7m are illustrated a $2^{nd}$ process of forming a glass substrate of the invention. Please referring to Fig. 7a-7b, there is illustrated a first metal plate 7 in Fig. 7a, illustrated a three-dimensional view of the first metal plate 7 in Fig. 7b. The first metal plate 7 has a thickness between 25 micrometers and 1000 micrometers, between 20 micrometers and 500 micrometers, between 30 micrometers and 400 micrometers or between 20 micrometers and 250 micrometers. The first metal plate 7 comprising a first portion 71, a second portion 73 and a third portion 75 between the first portion 71 and second portion 73, wherein the third portion 75 comprises multiple non-circular metal traces 752 are connected to the first portion 71 and the second portion 73, wherein a cross-section view of the non-circular trace 752 comprising a square shape or a rectangle shape. One of the non-circular traces 752 has a width greater than the thickness of one of the non-circular traces 752, such as between 150 micrometers and 3000 micrometers, between 300 micrometers and 1500 micrometers, between 200 micrometers and 800 micrometers or between 100 micrometers and 500 micrometers. Multiple gaps 754 are between each two neighboring non-circular traces 752, wherein the gap 754 is between 50 micrometers and 3000 micrometers, between 300 micrometers and 1500 micrometers, between 200 micrometers and 800 micrometers or between 150 micrometers and 500



IPR2026-00067
TSMC EX1002 Page 136

micrometers. The first metal plate 7 comprises a copper metal layer, copper-gold alloy metal layer, copper-gold-palladium alloy metal layer, copper-gold-silver alloy metal layer, copper-platinum alloy metal layer, copper-iron alloy metal layer, copper-nickel alloy metal layer, copper-tungsten metal layer, tungsten metal layer, brass metal layer, zinc plated brass metal layer, stainless metal layer, nickel plated stainless metal layer, phosphor bronze metal layer, copper plated the aluminum metal layer or aluminum metal layer. There are two holes 71a in the first portion 71, wherein the hole 71a has a diameter between 600 micrometers and 2000 micrometers, between 1000 micrometers and 3000 micrometers or between 2000 micrometers and 5000 micrometers. There are two holes 73a corresponding to the hole 71a in the first portion 71, wherein the hole 73a has a diameter between 600 micrometers and 2000 micrometers, between 1000 micrometers and 3000 micrometers or between 2000 micrometers and 5000 micrometers, wherein a first least distance between the two holes 71a is substantially the same to a second least distance between the two holes 73a.

**[0064]** Next, referring to Figs. 7c-7d, there is illustrated a second metal plate 9 in Fig. 7c, illustrated a three-dimensional view of the second metal plate 9 in Fig. 7d. The second metal plate 9 has a thickness between 25 micrometers and 600 micrometers, between 20 micrometers and 300 micrometers, between 30 micrometers and 250 micrometers or between 25 micrometers and 180 micrometers. There are two holes 90a in the second metal plate 9, wherein the hole 90a has a diameter between 600 micrometers and 2000 micrometers, between 1000 micrometers and 3000 micrometers or between 2000 micrometers and 5000 micrometers, wherein a third least distance between the two holes 90a is substantially the same to a second least distance between the two holes 73a and substantially the same to the first least distance between the two holes 71a. The second metal plate 9 comprises a copper metal layer, copper-gold alloy metal layer, copper-gold-palladium alloy metal layer, copper-gold-silver alloy metal layer, copper-platinum alloy metal layer, copper-iron alloy metal layer, copper-nickel alloy metal layer, copper-tungsten metal layer, tungsten metal



IPR2026-00067
TSMC EX1002 Page 137

layer, brass metal layer, zinc plated brass metal layer, stainless metal layer, nickel plated stainless metal layer, phosphor bronze metal layer, copper plated the aluminum metal layer or aluminum metal layer.

**[0065]** Next, referring to Fig. 7e, there is illustrated a three-dimensional view of a third metal plate 11 in Fig. 7e. The third metal plate 11 has a thickness between 25 micrometers and 600 micrometers, between 20 micrometers and 300 micrometers, between 30 micrometers and 250 micrometers or between 25 micrometers and 180 micrometers. There are four holes 110a, 112a, 114a, 116a in the third metal plate 11, wherein the hole 110a, 112a, 114a, 116a have a diameter between 600 micrometers and 2000 micrometers, between 1000 micrometers and 3000 micrometers or between 2000 micrometers and 5000 micrometers, wherein a fourth least distance between the hole 110a and hole 112a and a fifth least distance between the hole 114a and hole 116a are substantially the same to a second least distance between the two holes 73a and substantially the same to the first least distance between the two holes 71a. The third metal plate 11 comprises a copper metal layer, copper-gold alloy metal layer, copper-gold-palladium alloy metal layer, copper-gold-silver alloy metal layer, copper-platinum alloy metal layer, copper-iron alloy metal layer, copper-nickel alloy metal layer, copper-tungsten metal layer, tungsten metal layer, brass metal layer, zinc plated brass metal layer, stainless metal layer, nickel plated stainless metal layer, phosphor bronze metal layer, copper plated the aluminum metal layer or aluminum metal layer.

**[0066]** Next, referring to Fig. 7f-Fig.7i, providing two bolts 130, 132 pass through two holes 150a of a fixing metal plate 150 and providing two bolts 134, 136 pass through two holes 152a of a fixing metal plate 152 respectively. Next, the bolts 130, 132, 134, 136 are passing through the holes 110a, 112a, 114a, 116a of the third metal plate 11 respectively and the third metal plate 11 is formed on the fixing metal plate 150 and the fixing metal plate 152. Next, the bolts 130, 132 are passing through the hole 90a of the second metal plate 9 and the bolts 134, 136 are passing through the hole



IPR2026-00067
TSMC EX1002 Page 138

90a of another the second metal plate 9, then the second metal plates 9 are formed on the third metal plate 11. Next, the bolts 130, 132, 134, 136 are passing through the holes 71a, 73a of the first metal plate 7 respectively and the first metal plate 7 is formed on the second metal plates 9. Next, repeating to site another the second metal plates 9 on another the first metal plate 7 sequentially until to expose a top of the bolts 130, 132, 134, 136. Next, the top of the bolts 130, 132, 134, 136 are passing through the holes 110a, 112a, 114a and 116a of another the third metal plate 11 respectively and the third metal plate 11 is formed on the second metal plates 9. Next, the top of the bolts 130, 132 are passing through two holes 150a of another the fixing metal plate 150 and the top of the bolts 134, 136 are passing through two holes 152a of another the fixing metal plate 152 respectively, then the fixing metal plates 150, 152 are formed on the third metal plate 11. Finally, providing four sleeve nuts 17 lock on the top of the bolts 130, 132, 134, 136. Then, multiple the first metal plates 7, multiple the second metal plates 9, two the third metal plates 11, two fixing metal plates 150 and two fixing metal plates 152 forming a metal trace block 19.

**[0067]** Next, referring to Fig. 7j the metal trace block 19 is put in a mold 23. The mold 23 may be a metal mold, a ceramics mold or a polymer mold, which has a heat deflection temperature between 400 ℃ and 900 ℃ or between 800 ℃ and 1300 ℃. The mold 23 comprises a gas inlet 23a and a liquid input 23b, wherein the gas inlet 23a is used to input $N_2$ gas and the liquid input 23b is used to input the liquid form glass layer.

**[0068]** Next, referring to Fig. 7k, the glass layer (liquid form) 16 fill in the mold 23. The glass layer 16 is a high temperature liquid and fill in the mold 23, and then the glass layer 16 down to a suitable temperature becomes a solid state, wherein the glass layer 16 has a glass transition temperature between 300°C and 900°C, between 500°C and 800°C, between 900°C and 1200°C or between 1000°C and 1800°C. The glass layer 16 is a low melting point glass material, wherein the glass layer 16 has a melting point between 300°C and 900°C, 800°C and 1300°C, between 900°C



IPR2026-00067
TSMC EX1002 Page 139

and 1600°C, between 1000°C and 1850°C, or between 1000°C and 2000°C, wherein the melting point may smaller than 1500°C. Furthermore, there is a few bubbles or no bubble in glass layer 16, for example, there is zero to 3 bubbles in one cubic meter of the glass layer 16, 1 to 10 bubbles in one cubic meter of the glass layer 16, 5 to 30 bubbles in one cubic meter of the glass layer 16 or 20 to 60 bubbles in one cubic meter of the glass layer 16, wherein the bubble has a diameter between 0.0001 and 0.001 centimeters, between 0.001 and 0.05 centimeters, between 0.05 and 0.1 centimeters or between 0.05 and 0.5 centimeters. The glass layer 16 may be removed bubbles through multiple processes of a laminating process, a squeezing process and a heating process.

**[0069]** Next, referring to Fig. 7l, the mold 23is removed and cut the glass layer 16 along a cutting line 16a to remove the fixing metal plate 150, the fixing metal plate 152, the first portion 71 of the first metal plate 7, the second portion 73 of the first metal plate 7 and two the third metal plates 11, and then the column 25 is produced, showed in the Fig. 7m.

**[0070]** Next, referring to Fig. 7n, cutting the column 25 to produce multiple first substrates 20, wherein the first substrate 20 has a thickness between 20 and 100 micrometers, between 50 and 150 micrometers, between 100 and 300 micrometers or between 150 and 2000 micrometers or greater than 1000 micrometers. The first substrates 20 may be made a planarization process using a suitable process, such as a chemical mechanical polishing (CMP) procedure, mechanical grinding, or laser drilling.

**[0071]** Next, referring to Fig. 7o, the first substrate 20 comprises multiple second substrates 22. The second substrates 22 are well-regulated an array in the first substrate 20. Each of the second substrates has multiple metal plugs 21, wherein the metal plug 21 is formed from the non-circular metal traces 752. The metal plug 21 has the same material, structure and shape with the non-circular metal traces 752. A first pitch 21a and a second pitch 21b are between the metal plugs 21, wherein



IPR2026-00067
TSMC EX1002 Page 140

the first pitch 21a is controlled or the same-2 by a distance of the gap 754 and wherein the second pitch 21b is controlled by a distance of adjacent the non-circular traces 752.

**[0072]** Next, referring to Figs. 7p-7r, the metal plugs 21 may be arranged in different types, such as Fig. 7p, the metal plugs 21 are arranged on the side portions of the second substrate 22, or such as Fig. 7q, the metal plugs 21 are arranged on the side portions and center portion of the second substrate 22, or such as Fig. 7r, some portions of the second substrate 22 are not arranged the metal plugs 21.

**[0073]** Fig. 8a illustrates a cross-section view of the second substrate 22 illustrates a cross-section view of the metal plug 21. The second substrate 22 comprises an amorphous solid glass layer/body 16 and multiple metal plugs 21, wherein the amorphous solid glass layer/body 16 having a top surface and an opposing bottom surface and the metal plugs 21 extending through the amorphous solid glass layer/body 16 beginning at the top surface and ending at the bottom surface. The top surface of the metal plugs 21 are the same area as the bottom surface of the metal plugs 21.

**[0074]** Please referring Fig. 8b, the top surface of the metal plugs 21 and the top surface of the amorphous solid glass layer/body 16 are substantially coplanar. The bottom surface of the metal plugs 21 and the bottom surface of the amorphous solid glass layer/body 16 are substantially coplanar.

**[0075]** Please referring Fig. 8c, the top surface of the metal plugs 21 comprises a top surface of the metal traces 6/ metal traces 752 and a top surface of the first covering layer 6a are substantially coplanar with the top surface of the amorphous solid glass layer/body 16. The bottom surface of the metal plugs 21 comprises a bottom surface of the metal traces 6/ metal traces 752 and a bottom surface of the first covering layer 6a are substantially coplanar with the bottom surface of the amorphous solid glass layer/body 16.



IPR2026-00067
TSMC EX1002 Page 141

**[0076]** Please referring Fig. 8d, the top surface of the metal plugs 21 comprises a top surface of the metal traces 6/ metal traces 752, a top surface of the first covering layer 6a and a top surface of the second covering layer 6b are substantially coplanar with the top surface of the amorphous solid glass layer/body 16. The bottom surface of the metal plugs 21 comprises a bottom surface of the metal traces 6/ metal traces 752, a bottom surface of the first covering layer 6a and a bottom surface of the second covering layer 6b are substantially coplanar with the bottom surface of the amorphous solid glass layer/body 16.

**[0077]** Fig. 9a-Fig. 9t illustrate a process to form multiple traces on a top surface and a bottom surface of the first substrate 20.

**[0078]** Next, referring to Fig. 9a, a first dielectric layer 24 is formed on the top surface of the first substrate 20, wherein the first dielectric layer 24 may include or maybe a layer of silicon oxide (such as $SiO_2$), silicon nitride (such as $Si_3N_4$), silicon oxynitride (such as SiON), silicon oxycarbide (such as SiOC), phosphosilicate glass (PSG), silicon carbon nitride (such as SiCN), low k dielectric layer (K between 0.5 and 3), or polymer (such as polyimide, benzocyclobutene (BCB), polybenzoxazole (PBO), poly-phenylene oxide (PPO), epoxy, or silosane). The first dielectric layer 24 may be formed or deposited using a suitable process. The first dielectric layer 24 has a thickness between 0.3 and 5 micrometers, between 2 and 10 micrometers, between 1 and 30 micrometers or greater than 30 micrometers.

**[0079]** Next, referring to Fig. 9b, multiple openings 24a are formed in the first dielectric layer 24 to expose the metal plugs 21. The openings 24a may be formed in the first dielectric layer 24 by a suitable process, such as etching. The opening 24a has a width between 0.3 and 3 micrometers, between 0.5 and 8 micrometers, between 2 and 20 micrometers or between 2 and 50 micrometers.



IPR2026-00067
TSMC EX1002 Page 142

**[0080]** Next, referring to Fig. 9c, a first metal layer 26 is formed on the first dielectric layer 24, on the metal plugs 21 and in the openings 24a. The first metal layer 26 may include an adhesion/barrier layer, such as a layer of titanium, a titanium-tungsten alloy, titanium nitride, chromium, tantalum, tantalum nitride, nickel or nickel vanadium formed using a suitable process, such as a vacuum deposition, a Physical Vapor Deposition (PVD), a Plasma Enhanced Chemical Vapor Deposition (PECVD), a sputtering process or an electroplating process, with a thickness, e.g., between 1 nanometer and 2 micrometers, between 0.3 and 3 micrometers or between 0.5 and 10 micrometers.

**[0081]** Next, referring to Fig. 9d, a second metal layer 28 is formed on the first metal layer 26. The second metal layer 28 maybe comprises copper, nickel, gold or aluminum formed using a suitable process, such as a vacuum deposition, a Physical Vapor Deposition (PVD), a Plasma Enhanced Chemical Vapor Deposition (PECVD), a sputtering process or an electroplating process, with a thickness, e.g., between 1 nanometer and 5 micrometers, between 1 and 5 micrometers or between 5 and 30 micrometers.

**[0082]** Next, referring to Fig. 9e, a photoresist layer 30 is formed on the second metal layer 28 by using a suitable process, such as a spin coating process or a lamination process. Next, a photo exposure process using a 1X stepper and a development process using a chemical solution can be employed to form multiple openings 30a, exposing the second metal layer 28, in the photoresist layer. The photoresist layer 30 may have a thickness, e.g., between 3 and 50 micrometers, wherein the photoresist layer 30 may be a positive-type photo-sensitive resist layer or negative-type photo-sensitive resist layer.

**[0083]** Next, referring to Fig. 9f, remove the first metal layer 26 and the second metal layer 28 are under the openings 30a by using a suitable process, such as an etching process.



IPR2026-00067
TSMC EX1002 Page 143

**[0084]** Next, referring to Fig. 9g, remove the photoresist layer 30 by using a clean process.

**[0085]** Next, referring to Fig. 9h, a second dielectric layer 32 is formed on the first dielectric layer 24 and on the second metal layer 28, wherein the second dielectric layer 32 may include or may be a layer of silicon oxide (such as $SiO_2$), silicon nitride (such as $Si_3N_4$), silicon oxynitride (such as SiON), silicon oxycarbide (such as SiOC), phosphosilicate glass (PSG), silicon carbon nitride (such as SiCN), low k dielectric layer (K between 0.5 and 3), or polymer (such as polyimide, benzocyclobutene (BCB), polybenzoxazole (PBO), poly-phenylene oxide (PPO), epoxy, or silosane). The second dielectric layer 32 may be formed or deposited using a suitable process. The second dielectric layer 32 has a thickness between 0.3 and 5 micrometers, between 2 and 10 micrometers, between 1 and 30 micrometers or greater than 30 micrometers.

**[0086]** Next, referring to Fig. 9i, multiple openings 32a are formed in the second dielectric layer 32 to expose the second metal layer 28. The openings 32a may be formed in the second dielectric layer 32 by a suitable process, such as etching. The opening 32a has a width between 0.3 and 3 micrometers, between 0.5 and 8 micrometers, between 2 and 20 micrometers or between 2 and 50 micrometers.

**[0087]** Next, referring to Fig. 9j, a third metal layer 34 is formed on the second dielectric layer 32, on the second metal layer 28 and in the openings 32a. The third metal layer 34 may include an adhesion/barrier layer, such as a layer of titanium, a titanium-tungsten alloy, titanium nitride, chromium, tantalum, tantalum nitride, nickel or nickel vanadium formed using a suitable process, such as a vacuum deposition, a Physical Vapor Deposition (PVD), a Plasma Enhanced Chemical Vapor Deposition (PECVD), a sputtering process or an electroplating process, with a thickness, e.g., between 1 nanometer and 2 micrometers, between 0.3 and 3 micrometers or between 0.5 and 10 micrometers.



IPR2026-00067
TSMC EX1002 Page 144

**[0088]** Next, referring to Fig. 9k, a fourth metal layer 36 is formed on the third metal layer 34. The fourth metal layer 36 maybe comprises copper, nickel, gold or aluminum formed using a suitable process, such as a vacuum deposition, a Physical Vapor Deposition (PVD), a Plasma Enhanced Chemical Vapor Deposition (PECVD), a sputtering process or an electroplating process, with a thickness, e.g., between 1 nanometer and 5 micrometers, between 1 and 5 micrometers or between 5 and 30 micrometers.

**[0089]** Next, referring to Fig. 9l, a photoresist layer 38 is formed on the fourth metal layer 36 by using a suitable process, such as a spin coating process or a lamination process. Next, a photo exposure process using a 1X stepper and a development process using a chemical solution can be employed to form multiple openings 38a, exposing the fourth metal layer 36, in the photoresist layer. The photoresist layer 38 may have a thickness, e.g., between 3 and 50 micrometers, wherein the photoresist layer 38 may be a positive-type photo-sensitive resist layer or negative-type photo-sensitive resist layer.

**[0090]** Next, referring to Fig. 9m, remove the third metal layer 34 and the fourth metal layer 36 are under the openings 38a by using a suitable process, such as an etching process.

**[0091]** Next, referring to Fig. 9n, remove the photoresist layer 38 by using a clean process.

**[0092]** Next, referring to Fig. 9o, a third dielectric layer 40 is formed on the second dielectric layer 32 and on the fourth metal layer 36, wherein the third dielectric layer 40 may include or maybe a layer of silicon oxide (such as $SiO_2$), silicon nitride (such as $Si_3N_4$), silicon oxynitride (such as SiON), silicon oxycarbide (such as SiOC), phosphosilicate glass (PSG), silicon carbon nitride (such as SiCN), low k dielectric layer (K between 0.5 and 3), or polymer (such as polyimide, benzocyclobutene (BCB), polybenzoxazole (PBO), poly-phenylene oxide (PPO), epoxy, or silosane). The third dielectric layer 40 may be formed or deposited using a suitable process. The third



IPR2026-00067
TSMC EX1002 Page 145

dielectric layer 40 has a thickness between 0.3 and 5 micrometers, between 2 and 10 micrometers, between 1 and 30 micrometers or greater than 30 micrometers.

**[0093]** Next, referring to Fig. 9p, multiple openings 40a are formed in the third dielectric layer 40 to expose the fourth metal layer 36. The openings 40a may be formed in the third dielectric layer 40 by a suitable process, such as etching. The opening 40a has a width between 0.3 and 3 micrometers, between 0.5 and 8 micrometers, between 2 and 20 micrometers or between 2 and 50 micrometers.

**[0094]** Next, referring to Fig. 9q, a protecting layer 42 is formed in the openings 40a, on the third dielectric layer 40 and on the fourth metal layer 36, which can protect the third dielectric layer 40 not to be damaged and the fourth metal layer 36 not be damaged and oxidized.

**[0095]** Next, referring to Fig. 9r, repeat the processes of Fig.9a-Fig.9p to form the first dielectric layer 24, the first metal layer 26, the second metal layer 28, the second dielectric layer 32, the third metal layer 34, the fourth metal layer 36 and the third dielectric layer 40 on the bottom surface of the first substrate 20.

**[0096]** Furthermore, referring to Fig. 9s, a passive device 44 may be formed in the first metal layer 28 and the second metal layer 36, such as an inductor, a capacitor or a resistor.

**[0097]** Next, referring to Fig. 9t, multiple chips 46 and chips 56 set up over the third dielectric layer 40 through a flip-chip package process or a wire-bonding package process, wherein the chip 46 or 56 comprises may be a memory chip, such as NAND-Flash memory chip, Flash memory chip, DRAM chip, SRAM chip or SDRAM chip, a central-processing-unit (CPU) chip, a graphics-processing-unit (GPU) chip, a digital-signal-processing (DSP) chip, a baseband chip, a wireless local area network (WLAN) chip, a logic chip, an analog chip, a global-positioning-system (GPS)



IPR2026-00067
TSMC EX1002 Page 146

chip, a "Bluetooth" chip, or a chip including one or more of a CPU circuit block, a GPU circuit block, a DSP circuit block, a memory circuit block (such as DRAM circuit block, SRAM circuit block, SDRAM circuit block, Flash memory circuit block, or NAND-Flash memory circuit block), a baseband circuit block, a Bluetooth circuit block, a GPS circuit block, a MEMS chip, a COMS image sensor device, a WLAN circuit block, and a modem circuit block, from the semiconductor wafer.

**[0098]** The chips 46 are set up on the third dielectric layer 40 through a flip-chip package process, wherein the chip 46 comprises multiple metal pads 48 and multiple metal bumps 50 formed on the metal pads 48. The metal pad 48 may be an electroplated copper pad, a damascene copper pad or an aluminum pad. The metal bump 50 comprises an adhesion/barrier metal layer formed on the metal pad 48, an electroplated metal layer or an electro-less metal layer formed on the adhesion/barrier metal layer, wherein the adhesion/barrier metal layer comprises a titanium-containing layer, a chromium-containing layer, a tantalum-containing layer or a nickel layer, and the electroplated metal layer comprises a copper layer, a gold layer, a nickel layer, a tin-containing layer, a solder layer, a solder layer over a nickel layer and a copper layer, and the electro-less layer comprises a copper layer, a gold layer or a nickel layer. The electroplated metal layer has a thickness between 2 and 5 micrometers, between 5 and 30 micrometers or between 10 and 50 micrometers. The metal bumps 50 are connected to the fourth metal layer 36 exposed by the openings 40a through a solder layer 54, wherein the solder layer 54 is formed on the fourth metal layer 36 exposed by the openings 40a or is a portion of the metal bump

**[0099]** 50. An underfill layer 52 is formed between the chips 46 and the third dielectric layer 40.

**[00100]** The chips 56 are set up over the third dielectric layer 40 through a polymer adhesion layer 60, wherein the chip 56 comprises multiple metal pads 58. The metal pad 58 may be an



IPR2026-00067
TSMC EX1002 Page 147

electroplated copper pad, a damascene copper pad or an aluminum pad. Multiple metal wires 62 are connected to the metal pads 58 and the fourth metal layer 36 exposed by the openings 40a, wherein the metal wires 62 comprises a gold wire, a copper wire, a metal alloy wire, a silver-containing wire, an aluminum-containing wire or gold-copper alloy wire. An underfill layer 64 is covered the chip56, the metal wires 62 and the metal pads 58.

**[00101]** Multiple discrete passive components 66 set up on the third dielectric layer 40, such as a discrete inductor, a discrete capacitor or a discrete resistor, wherein the discrete passive component 66 comprises a multiple metal pad 68. The discrete passive components 66 mounted on the third dielectric layer 40 through a solder layer 70.

**[00102]** Next, referring to Fig. 9u, multiple metal bumps 72 are formed on the bottom surface of the substrate 20.

**[00103]** Fig. 9v is disclosed some structures of metal bump 72.

- Lift side: 1st type of structures of metal bump 72 comprises an adhesion/barrier metal layer 61 formed on the metal pad 48, a metal seed layer 63 formed on the adhesion/barrier metal layer 61, an electroplated metal layer 65 formed on the metal seed layer 63 and a solder layer 67 formed on the electroplated metal layer 65, wherein the adhesion/barrier metal layer 61 comprises a titanium-containing layer, a chromium-containing layer, a tantalum-containing layer or a nickel layer, wherein the first electroplated metal layer 65 comprises a copper layer, a gold layer, a nickel layer, wherein the solder layer 67 can be formed by screen plating, ball mounting, or an electroplating process, such as gold-tin alloy, tin-silver alloy, tin-silver-copper alloy, indium, tin-bismuth alloy, or other lead-free alloy. Lead alloy solders can also be used but may be less desirable in some embodiments due to toxicity considerations. The adhesion/barrier metal layer 61 has a thickness between 0.05 and 2

micrometers. The metal seed layer 63 has a thickness between 0.05 and 2 micrometers. The first electroplated metal layer 65 has a thickness between 1 and 5 micrometers, between 2 and 8 micrometers or between 5 and 20 micrometers. The solder layer 67 has a thickness between 30 and 80 micrometers, between 50 and 100 micrometers, between 80 and 150 micrometers or between 120 and 350 micrometers.

- Right side: 2nd type of structure of metal bump 72 comprises an adhesion/barrier metal layer 61 formed on the metal pad 48, a metal seed layer 63 formed on the adhesion/barrier metal layer 61, a first electroplated metal layer 65 formed on the metal seed layer 63 and a second electroplated metal layer 69 formed on the first electroplated metal layer 65, wherein the adhesion/barrier metal layer 61 comprises a titanium-containing layer, a chromium-containing layer, a tantalum-containing layer or a nickel layer, wherein the first electroplated metal layer 65 comprises a copper layer, a gold layer, a nickel layer, wherein the second electroplated metal layer 69 comprises a copper layer, a gold layer, a nickel layer. The adhesion/barrier metal layer 61 has a thickness between 0.05 and 2 micrometers. The metal seed layer 63 has a thickness between 0.05 and 2 micrometers. The first electroplated metal layer 65 has a thickness between 1 and 5 micrometers, between 2 and 4 micrometers, between 5 and 15 micrometers or between 10 and 25 micrometers. The second electroplated metal layer 69 has a thickness between 1 and 5 micrometers, between 2 and 4 micrometers, between 10 and 30 micrometers or between 20 and 60 micrometers.

**[00104]** Furthermore, referring to Fig. 9w, the chips 46 may be set up on the bottom surface of the first substrate 20.

**[00105]** Furthermore, referring to Fig. 9x, the chip 46 may be replaced a 3D IC chip package, wherein the chip 46 comprises a multiple metal pad 48 formed on the top and bottom surface. The



IPR2026-00067
TSMC EX1002 Page 149

metal pads 48 of the top surface of the chip 46 are connected to the metal pads 48 of the bottom surface of the chip 46 through multiple through-silicon-via metal layers. A chip 47 is connected to the 3D IC chip 46 through the flip-chip package process, wherein the chip 47 comprises multiple metal pads 49, wherein the metal pad 49 may be an electroplated copper pad, a damascene copper pad or an aluminum pad. The metal pads 49 are connected to the metal pads 48 through a solder layer 51.

**[00106]** Fig. 9y, illustrates a top view of the first substrate 20. Fig. 9u-Fig. 9w illustrate a cross-section view of Line L-L' in Fig. 9y. Multiple the chips 46, the chips 56 and the passive components 66 may also be provided in or on the first substrate 20.

**[00107]** Next, cutting the first substrate 20 to produce multiple second substrates 22.

**[00108]** Fig. 10a-Fig. 10j illustrate a damascene process to form the first metal layer 26, the second metal layer 28, the third metal layer 34 and the fourth metal layer 36 on a top surface and a bottom surface of the first substrate 20.

**[00109]** Referring to Fig. 10a, the dielectric layers 24 in Fig. 9a include two dielectric layers 80 and 82. The dielectric layer 80 is formed on the dielectric layer 82 by a chemical vapor deposition (CVD) process or a spin-on coating process, wherein each of the dielectric layers 80 and 82 may be composed of a low-K oxide layer with a thickness of between 0.3 and 5μm, and preferably of between 0.5 and 3μm, and an oxynitride layer on the low-K oxide layer, of a low-K polymer layer with a thickness of between 0.3 and 5μm, and preferably of between 0.5 and 3μm, and an oxynitride layer on the low-K polymer layer, of a low-K oxide layer with a thickness of between 0.3 and 5μm, and preferably of between 0.5 and 3μm, and a nitride layer on the low-K oxide layer, of a low-K polymer layer with a thickness of between 0.3 and 5μm, and preferably of between 0.5 and 3μm, and a nitride layer on the low-K polymer layer, or of a low-K dielectric layer with a



IPR2026-00067
TSMC EX1002 Page 150

thickness of between 0.3 and 5μm, and preferably of between 0.5 and 3μm, and a nitride-containing layer on the low-K dielectric layer. Next, referring to Fig. 10b, a photoresist layer 84 is formed on the dielectric layer 82, an opening 84a in the photoresist layer 84 exposing the dielectric layer 82. Next, referring to Fig. 10c, the dielectric layer 82 under the opening 84a is removed by a dry etching method to form a trench in the dielectric layer 82 exposing the dielectric layer 80. Next, referring to Fig. 10d, after forming the trench in the dielectric layer 82, the photoresist layer 84 is removed. Next, referring to Fig. 10e, a photoresist layer 86 is formed on the dielectric layer 82 and on the dielectric layer 80 exposed by the trench, an opening 86a in the photoresist layer 86 exposing the dielectric layer 80 exposed by the trench. Next, referring to Fig. 19f, the dielectric layer 80 under the opening 86a is removed by a dry etching method to form a via 80a in the dielectric layer 80 exposing the metal plugs 21 in the substrate 20. Next, referring to Fig. 10g, after forming the via 80a in the dielectric layer 80, the photoresist layer 86 is removed. Thereby, an opening 88 including the trench and the via 80a is formed in the dielectric layers 82 and 80. Next, referring to Fig. 10h, an adhesion/barrier layer 90 having a thickness of between 0.1 and 3 micrometers is formed on the metal plugs 21 exposed by the opening 88, on the sidewalls of the opening 88 and on the top surface of the dielectric layer 82. The adhesion/barrier layer 90 can be formed by a sputtering process or a chemical vapor deposition (CVD) process. The material of the adhesion/barrier layer 90 may include titanium, titanium nitride, a titanium-tungsten alloy, tantalum, tantalum nitride, or a composite of the abovementioned materials. For example, the adhesion/barrier layer 90 may be formed by sputtering a tantalum layer on the metallization structure exposed by the opening 88, on the sidewalls of the opening 88 and on the top surface of the dielectric layer 82. Alternatively, the adhesion/barrier layer 90 may be formed by sputtering a tantalum-nitride layer on the metallization structure exposed by the opening 88, on the sidewalls of the opening 88 and on the top surface of the dielectric layer 82. Alternatively, the adhesion/barrier layer 90 may be formed by forming a tantalum-nitride layer on the metallization structure exposed by the opening 88, on the sidewalls of



IPR2026-00067
TSMC EX1002 Page 151

the opening 88 and on the top surface of the dielectric layer 82 by a chemical vapor deposition (CVD) process. Next, referring to Fig. 10i, a seed layer 92, made of copper, having a thickness of between 0.1 and 3 micrometers is formed on the adhesion/barrier layer 90 using a sputtering process or a chemical vapor deposition (CVD) process, and then a copper layer 94 having a thickness of between 0.5 and 5μm, and preferably of between 1 and 2μm, is electroplated on the seed layer 92. Next, referring to Fig. 10j, the copper layer 94, the seed layer 92 and the adhesion/barrier layer 90 outside the opening 88 in the dielectric layers 82 and 80 are removed using a chemical mechanical polishing (CMP) process until the top surface of the dielectric layer 82 is exposed to an ambient.

**[00110]** Fig. 11a-Fig. 11i illustrate an embossing process to form the first metal layer 26, the second metal layer 28, the third metal layer 34 and the fourth metal layer 36 on a top surface and a bottom surface of the first substrate 20.

**[00111]** Referring to Fig. 11a, the metal plugs 21 are in the glass layer 16 of the first substrate 20, and the opening 96a in the dielectric layer 96 exposes the metal plugs 21.

**[00112]** Referring to Fig. 11a, a polymer layer 98 can be formed on the dielectric layer 96, and at least one opening 98a is formed in the polymer layer 98 by patterning the polymer layer 98 to expose at least one metal trace 6, as shown in Fig. 11b and Fig. 11c. The metal plugs 21 may include a center portion exposed by an opening 98a and a peripheral portion covered with the polymer layer 98, as shown in Fig. 11b. Alternatively, the opening 98a may expose the entire upper surface of the metal plugs 21 exposed by the opening 96a in the dielectric layer 96 and further may expose the upper surface of the dielectric layer 96 near the metal trace 6, as shown in Fig. 11c.

**[00113]** The material of the polymer layer 98 may include benzocyclobutane (BCB), polyimide (PI), polyurethane, epoxy resin, a parylene-based polymer, a solder-mask material, an



IPR2026-00067
TSMC EX1002 Page 152

elastomer, or a porous dielectric material. The polymer layer 98 has a thickness of between 3 and 25μm or between 5 and 50 micrometers.

**[00114]** The polymer layer 98 can be formed by a spin-on coating process, a lamination process or a screen-printing process. Below, the process of forming a patterned polymer layer 98 is exemplified with the case of spin-on coating a polyimide layer on the dielectric layer 96 and then patterning the polyimide layer.

**[00115]** Referring to Fig. 11d, an adhesion/barrier layer 100 having a thickness of between 0.1 and 3 micrometers, and preferably between 0.5 and 2 micrometers, is formed on the polymer layer 98 and on the metal plugs 21. The adhesion/barrier layer 100 may be a titanium-tungsten-alloy layer, tantalum-containing layer, a chromium-containing layer or a titanium-nitride layer. The adhesion/barrier layer 100 may be formed by a sputtering method, an evaporation method, or a chemical vapor deposition (CVD) method.

**[00116]** Referring to Fig. 11e, a photoresist layer 102 can be formed on the adhesion/barrier layer 100 by a spin coating process or a lamination process. Referring to Fig. 11f, the photoresist layer 102 is patterned with the processes of exposure, development, etc., to form a photoresist opening 102a on the above-mentioned adhesion/barrier layer 100 over the metal plugs 21 exposed by the opening 98a.

**[00117]** Referring to Fig. 11g, an electroplated metal layer 104 is formed on the adhesion/barrier layer 100 in the opening 102a, wherein the electroplated metal layer 104 comprises a copper layer, gold layer, a nickel layer, has a thickness between 2 and 10 micrometers, between 5 and 20 micrometers or between 5 and 35 micrometers.

**[00118]** Referring to Fig. 11h, removing the photoresist layer 102.



IPR2026-00067
TSMC EX1002 Page 153

**[00119]** Referring to Fig. 11i, the above-mentioned adhesion/barrier layer 100 not under the electroplated metal layer 104 is removed with a dry etching method or a wet etching method. For example, the adhesion/barrier layer 100 made of titanium, titanium-tungsten alloy, titanium nitride, tantalum or tantalum nitride, not under the electroplated metal layer 104 is removed with a reactive ion etching (RIE) process.

**[00120]** First Application: Please referring to Fig. 12, the second substrates 22 is connected to a OLED display substrate through COG bonding process, wherein the OLED display substrate comprises a first glass substrate 106, a second glass substrate 108, an organic light-emitting diodes layer 110 (or a polymer light-emitting diodes layer, PLED layer) between the first glass substrate 106 and the second glass substrate 108 and multiple transparent electrodes 114. The metal bumps 72 are connected to the transparent electrodes 114 through an anisotropic conductive film (ACF) layer 116, wherein the ACF layer 116 comprises multiple conductive particles 117, such as nickel (Ni) particles, gold (Au) particles, nickel-gold alloy particles, silver-tin alloy particles, silver particles, gold plated particles, silver plated particles or nickel plated particles. The OLED display substrate comprises multiple OLED display panels. The OLED display substrate may comprise a touch screen function. A least distance 106a between a centerline of the metal bump 72 and a boundary of the glass substrate 106 is between 3 micrometers and 10 micrometers, 5 micrometers and 15 micrometers, 10 micrometers and 25 micrometers or 20 micrometers and 40 micrometers.

**[00121]** Next, cutting the second substrates 22 and the OLED display substrate to produce multiple package units.

**[00122]** Second Application: Furthermore, the OLED display substrate can be replaced with a Micro Electro Mechanical Systems (MEMS) display substrate. Please referring to Fig. 13, the second substrates 22 is connected to a MEMS display substrate through COG bonding process,



IPR2026-00067
TSMC EX1002 Page 154

wherein the MEMS display substrate comprises a first glass substrate 106, a MEMS layer 109 and multiple transparent electrodes 114 formed on the first glass substrate 106. The metal bumps 72 are connected to the transparent electrodes 114 through an anisotropic conductive film (ACF) layer 116, wherein the ACF layer 116 comprises multiple conductive particles 117, such as nickel (Ni) particles, gold (Au) particles, nickel-gold alloy particles, silver-tin alloy particles, silver particles, gold plated particles, silver plated particles or nickel plated particles. The MEMS display substrate comprises multiple MEMS display panels. The MEMS display substrate may comprise touch screen function. A least distance 106a between a centerline of the metal bump 72 and a boundary of the glass substrate 106 is between 3 micrometers and 10 micrometers, 5 micrometers and 15 micrometers, 10 micrometers and 25 micrometers or 20 micrometers and 40 micrometers.

**[00123]** Next, cutting the second substrates 22 and the MEMS display substrate to produce multiple package units.

**[00124]** Third application: Please refer to Fig. 14, multiple LED devices 122 are packaged on the bottom surface of the second substrates 22. The second substrates 22 is connected to a LCD display substrate through COG bonding process, wherein the LCD display substrate comprises a first glass substrate 106, a second glass substrate 108, and a transistor liquid crystal display layer 111 between the first glass substrate 106 and the second glass substrate 108 and multiple transparent electrodes 114. The metal bumps 72 are connected to the electrodes 114 through an anisotropic conductive film (ACF) layer 116, wherein the ACF layer 116 comprises multiple conductive particles 117, such as nickel (Ni) particles, gold (Au) particles, nickel-gold alloy particles, silver-tin alloy particles, silver particles, gold plated particles, silver plated particles or nickel plated particles. The LCD display substrate comprises multiple LCD display panels. The LCD display substrate may comprises a touch screen function, wherein the LCD display substrate comprises an in-cell TFT LCD substrate. There are multiple optical layers 128 between the second substrates 22 and LCD



IPR2026-00067
TSMC EX1002 Page 155

display substrate, such as a diffuser sheet layer, a prism sheet layer, a diffuser layer (or diffuser plate) and a reflector layer. A least distance 106a between a centerline of the metal bump 72 and a boundary of the glass substrate 106 is between 3 micrometers and 10 micrometers, 5 micrometers and 15 micrometers, 10 micrometers and 25 micrometers or 20 micrometers and 40 micrometers.

**[00125]** Next, cutting the second substrates 22 and the LCD display substrate to produce multiple package units.

**[00126]** Fourth application: Referring to Fig. 15, this structure of the fourth application is similar to the structure of the third application in Fig. 14. The second substrates 22 is connected to a LCD display substrate through flip-chip bonding process, wherein the LCD display substrate comprises a first glass substrate 106 and a second glass substrate 108, and a transistor liquid crystal display layer 111 and thin film transistor circuit layers (not shown) between the first glass substrate 106 and the second glass substrate 108, wherein multiple transparent electrodes 114 on the bottom surface of the first glass substrate 106 and multiple metal plugs 113 in the first glass substrate 106, wherein the multiple metal plugs 113 are connected to the transparent electrodes 114 respectively. The structure of the first glass substrate 106 can refer to the second substrates 22 in the invention. The metal bumps 72 are connected to the transparent electrodes 114 through a solder layer 107, wherein the solder layer 107 comprises gold-tin alloy, tin-silver alloy, tin-silver-copper alloy, indium, tin-bismuth alloy, or other lead-free alloy. The LCD display substrate comprises multiple LCD display panels. The LCD display substrate may comprise touch screen function, wherein the LCD display substrate comprising an in-cell TFT LCD substrate. There are multiple optical layers 128 between the second substrates 22 and LCD display substrate, such as a diffuser sheet layer, a prism sheet layer, a diffuser layer (or diffuser plate) and a reflector layer. A least distance 106a between a centerline of the metal bump 72 and a boundary of the glass substrate 106 is between 30



IPR2026-00067
TSMC EX1002 Page 156

micrometers and 100 micrometers, 50 micrometers and 150 micrometers, 100 micrometers and 250 micrometers or 50 micrometers and 300 micrometers.

**[00127]** Fifth application: Referring to Fig. 16, this structure of the fifth application is similar to the structure of the fourth application in Fig. 14. The organic light-emitting diodes layer 110 (or a polymer light-emitting diodes layer, PLED layer) is replaced with the liquid crystal display layer 111. The second substrates 22 is connected to a OLED display substrate through flip-chip bonding process, wherein the OLED display substrate comprises a first glass substrate 106 and a second glass substrate 108, and an organic light-emitting diodes layer 110 (or a polymer light-emitting diodes layer, PLED layer) and thin film transistor circuit layers (not shown) between the first glass substrate 106 and the second glass substrate 108, wherein multiple transparent electrodes 114 on the bottom surface of the first glass substrate 106 and multiple metal plugs 113 in the first glass substrate 106, wherein the multiple metal plugs 113 are connected to the transparent electrodes 114 respectively. The structure of the first glass substrate 106 can refer to the second substrates 22 in the invention. The metal bumps 72 are connected to the transparent electrodes 114 through a solder layer 107, wherein the solder layer 107 comprises gold-tin alloy, tin-silver alloy, tin-silver-copper alloy, indium, tin-bismuth alloy, or other lead-free alloy. The OLED display substrate comprises multiple OLED display panels. The OLED display substrate may comprise touch screen function, wherein the OLED display substrate comprising an in-cell TFT OLED substrate. A least distance 106a between a centerline of the metal bump 72 and a boundary of the glass substrate 106 is between 30 micrometers and 100 micrometers, 50 micrometers and 150 micrometers, 100 micrometers and 250 micrometers or 50 micrometers and 300 micrometers.

**[00128]** Sixth application: Referring to Fig. 17a, the second substrates 22 can be a port of an OLED display substrate. The OLED display substrate comprises the second substrates 22 and the second glass substrate 108, and an organic light-emitting diodes layer 110 (or a polymer light-



IPR2026-00067
TSMC EX1002 Page 157

emitting diodes layer, PLED layer), thin film transistor circuit layers (not shown) and transparent electrodes 114 between the second substrates 22 and the second glass substrate 108, wherein the metal plugs 21 connected to transparent electrodes 114 through the first metal layer 26. The OLED display substrate comprises multiple OLED display panels. The OLED display substrate may comprise touch screen function, wherein the OLED display substrate comprising an in-cell TFT OLED substrate.

**[00129]** Referring to Fig. 17b, the structure of the OLED display substrate comprises multiple thin film transistors circuits 700 and multiple organic light-emitting components 800 between the second substrates 22 and the second glass substrate 108, wherein the thin film transistors circuit 700 comprises a buffer layer 702, a first gate electrode 704a and a first source electrode 704b formed on the buffer layer 702, a first insulating layer 706 formed on the first gate electrode 704a, the first source electrode 704b and the buffer layer 702. An oxide semiconductor layer 710 is formed on the first insulating layer 706 over the first gate electrode 704a and the first source electrode 704b, wherein the oxide semiconductor layer 710 is connected to the first source electrode 704b through the opening in the first insulating layer 706. A second insulating layer 712 is formed on the oxide semiconductor layer 710. A second gate electrode 714a and a second source electrode 714b formed on the second insulating layer 712, wherein the second source electrode 714b connected to the oxide semiconductor layer 710 through an opening in the second insulating layer 712. A protection layer 716 is formed on the second gate electrode 714a, the second source electrode 714b and the second insulating layer 712. The organic light-emitting component 800 formed on the protection layer 716 and connected to the second source electrode 714b through an opening in the protection layer 716.

**[00130]** The oxide semiconductor layer 710 comprises a ZnO containing layer, wherein the ZnO containing layer can be doped with a group selected from the group constituted of at least one ionic: Gallium (Ga), indium (In), tin (Sn), zirconium (Zr), hafnium (Hf), cadmium (Cd), magnesium



IPR2026-00067
TSMC EX1002 Page 158

(Mg), vanadium (V). The first gate electrode 704a, the first source electrode 704b, the second gate electrode 714a and the second source electrode 714b are formed of a metal selected from the following groups: tungsten (W), titanium (Ti), molybdenum (Mo), silver (Ag), tantalum (Ta), aluminum (Al), copper (Cu), gold (Au), chromium (Cr) or niobium (Nb).

**[00131]** The organic light-emitting component 800 comprises an anode layer 802, a cathode layer 804 and an organic light-emitting layer 806 between the anode layer 802 and the cathode layer 804, wherein the anode layer 802 formed on the protection layer 716 and connected to the second source electrode 714b. A third insulating layer 808 formed on the protection layer 716 and the anode layer 802, then formed a hole/opening in the third insulating layer 808 and on the anode layer 802. Forming the organic light-emitting layer 806 in the opening and on the third insulating layer 808, then formed the cathode layer 804 on the third insulating layer 808 and on the organic light-emitting layer 806. The anode layer 802 is connected to the metal plugs 21 via a conductive layer formed on the opening through the buffer layer 702, a first insulating layer 706 and second insulating layer 712. The cathode layer 804 is connected to the metal plugs 21 via a conductive layer formed on the opening through the buffer layer 702, the first insulating layer 706, the second insulating layer 712 and the third insulating layer 808. The buffer layer 702、the first insulating layer 706, the second insulating layer 712 and the third insulating layer 808 comprise a polyimide, polyamide, acryl resin, benzocyclobutene, phenol resin, oxide layer (buffer layer 702), nitride layer (buffer layer 702).

**[00132]** The anode layer 802 may contain one or more transparent materials such as indium tin oxide (ITO), indium zinc oxide (IZO), zinc oxide (ZnO), indium gallium oxide (IGO), aluminum zinc oxide (AZO) and In2O3, or non-transparent materials such as Ag, Mg, Al, Pt, Pd, Au, Ni, Nd, Ir, Cr, Li, Ca, Mo, Ti, W, MoW, and Al/Cu. The cathode layer 804 may contain one or more transparent materials such as indium tin oxide (ITO), indium zinc oxide (IZO), zinc oxide (ZnO), indium gallium oxide (IGO), aluminum zinc oxide (AZO) and $In_2O_3$.



IPR2026-00067
TSMC EX1002 Page 159

**[00133]** The organic light-emitting layer 806 may include a hole transport layer (HTL) and a hole injection layer (HIL) stacked toward the pixel electrode (anode layer 802 or cathode layer 804), and an electron transport layer (ETL) and an electron injection layer (EIL) stacked toward the pixel electrode (anode layer 802 or cathode layer 804). Furthermore, various other layers may be stacked if required. Further, the light-emitting layer 806 comprises a carbazole biphenyl(CBP), (III)(bis(1-phenylisoquinoline)(acetylacetonate)iridium, PIQIr(acac)),(III)(bis(1-phenylquinoline)(acetylacetonate)iridium, PQIr(acac)), (III)(tris(1-phenylquinoline)iridium (PQIr), octaethylporphyrin platinum,PtOEP 、 (III))(tris(dibenzoylmethane)(o-phenanthroline)europium(III),PED ： Eu(DBM)3(Phen)),perylene, N,N'-Di(naphthalene-1-yl)-N,N'-diphenyl-benzidine, tris-8-hydroxyquinoline aluminum (PEDOT), copper phthalocyanine,CuPc, 4,4',4"-tris(N-(3-methylphenyl)-N-phenylamino)triphenylamine (MTDATA).

**[00134]** Referring to Fig. 18 and Fig. 19, an outward of display substrate produced from above first application to sixth application is an unframed display 119, wherein the unframed display 119 comprises a display area 119a has four edges 119b, wherein a gap between each edge 119b and one of four boundaries of the unframed display 119 has a least distance smaller than 15 micrometers, 20 micrometers, 30 micrometers, 50 micrometers, 100 micrometers, 150 micrometers or 200 micrometers. The unframed display 119 is installed in a shell 123 of a display device 125. Some components (not showed in drawings) can install in the display device 125 (or installed on the second substrates 22), for example, a speaker component, a battery component, a microphone component, a signal receiver component, a wireless signal receiver component, a wireless signal transmitter module.

**[00135]** Referring to Fig. 19, the display device 125 comprises multiple connecting ports 127 on the shell 123, wherein the connecting ports 127 comprise a signal connecting port, a power



IPR2026-00067
TSMC EX1002 Page 160

connecting port, and/or a ground connecting port. The display device 125 can connect to another one display device 125b to become a bigger display device 129, wherein the connecting ports 127 of the display device 125 are connected to the connecting ports 127 of the display device 125b. Multiple display devices 125 can be combined with a big display device, an advertising billboard. The display devices 125 can be used as a tile on the wall of the building. The display devices 125 can be a display unit on a surface of a magic cube.

**[00136]** The structure of the OLED display substrate disclosed in Fig. 12 and Fig. 16 can be referred to related specifications as above.

**[00137]** Those described above are the embodiments to exemplify the present disclosure to enable the person skilled in the art to understand, make and use embodiments of the present disclosure. This description, however, is not intended to limit the scope of the present disclosure. Any equivalent modification and variation according to the spirit of the present disclosure is to be also included within the scope of the claims stated below.

**[00138]** The components, steps, features, benefits and advantages that have been discussed are merely illustrative. None of them, nor the discussions relating to them, are intended to limit the scope of protection in any way. Numerous other embodiments are also contemplated. These include embodiments that have fewer, additional, and/or different components, steps, features, benefits and advantages. These also include embodiments in which the components and/or steps are arranged and/or ordered differently.

**[00139]** In reading the present disclosure, one skilled in the art will appreciate that embodiments of the present disclosure can be implemented in hardware, software, firmware, or any combinations of such, and over one or more networks. Suitable software can include computer-readable or machine-readable instructions for performing methods and techniques (and portions



IPR2026-00067
TSMC EX1002 Page 161

thereof) of designing and/or controlling the fabrication and design of integrated circuit chips according to the present disclosure. Any suitable software language (machine-dependent or machine-independent) may be utilized. Moreover, embodiments of the present disclosure can be included in or carried by various signals, e.g., as transmitted over a wireless radio frequency (RF) or infrared (IR) communications link or downloaded from the Internet.

**[00140]** Unless otherwise stated, all measurements, values, ratings, positions, magnitudes, sizes, and other specifications that are set forth in this specification, including in the claims that follow, are approximate, not exact. They are intended to have a reasonable range that is consistent with the functions to which they relate and with what is customary in the art to which they pertain. The scope of protection is limited solely by the claims. That scope is intended and should be interpreted to be as broad as is consistent with the ordinary meaning of the language that is used in the claims when interpreted in light of this specification and the prosecution history that follows and to encompass all structural and functional equivalents.



IPR2026-00067
TSMC EX1002 Page 162

## CLAIMS

What is claimed is:

1. A chip package comprising:

a solid layer having a first surface and a second surface opposite to said first surface, wherein said solid layer comprises a compound of silicon and oxygen, wherein said solid layer has a thickness between 50 and 150 micrometers, wherein said solid layer comprises a first region and a second region between said first region and a first edge of said solid layer;

a plurality of metal posts in a plurality of through holes in said second region respectively, wherein one of said plurality of metal posts comprises a first copper layer contacting a sidewall of one of said plurality of through holes, wherein said first region has a width in a direction greater than a shortest distance between said sidewall of one of said plurality of through holes and said first edge in said direction and greater than a pitch between two neighboring metal posts of said plurality of metal posts;

a first interconnection scheme over said first surface, wherein said first interconnection scheme comprises a first metal interconnect over said second surface and a first polymer layer over said first metal interconnect, wherein said first metal interconnect is connected to a first metal post of said plurality of metal posts, wherein said first metal interconnect comprises a first metal layer and a second copper layer over said first metal layer;

a first metal bump over said first interconnection scheme, wherein said first metal bump comprises a second metal layer and a tin-containing layer over said second metal layer; and

a first semiconductor chip under said second surface, wherein said first interconnection scheme comprise a second metal interconnect across over a sidewall of the first semiconductor chip, wherein said first semiconductor chip comprises a third metal interconnect on a first metal pad of said first semiconductor chip, wherein said third metal interconnect comprises a third metal layer on said first



IPR2026-00067
TSMC EX1002 Page 163

metal pad and a third copper layer over said third metal layer, wherein said third copper layer has a thickness between 5 and 30 micrometers, wherein said first semiconductor chip is connected to a second metal post of said plurality of metal posts through said third metal interconnect.

2. The chip package of claim 1, wherein said first semiconductor chip comprises a central-processing-unit (CPU) circuit block and a graphics-processing-unit (GPU) circuit block.

3. The chip package of claim 1, wherein said first interconnection scheme further comprises a fourth metal interconnect over said first metal interconnect and said first polymer layer, wherein said first polymer is between said first and fourth metal interconnects, wherein said fourth metal interconnect comprises a fourth metal layer and a fourth copper layer over said fourth metal layer.

4. The chip package of claim 1, wherein said first metal pad is an aluminum pad.

5. The chip package of claim 1, wherein said first metal pad is a copper pad.

6. The chip package of claim 1, wherein no any metal post in said first region.

7. The chip package of claim 1, wherein said compound comprises a SiO2 compound.

8. The chip package of claim 1, further comprising a second semiconductor chip over said first semiconductor chip, wherein said second semiconductor chip comprises a second metal bump on a second metal pad of said second semiconductor chip, wherein said second metal bump comprises a tin-containing layer.



IPR2026-00067
TSMC EX1002 Page 164

9. The chip package of claim 1, wherein said solid layer further comprises a third region opposite to said second region, wherein said third region is between said first region and a second edge of said solid layer, wherein said plurality of metal posts in said plurality of through holes in said third region respectively.

10. The chip package of claim 1, wherein said second region is a rectangle region and surrounding said first region.

11. A chip package comprising:

a solid layer having a first surface and a second surface opposite to said first surface, wherein said solid layer comprises a compound of silicon and oxygen, wherein said solid layer has a thickness between 100 and 300 micrometers, wherein said solid layer comprises a first region and a second region between said first region and a first edge of said solid layer;

a plurality of copper posts in a plurality of through holes in said second region respectively, wherein said first region has a width in a direction greater than a shortest distance between said sidewall of one of said plurality of through holes and said first edge in said direction and greater than a pitch between two neighboring copper posts of said plurality of copper posts;

a first interconnection scheme over said first surface, wherein said first interconnection scheme comprises a first metal interconnect over said first surface, and a first polymer layer over said first metal interconnect, wherein said first metal interconnect is connected to a first copper post of said plurality of copper posts, wherein said first metal interconnect comprises a first metal layer and a first copper layer over said first metal layer;

a first metal bumps over said first interconnection scheme, wherein first metal bumps comprises a tin-containing layer;

a second metal bumps over said first interconnection scheme;



IPR2026-00067
TSMC EX1002 Page 165

a first semiconductor chip over said first interconnection scheme and between said first and second metal bumps, wherein said first semiconductor chip has a height between a backside surface of said first semiconductor chip and a top surface of said first polymer layer is smaller than a thickness of said first metal bump, wherein said first semiconductor chip comprises a third metal bump on a first metal pad of said first semiconductor chip, wherein said third metal bump comprises a tin-containing layer; and

a second semiconductor chip over said first interconnection scheme, wherein said second semiconductor chip comprises a fourth metal bump on a second metal pad of said second semiconductor chip, wherein said fourth metal bump comprises a tin-containing layer.

12. The chip package of claim 11, wherein said compound comprises a SiO2 compound.

13. The chip package of claim 11, wherein said first metal pad is an aluminum pad.

14. The chip package of claim 11, wherein no any metal post in said first region.

15. The chip package of claim 11, further comprising a third semiconductor chip under said first interconnection scheme, wherein said third semiconductor chip comprises a second metal interconnect on a third metal pad of said third semiconductor chip, wherein said second metal interconnect comprises a second metal layer on said third metal pad and a second copper layer over said second metal layer, wherein said second copper layer has a thickness between 5 and 30 micrometers.

16. The chip package of claim 11, further comprising a third semiconductor chip under said first interconnection scheme, wherein said third semiconductor chip comprises a second metal



IPR2026-00067
TSMC EX1002 Page 166

interconnect on a third metal pad of said third semiconductor chip, wherein said second metal interconnect comprises a second metal layer on said third metal pad and a second copper layer over said second metal layer, wherein said third semiconductor chip comprises a central-processing-unit (CPU) circuit block and a graphics-processing-unit (GPU) circuit block.

17. The chip package of claim 11, further comprising an electrical device under said second surface, wherein said electrical device comprises a third semiconductor chip and a metal wire connected to a third metal pad of said third semiconductor chip, wherein said third semiconductor chip is a memory chip.

18. The chip package of claim 11, wherein said solid layer further comprises a third region opposite to said second region, wherein said third region is between said first region and a second edge of said solid layer, wherein said plurality of copper posts in said plurality of through holes in said third region respectively.

19. The chip package of claim 11, wherein said second region is a rectangle region and surrounding said first region.

20. The chip package of claim 11, further comprising an electrical device under said second surface, wherein said electrical device comprise a third semiconductor chip and a metal wire connected to a third metal pad of said third semiconductor chip, wherein said third semiconductor chip is a DRAM chip.



IPR2026-00067
TSMC EX1002 Page 167

## ABSTRACT

A display device comprises a display panel substrate and a glass substrate over said display panel substrate, wherein said display panel substrate comprises multiple contact pads, a display area, a first boundary, a second boundary, a third boundary and a fourth boundary, wherein said display area comprises a first edge, a second edge, a third edge and a fourth edge, wherein said first boundary is parallel to said third boundary and said first and third edges, wherein said second boundary is parallel to said fourth boundary and said second and fourth edges, wherein a first least distance between said first boundary and said first edge, wherein a second least distance between said second boundary and said second edge, a third least distance between said third boundary and said third edge, a fourth distance between said fourth boundary and said fourth edge, and wherein said first, second, third and fourth least distances are smaller than 100 micrometers, and wherein said glass substrate comprising multiple metal conductors through in said glass substrate and multiple metal bumps are between said glass substrate and said display panel substrate, wherein said one of said metal conductors is connected to one of said contact pads through one of said metal bumps.



IPR2026-00067
TSMC EX1002 Page 168

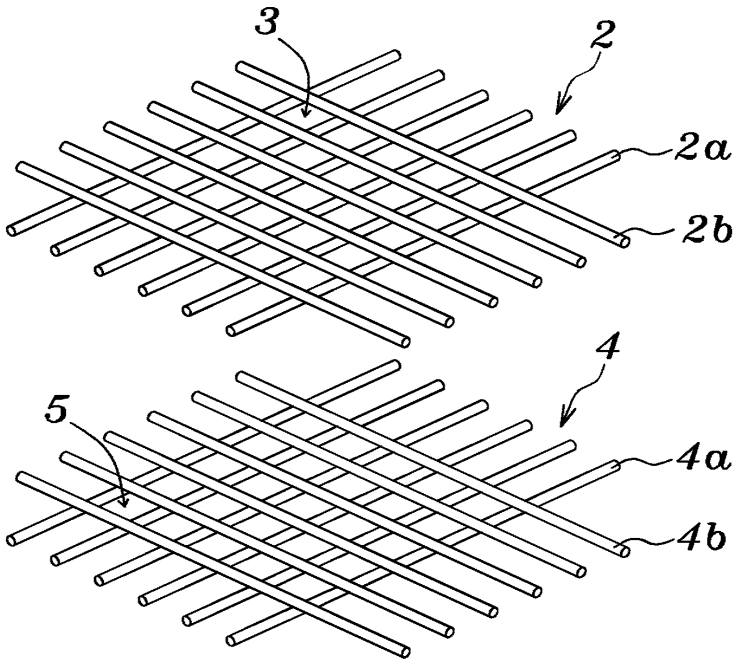



Fig. 1

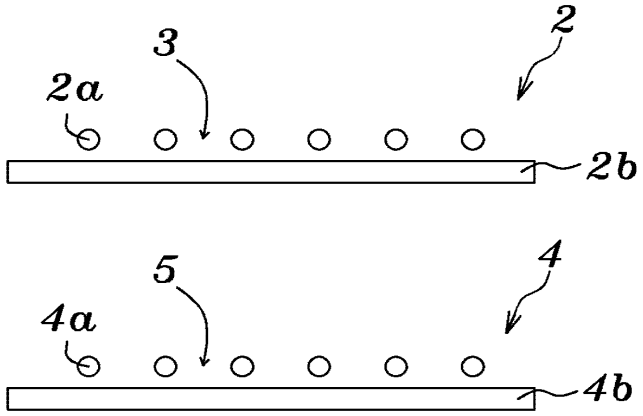



Fig. 2

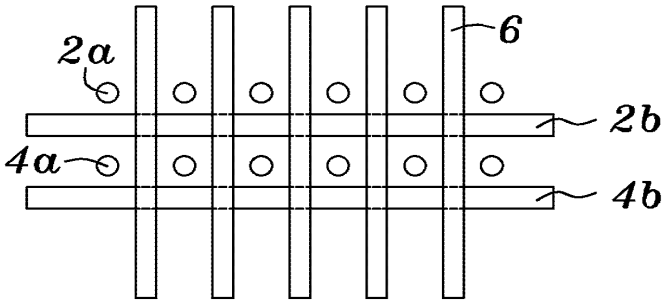



Fig. 3

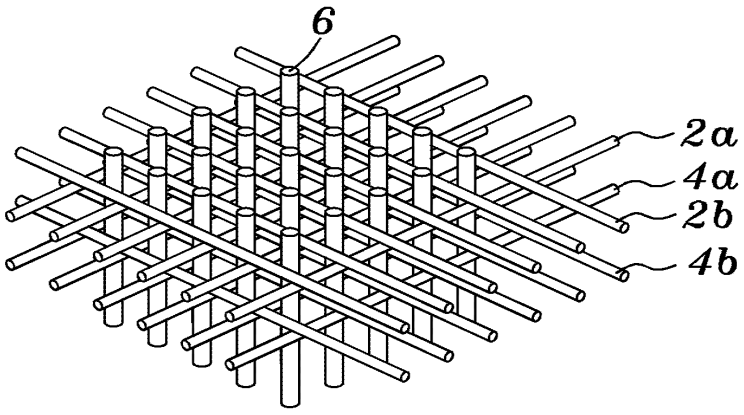



Fig. 4

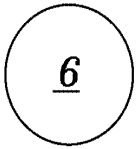



Fig. 5a

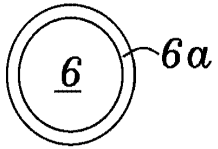



Fig. 5b

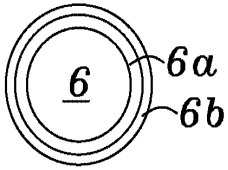



Fig. 5c

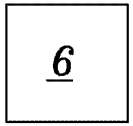



Fig. 5d

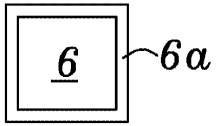



Fig. 5e

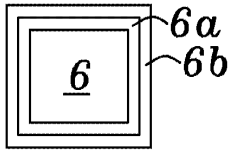



Fig. 5f

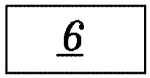



Fig. 5g

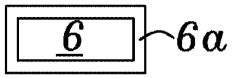



Fig. 5h

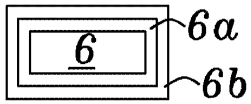



Fig. 5i

IPR2026-00067
TSMC EX1002 Page 171

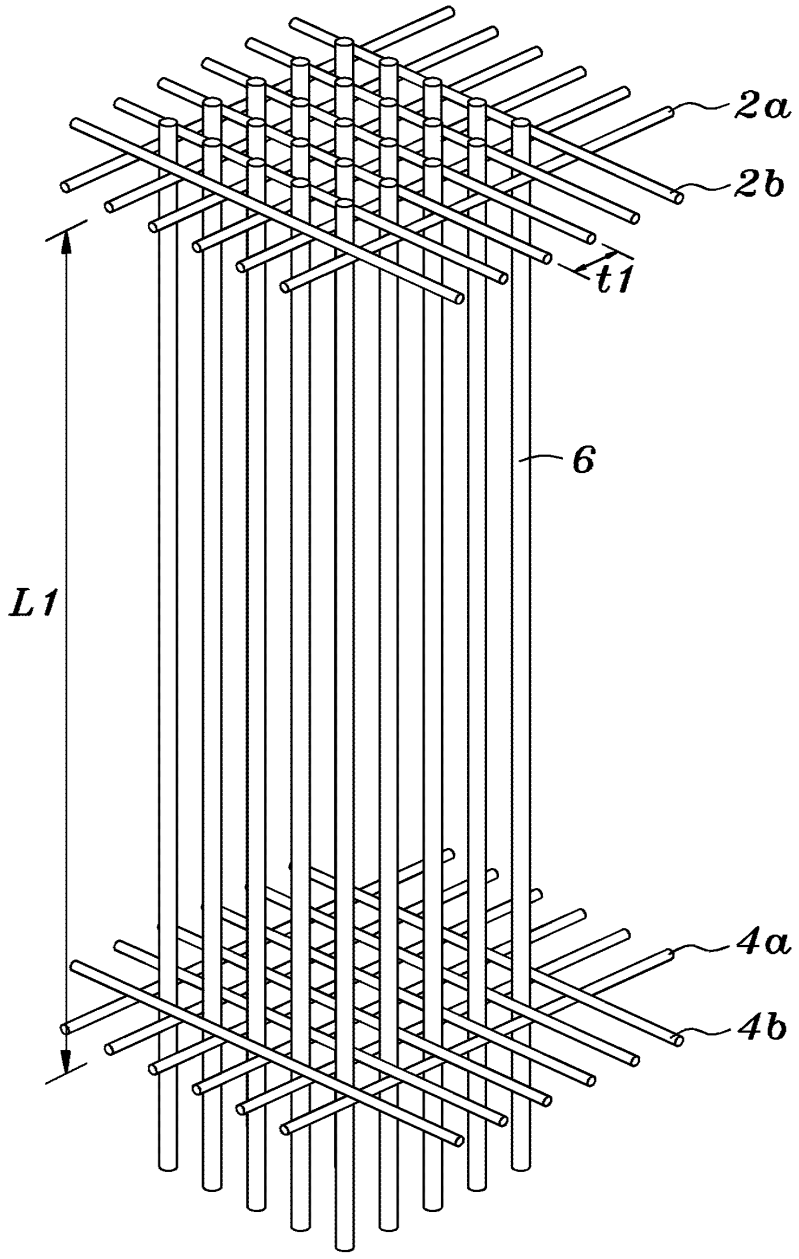



Fig. 6a

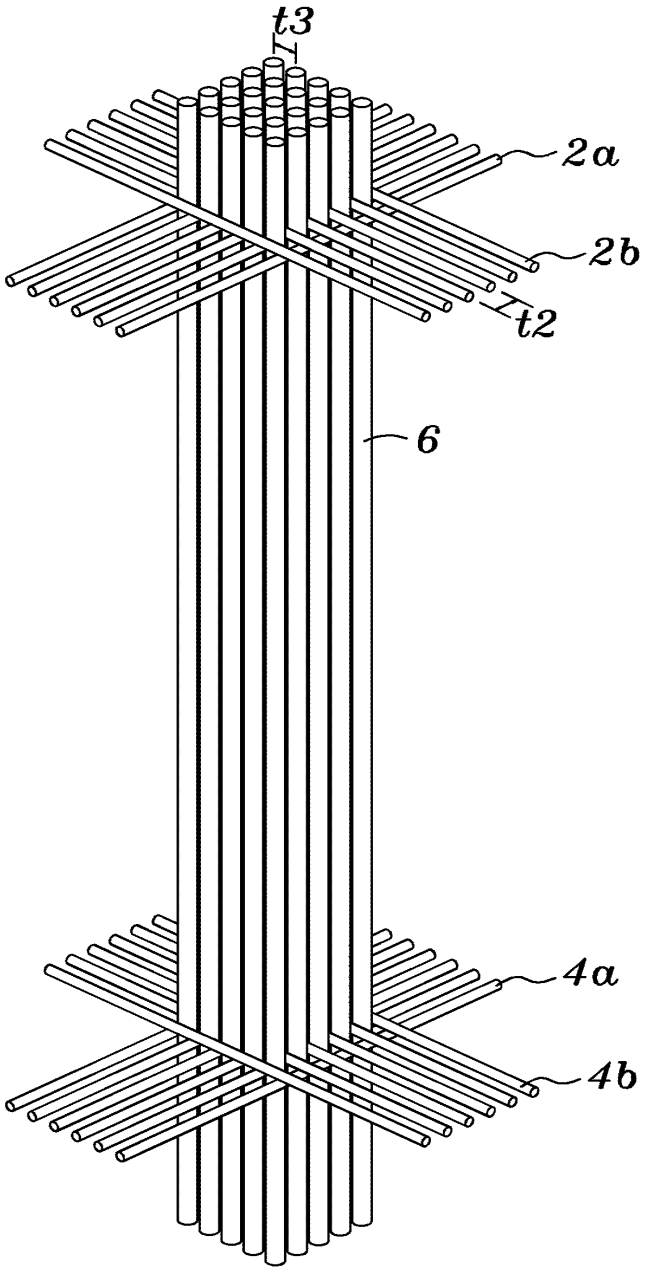



Fig. 6b

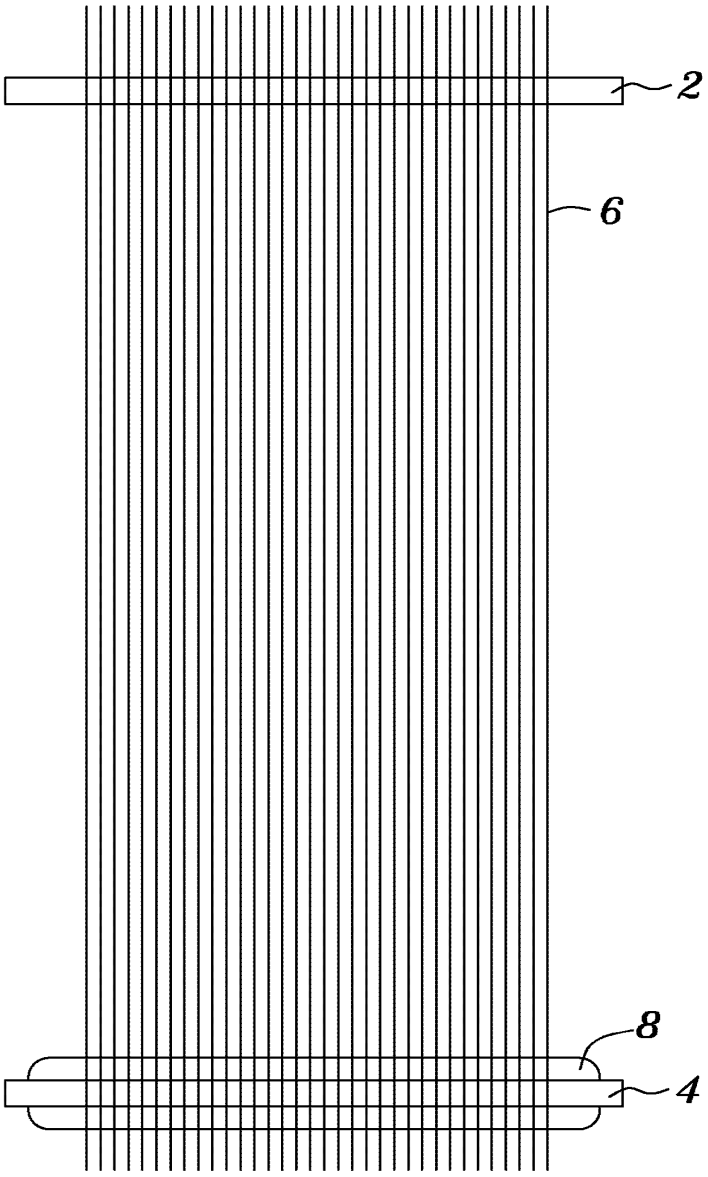



Fig. 6c

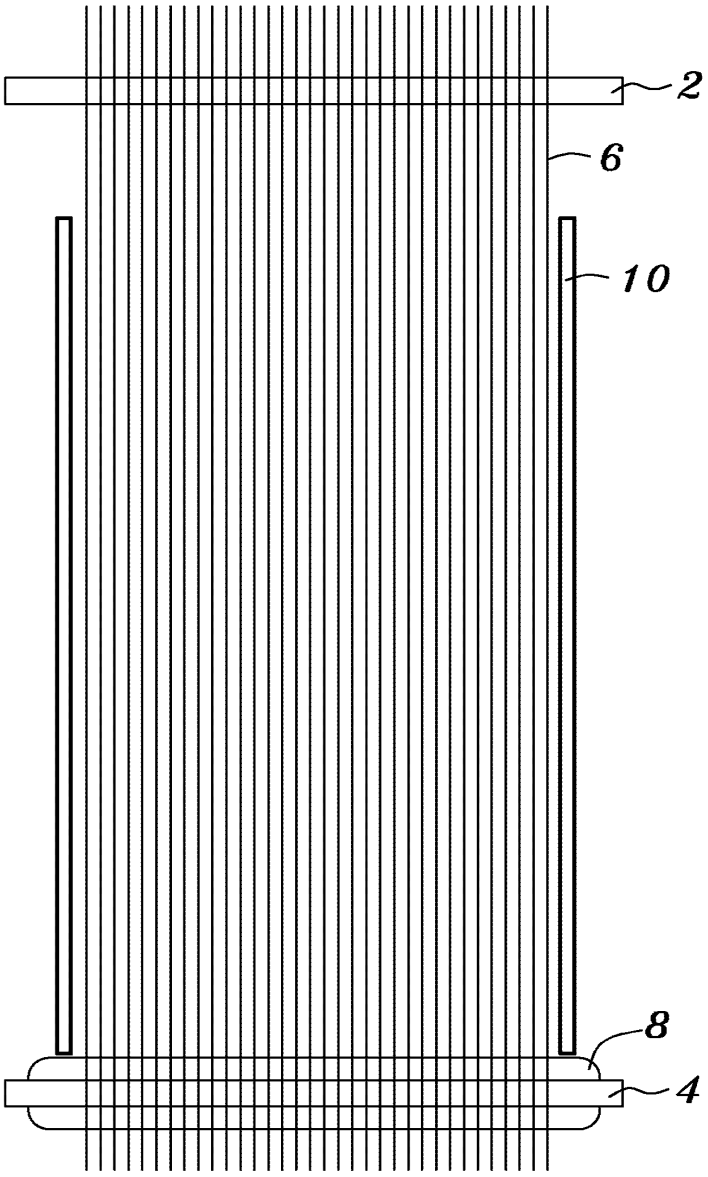



Fig. 6d

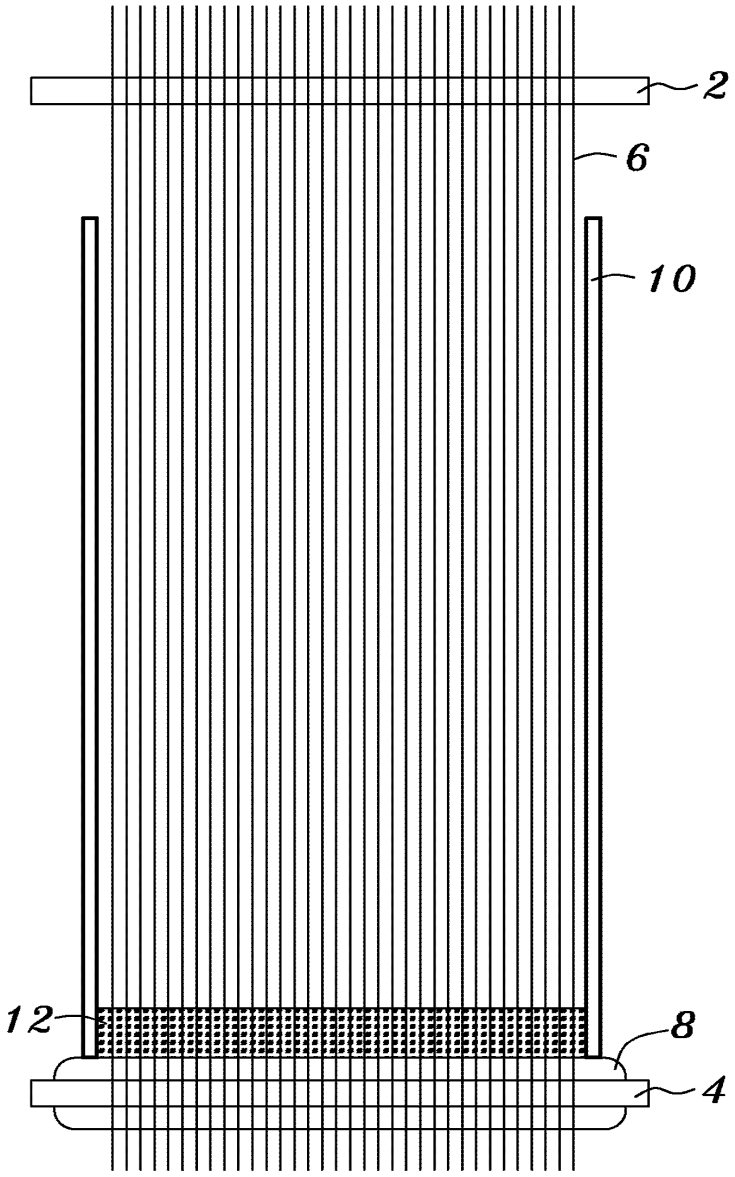



Fig. 6e

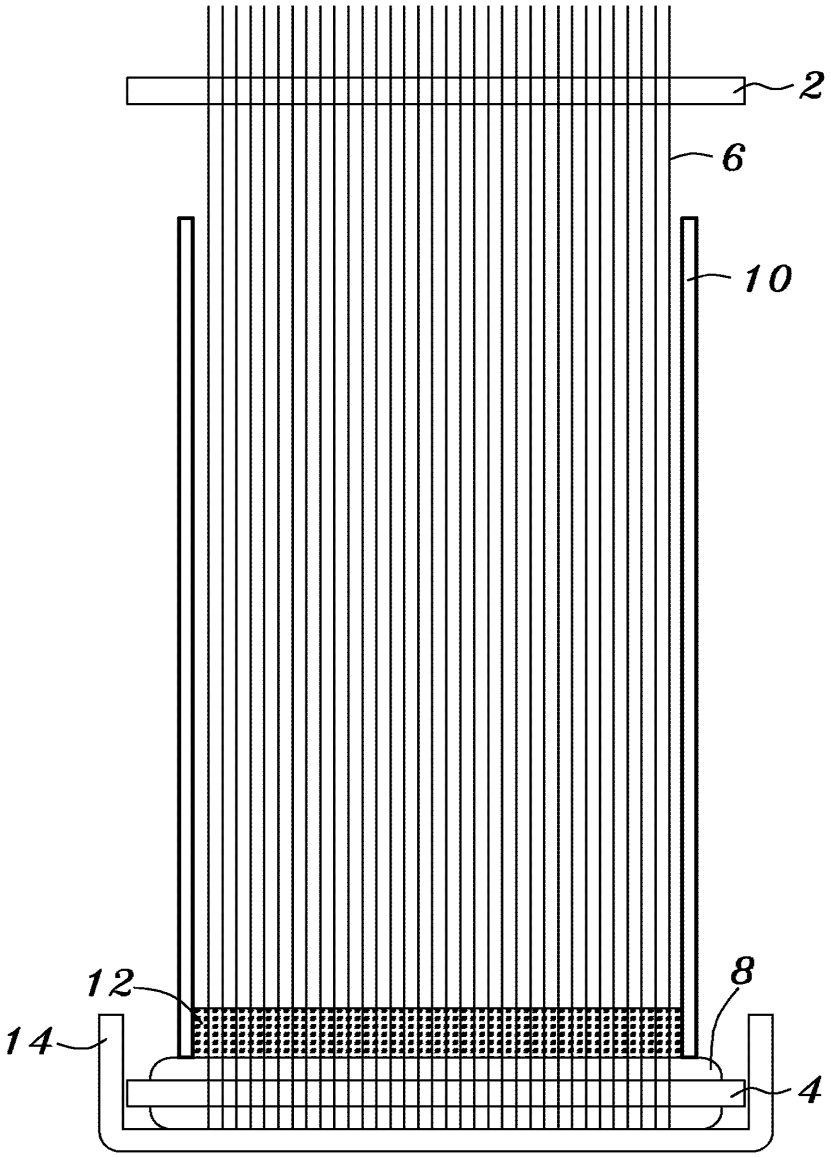



Fig. 6f

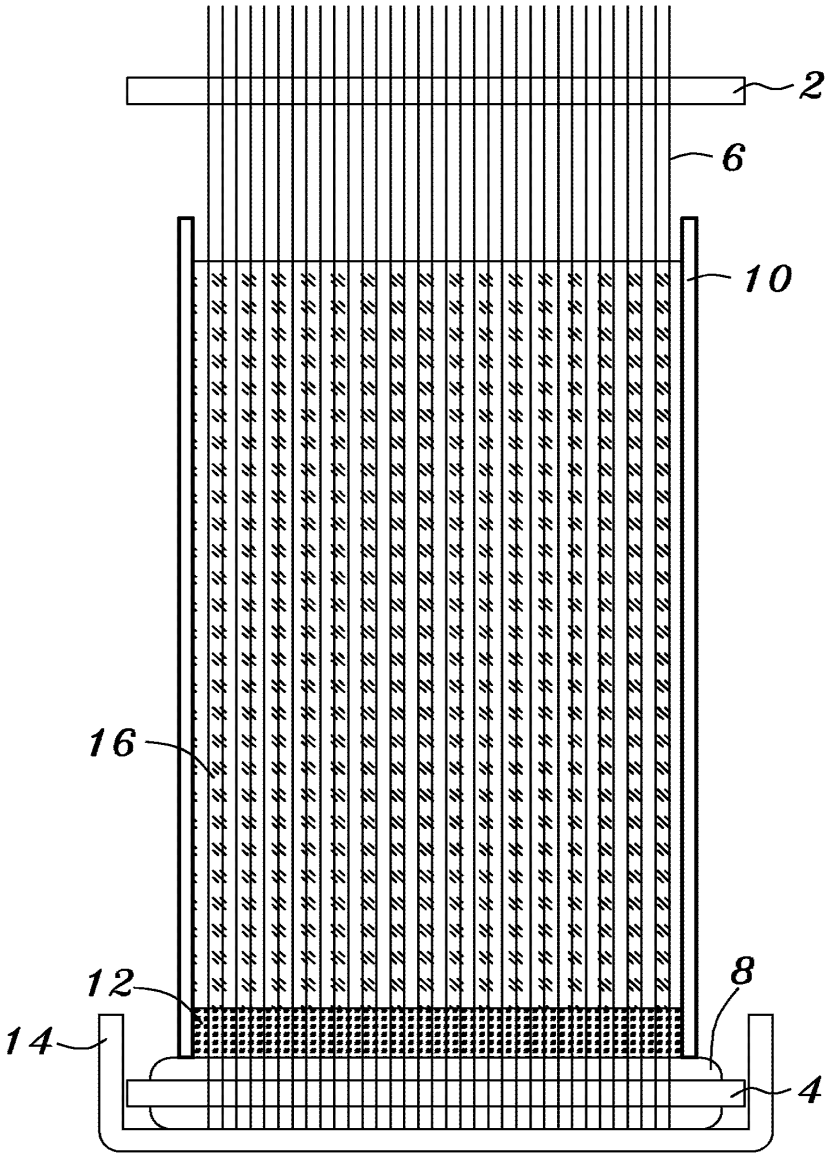



Fig. 6g

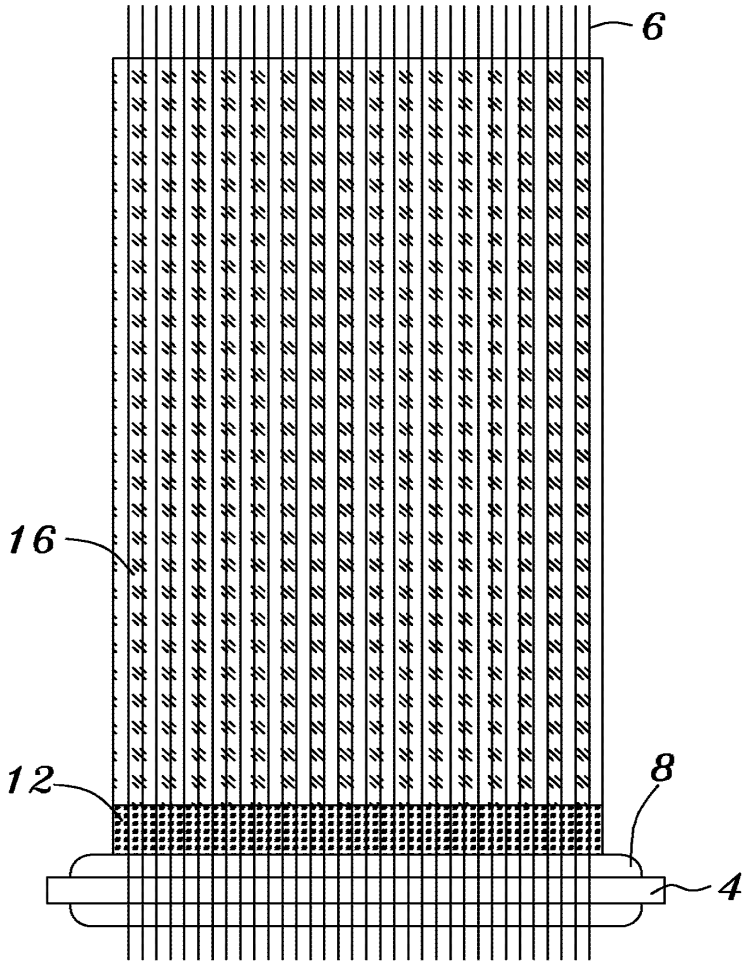



Fig. 6h

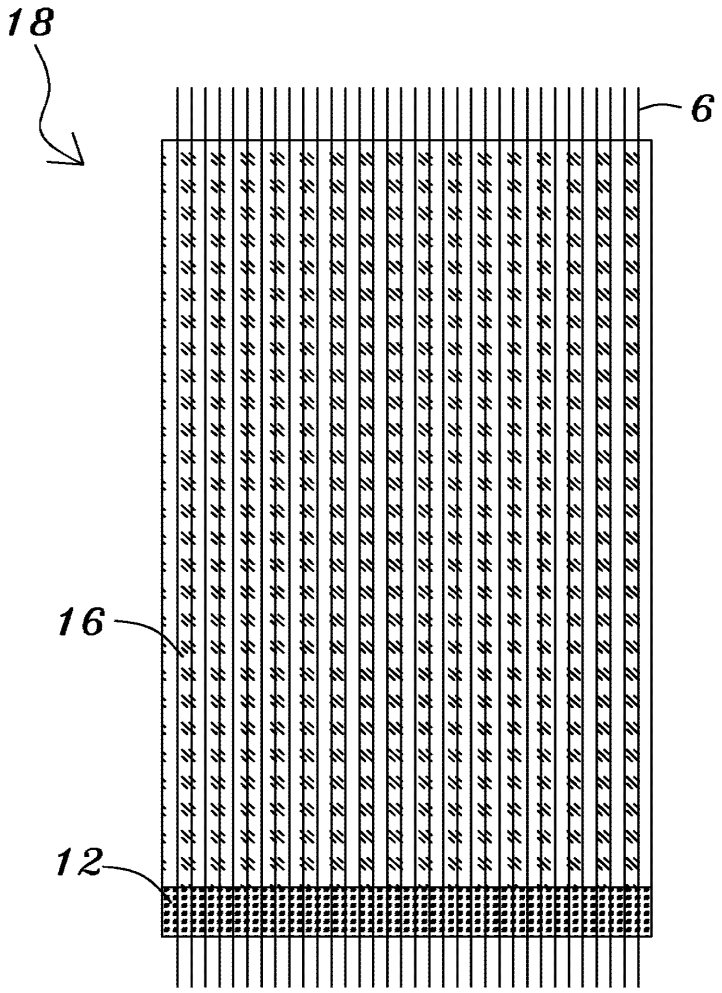



Fig. 6i

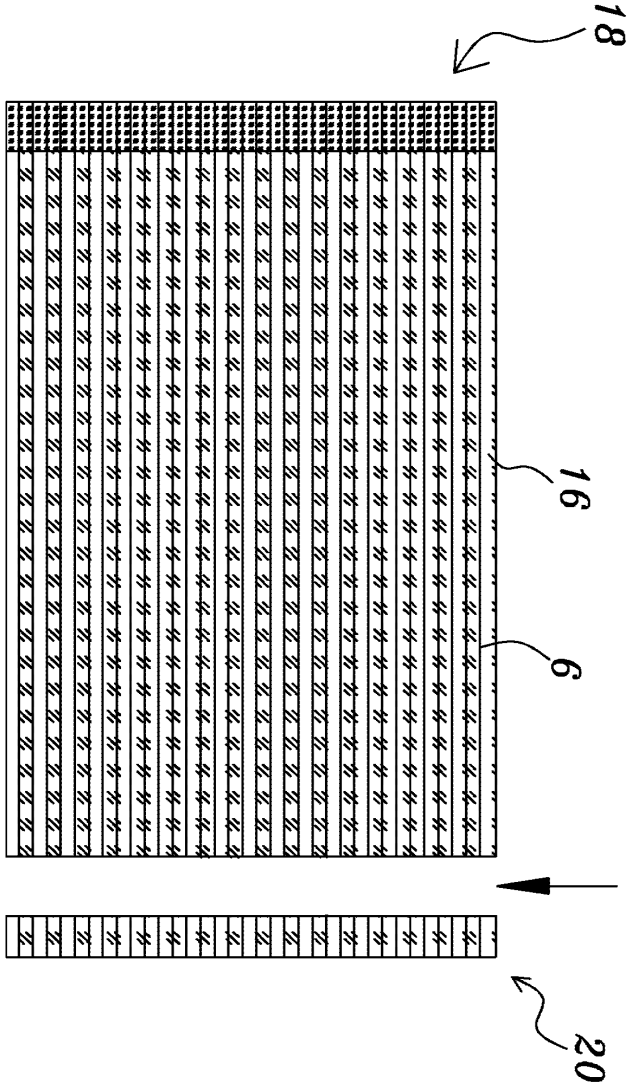



Fig. 6j

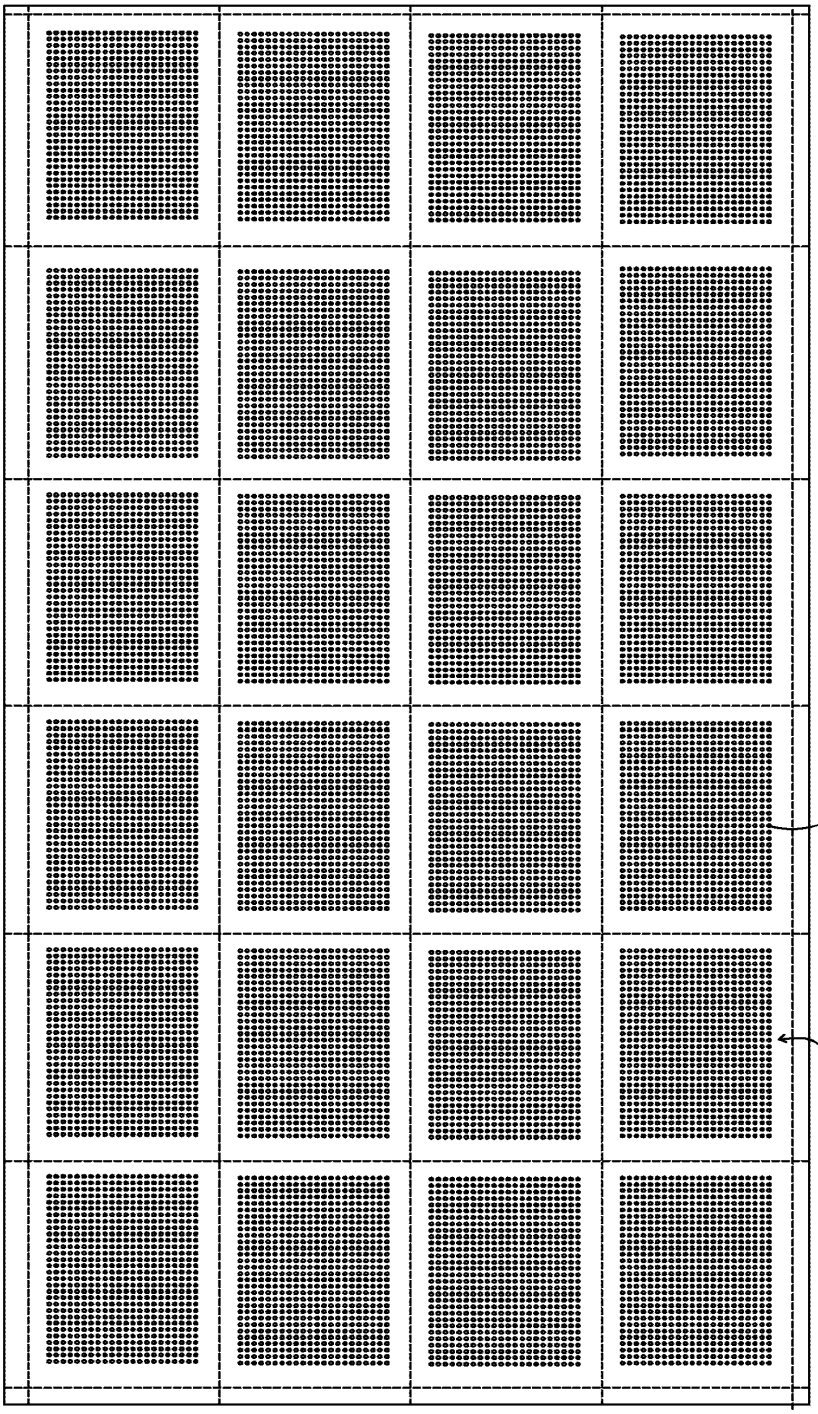



Fig. 6k

IPR2026-00067
TSMC EX1002 Page 183

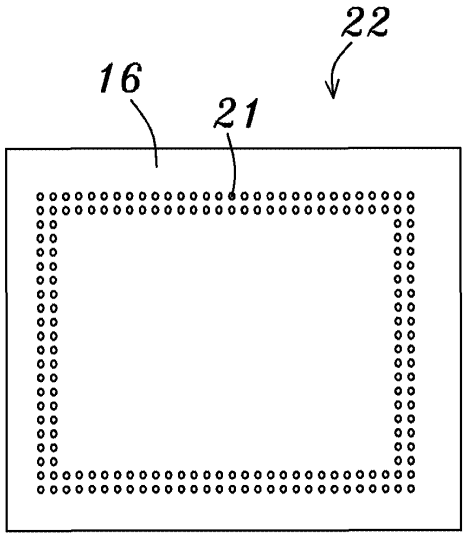



Fig. 6l

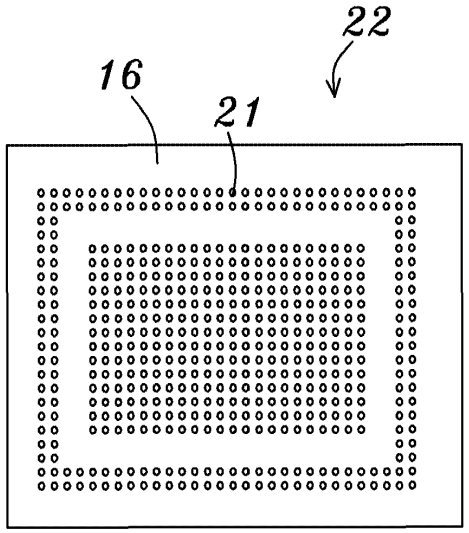



Fig. 6m

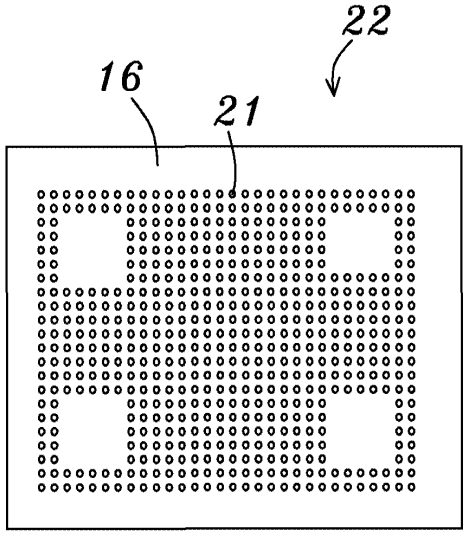



Fig. 6n

IPR2026-00067
TSMC EX1002 Page 184

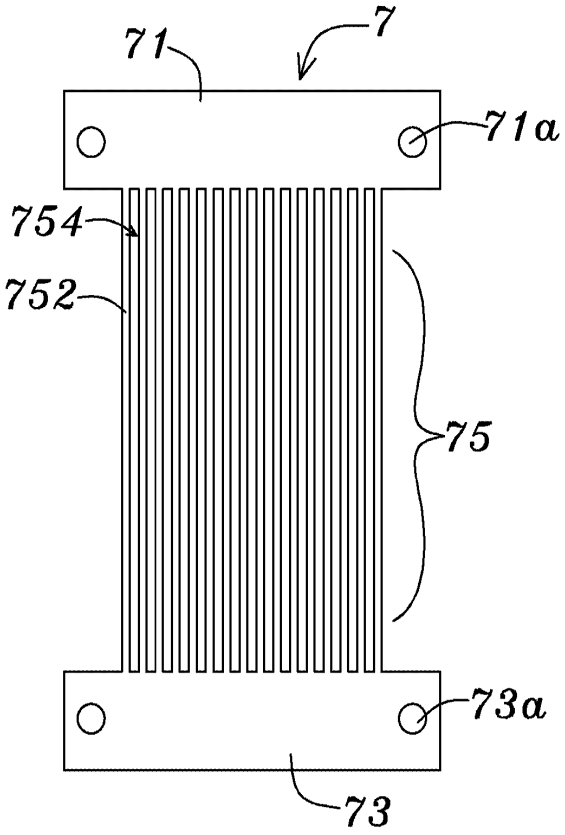



Fig. 7a

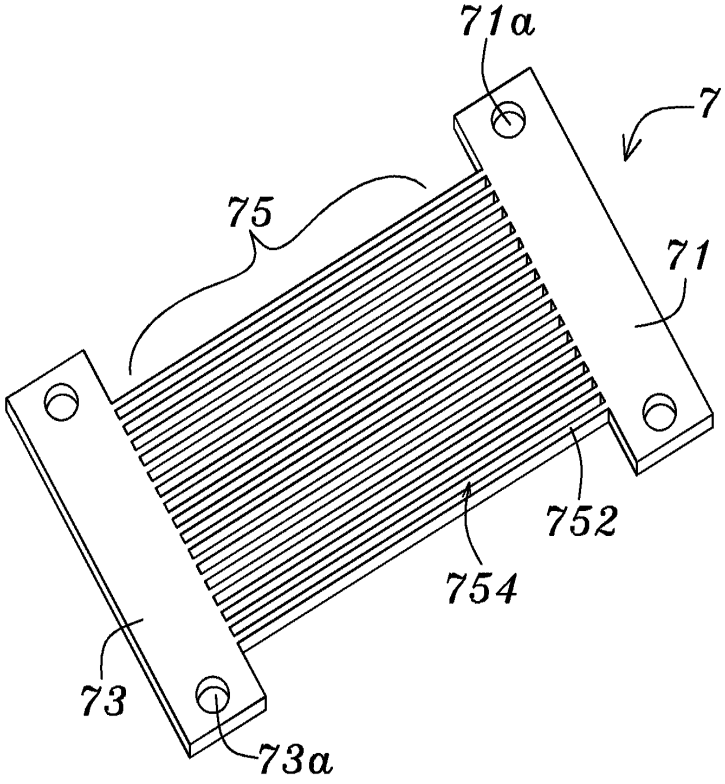



Fig. 7b

IPR2026-00067
TSMC EX1002 Page 185

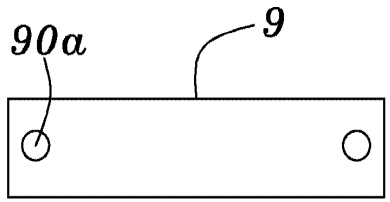



Fig. 7c

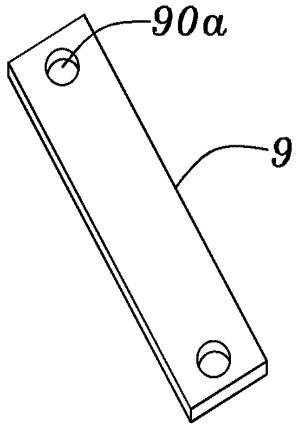



Fig. 7d

IPR2026-00067
TSMC EX1002 Page 186

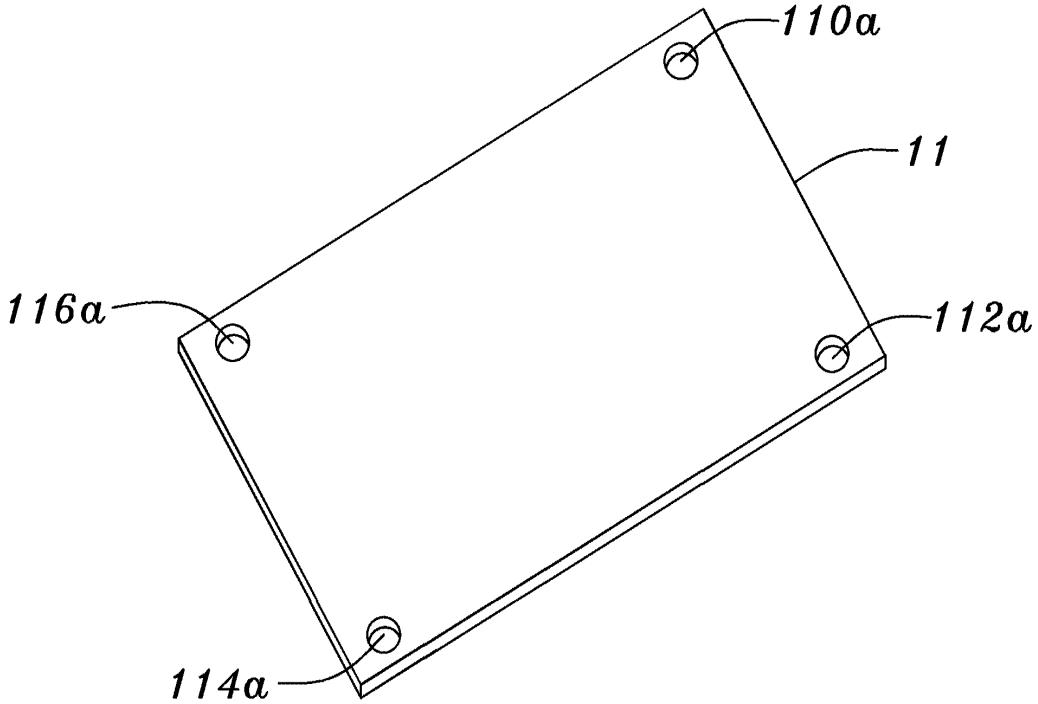



Fig. 7e

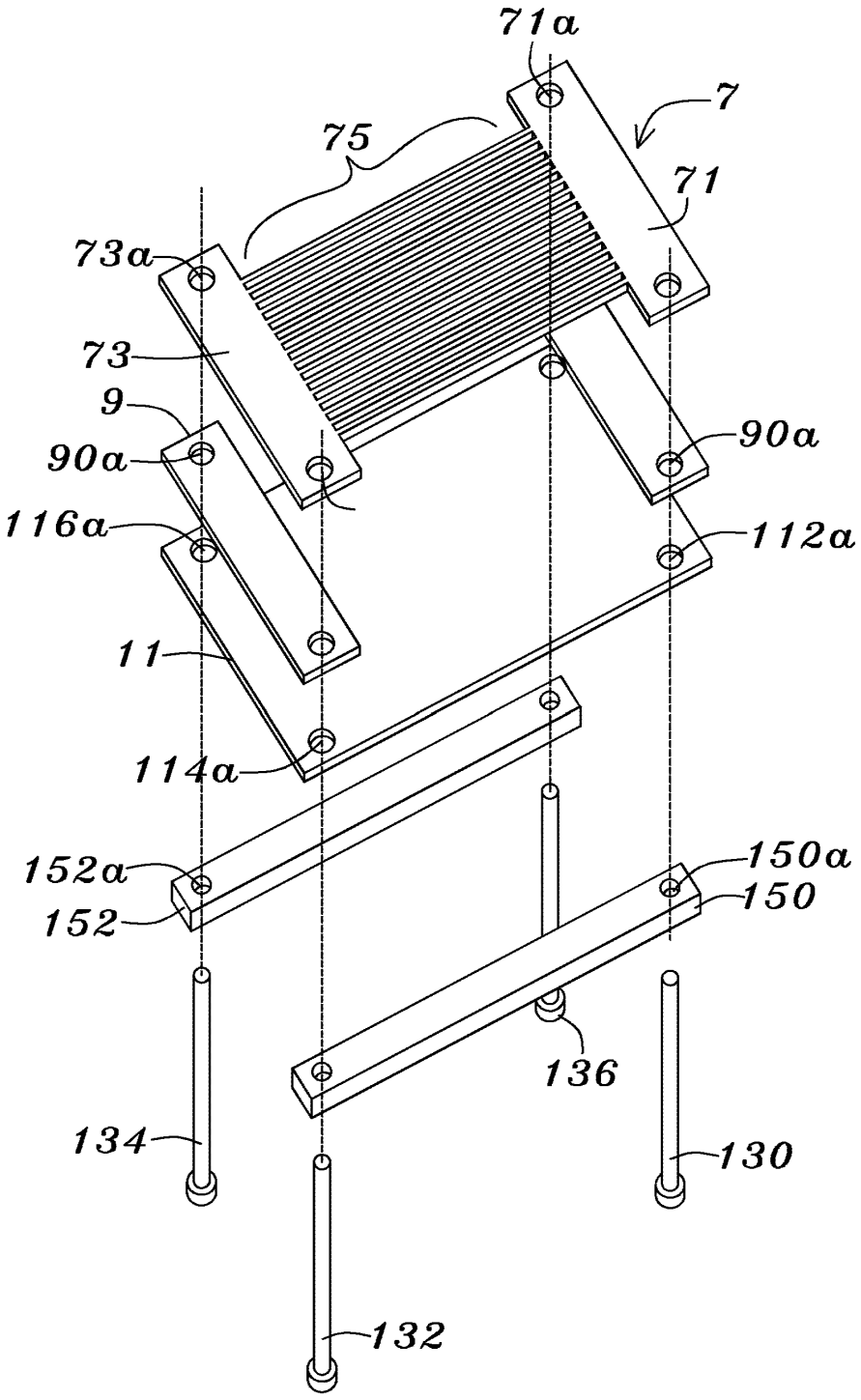

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Fig. 7f

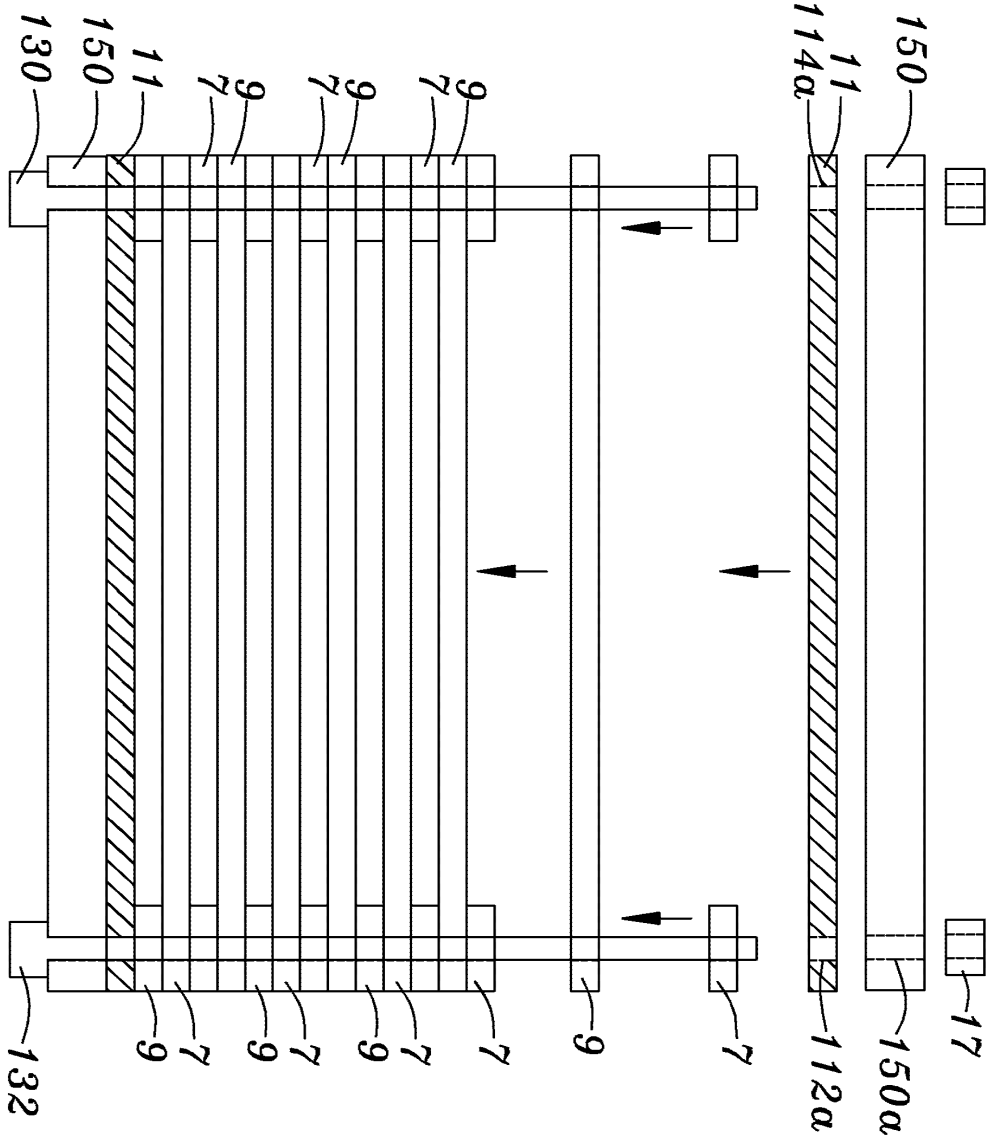



Fig. 7g

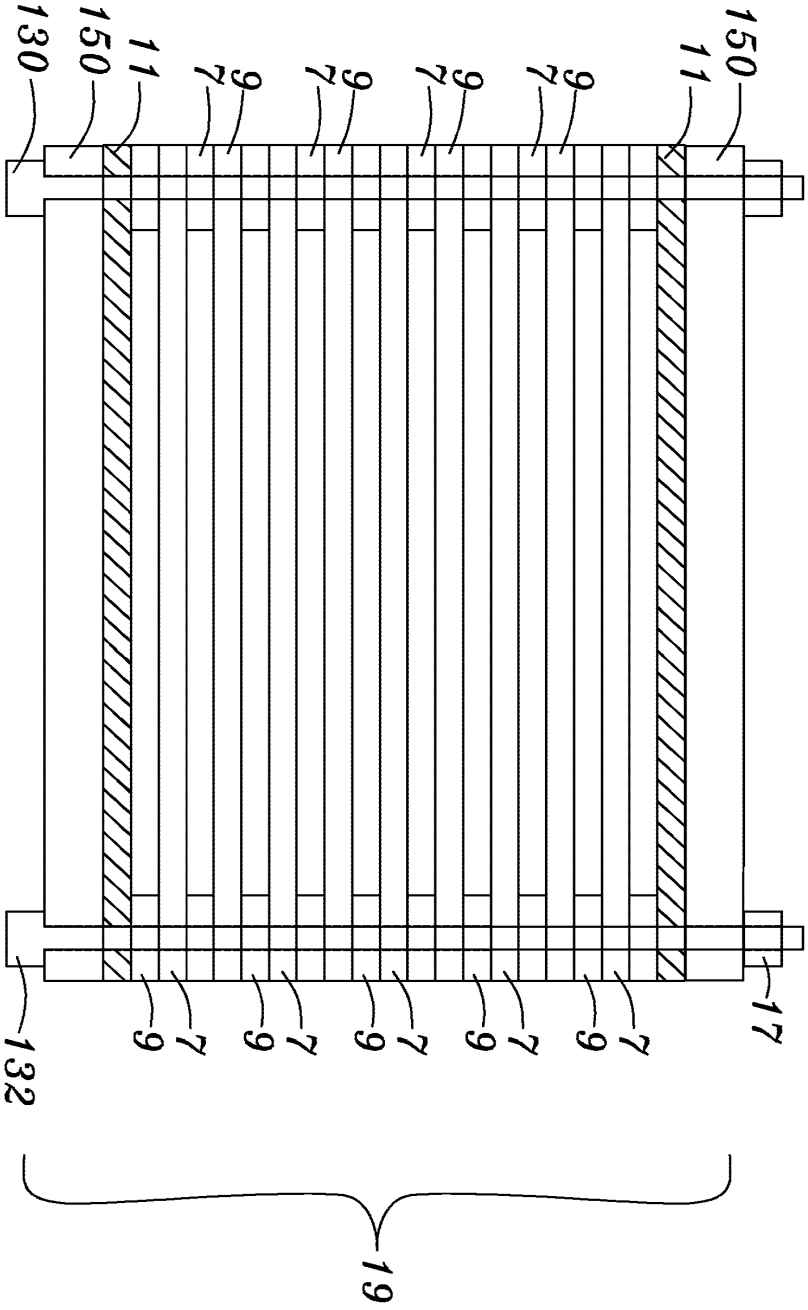



Fig. 7h

IPR2026-00067
TSMC EX1002 Page 190

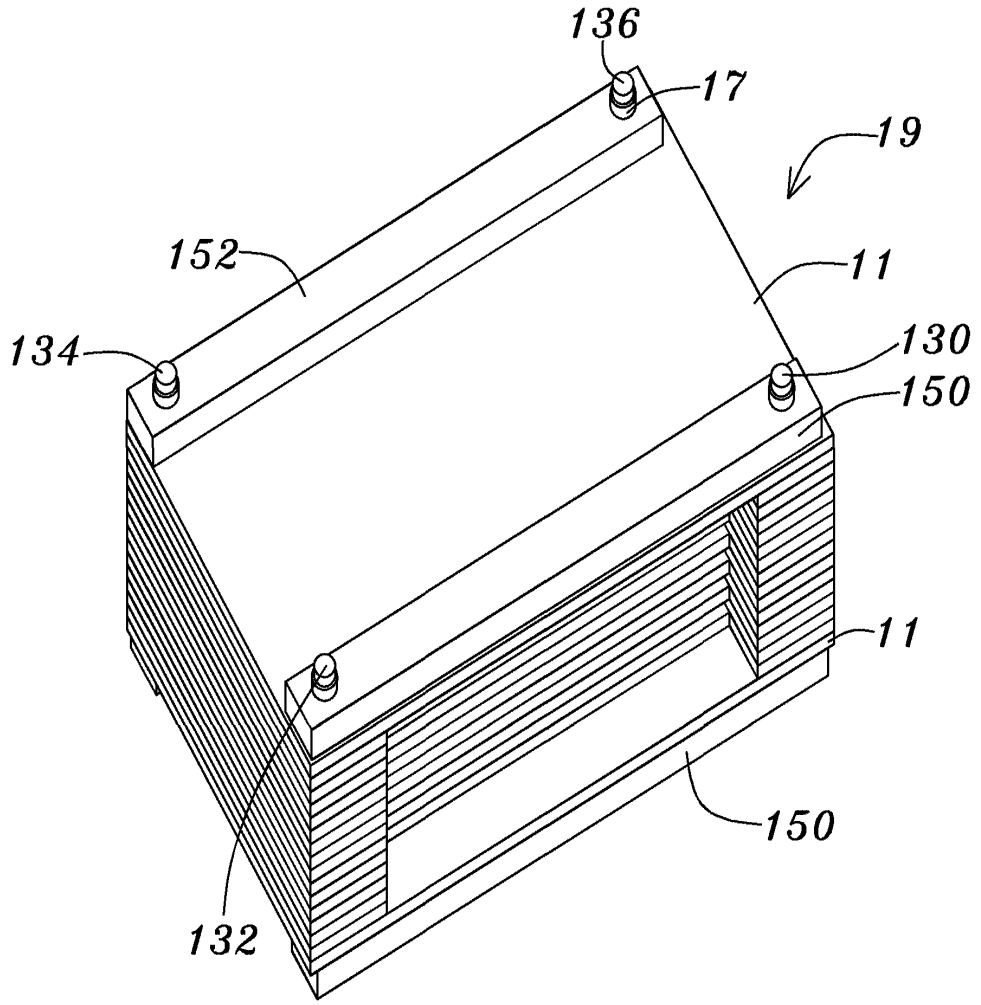



Fig. 7i

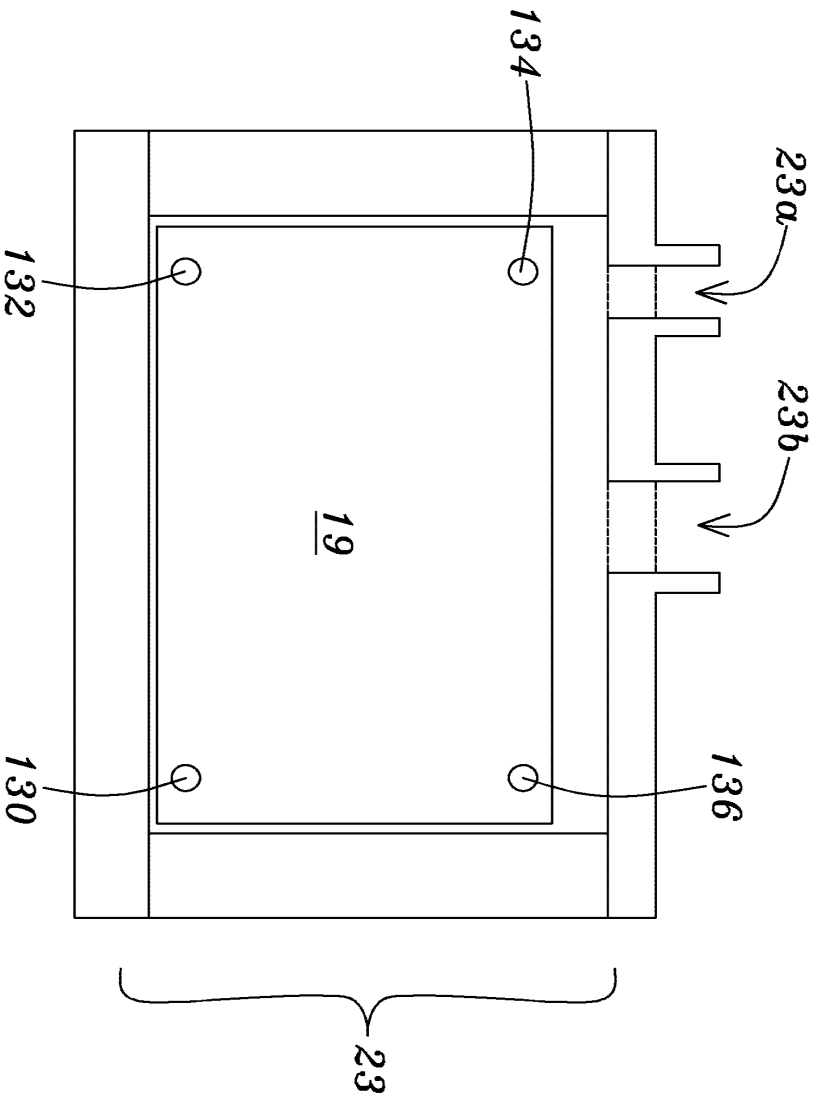



Fig. 7j

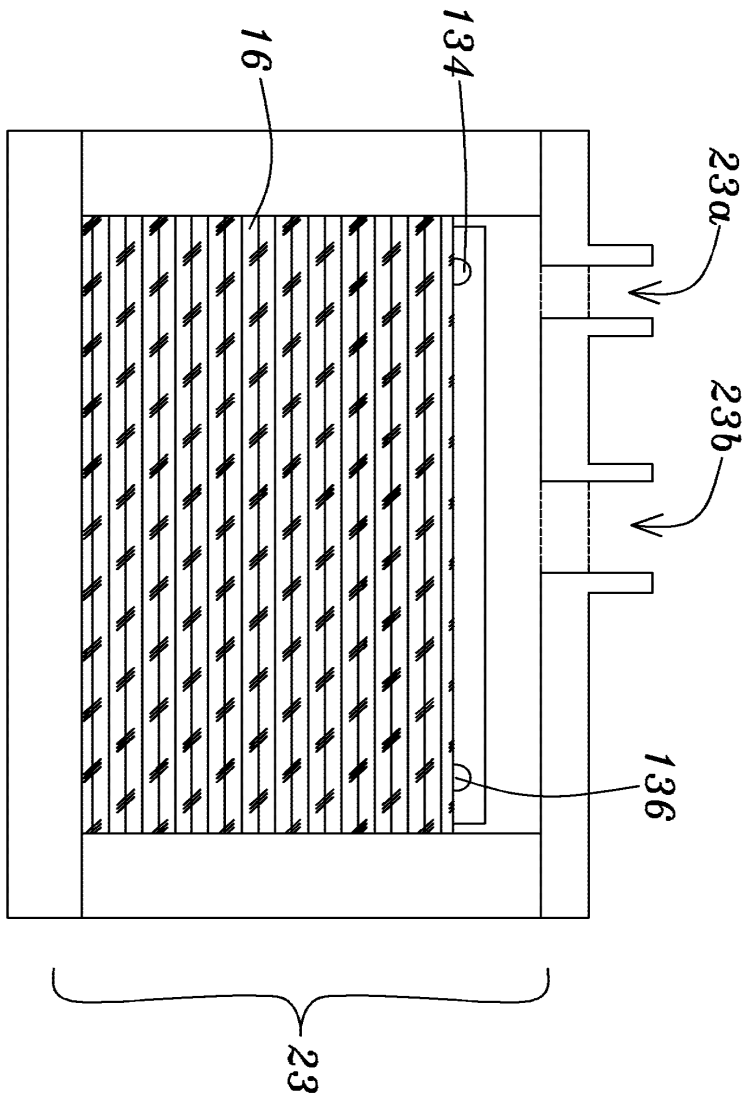



Fig. 7k

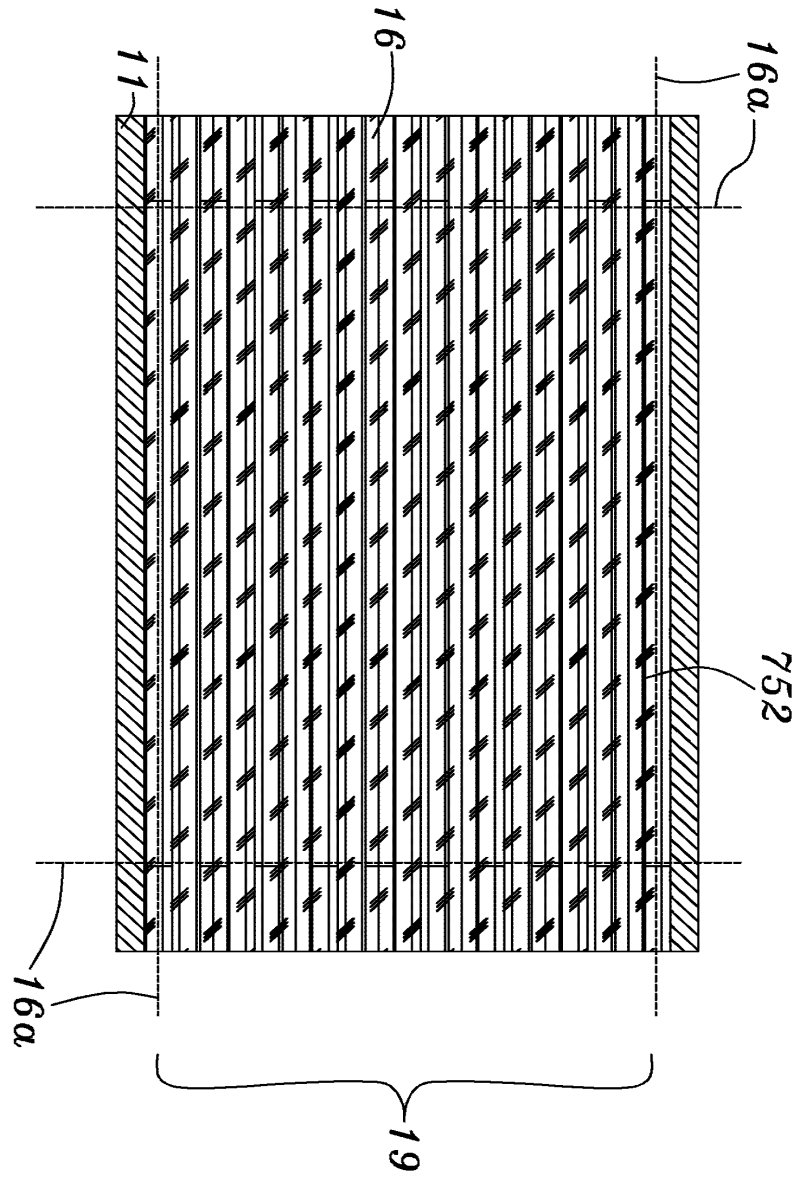



Fig. 7l

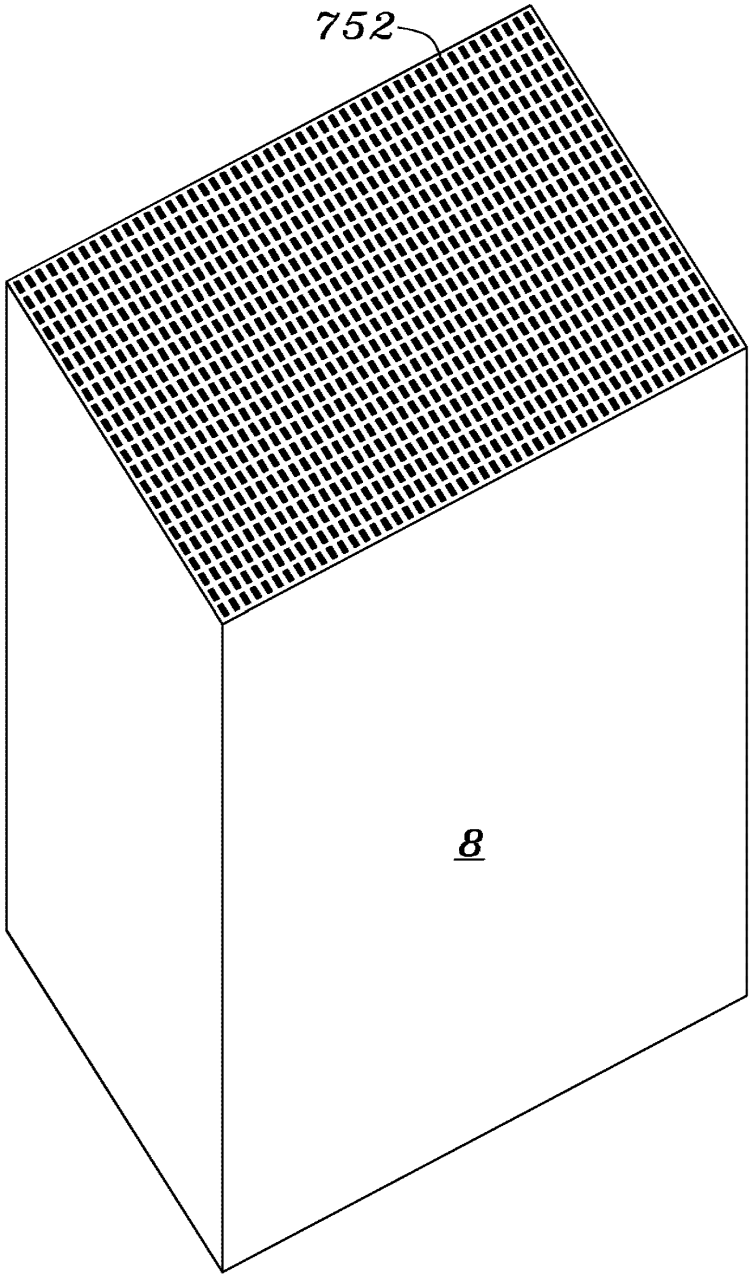



Fig. 7m

IPR2026-00067
TSMC EX1002 Page 195

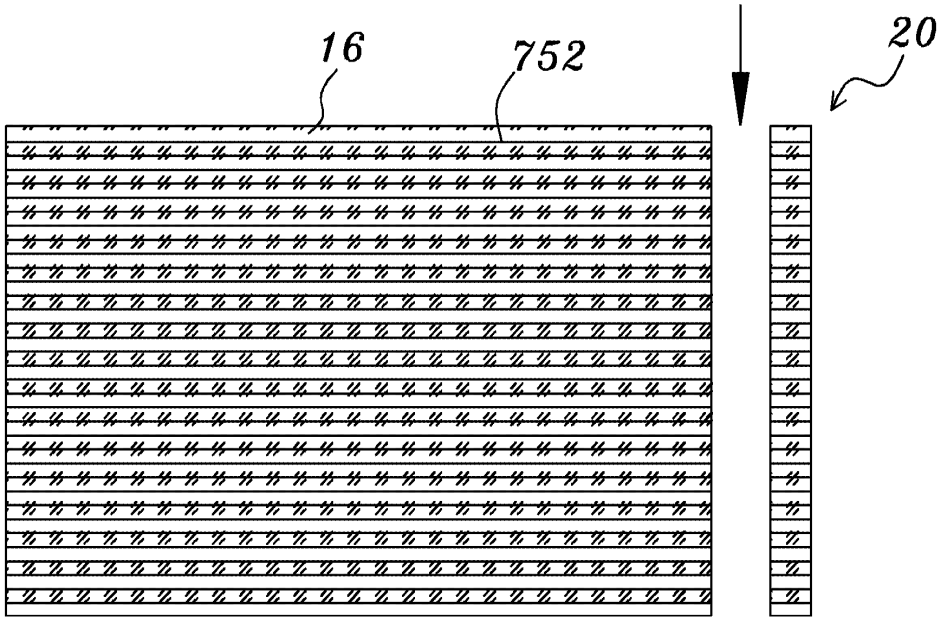



Fig. 7n

IPR2026-00067
TSMC EX1002 Page 196

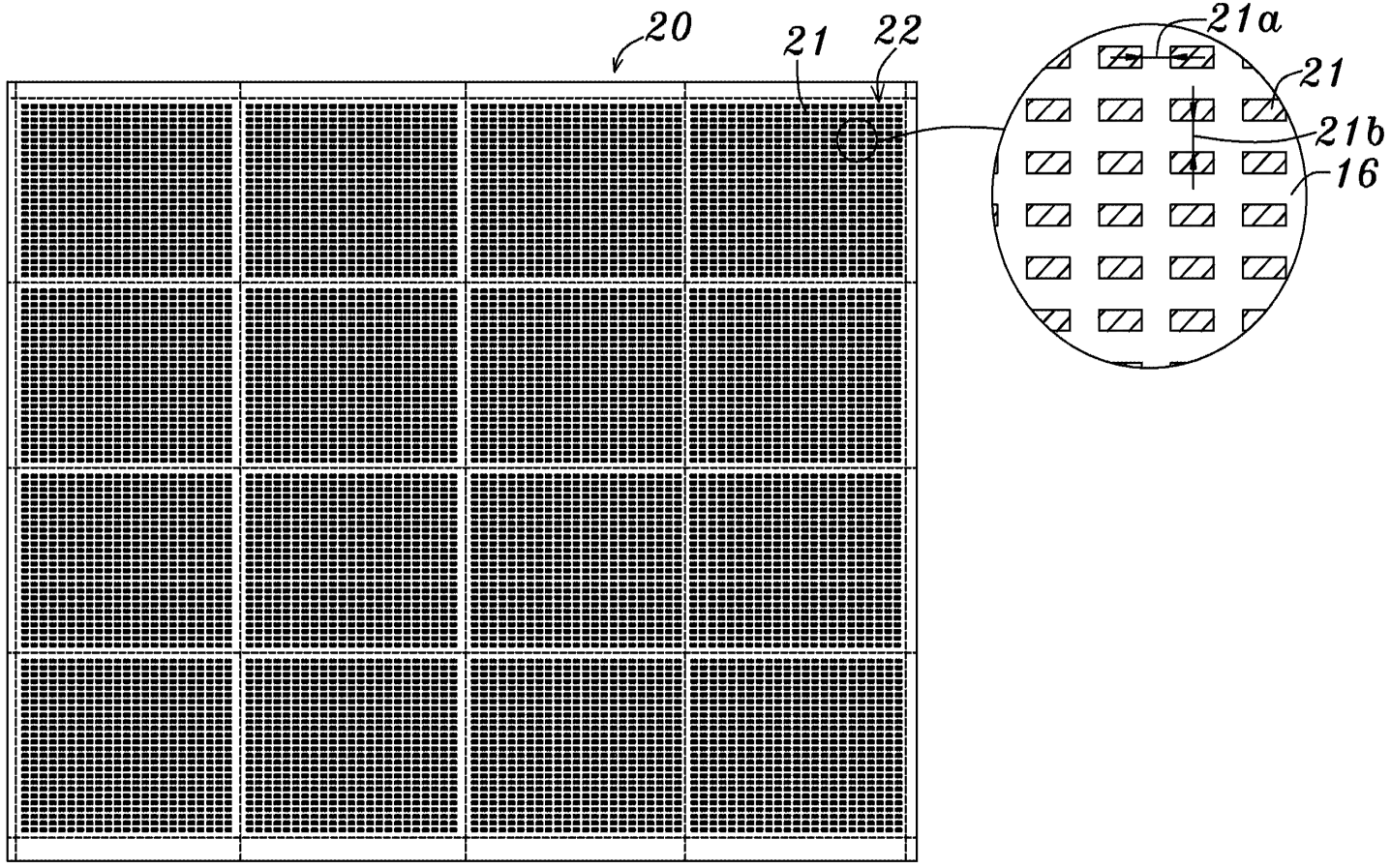



Fig. 7o

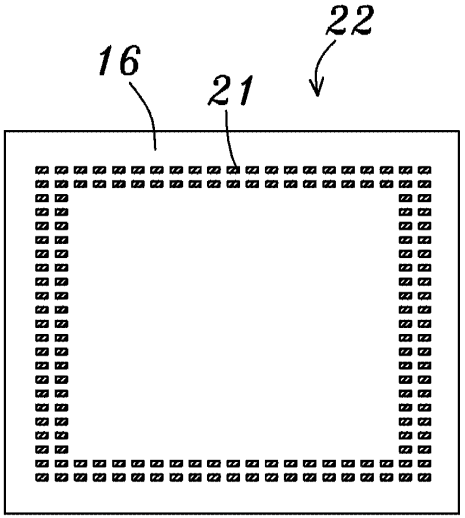



Fig. 7p

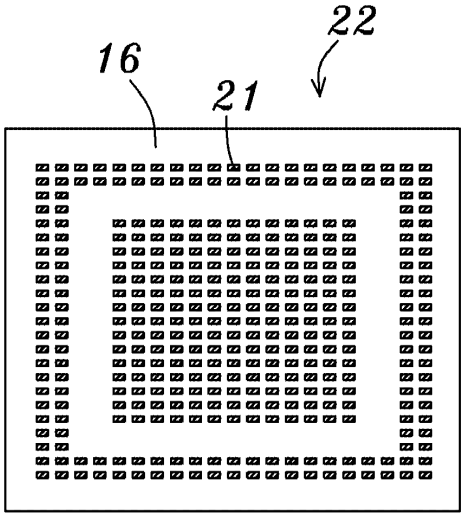



Fig. 7q

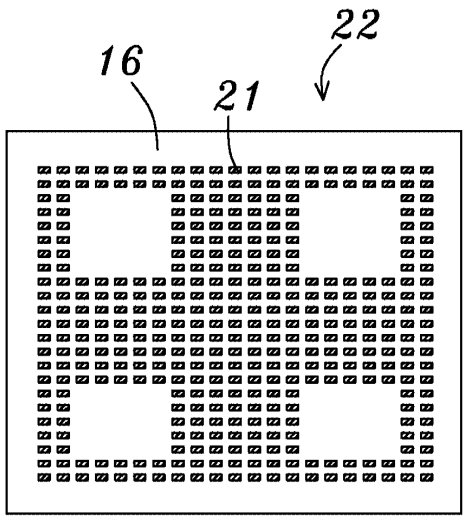



Fig. 7r

IPR2026-00067
TSMC EX1002 Page 197

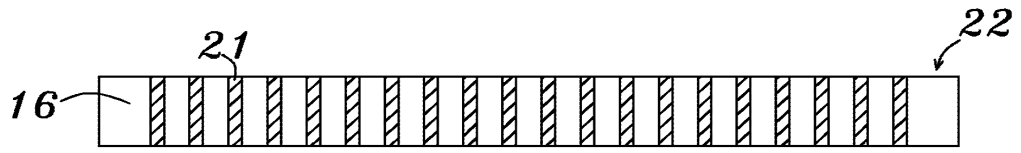



Fig. 8a

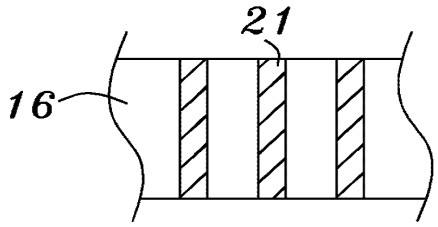



Fig. 8b

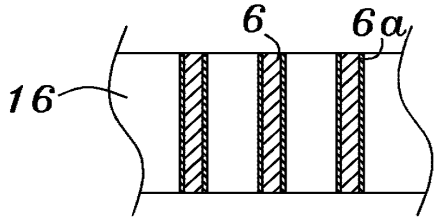



Fig. 8c

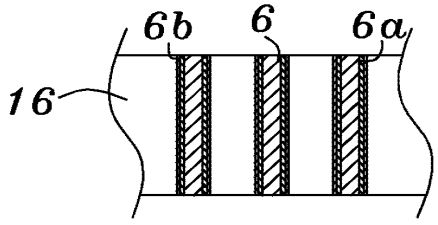



Fig. 8d

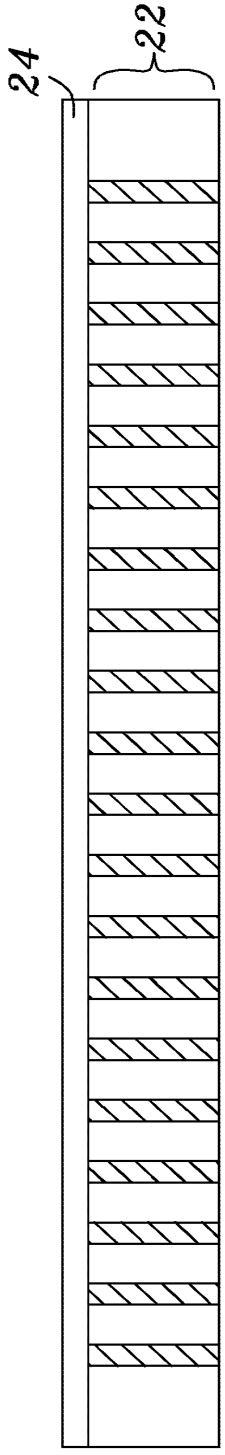



Fig. 9a

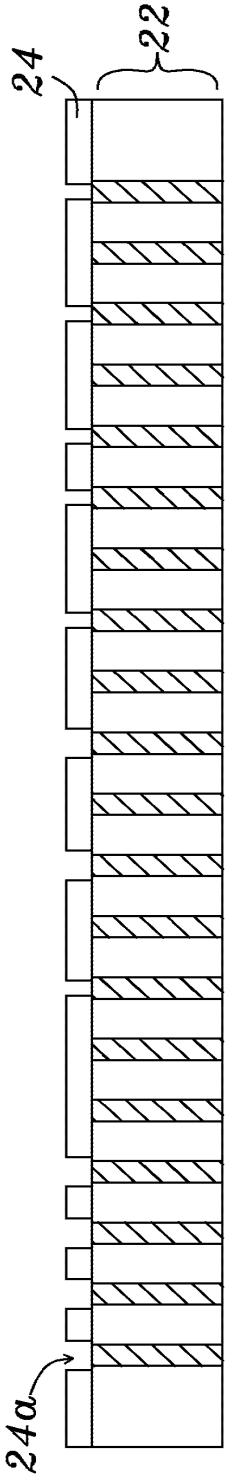



Fig. 9b

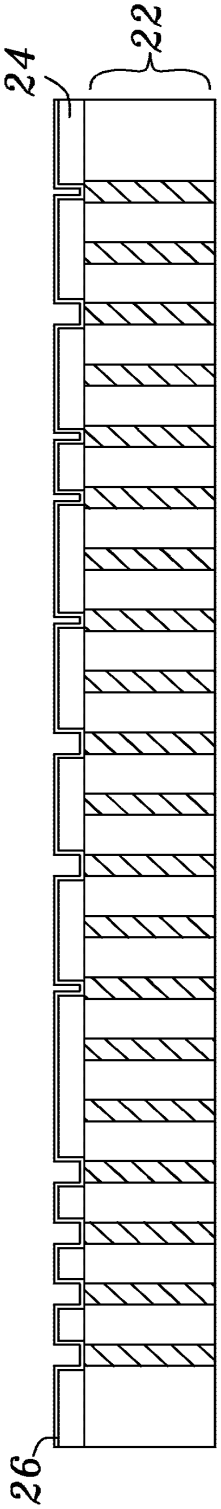



Fig. 9c

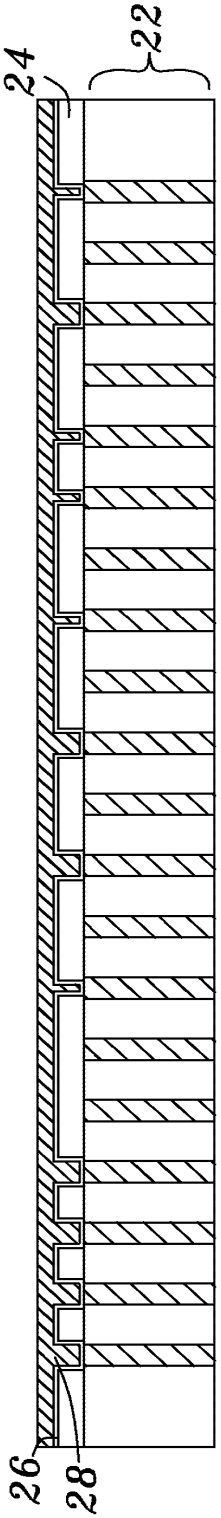



Fig. 9d

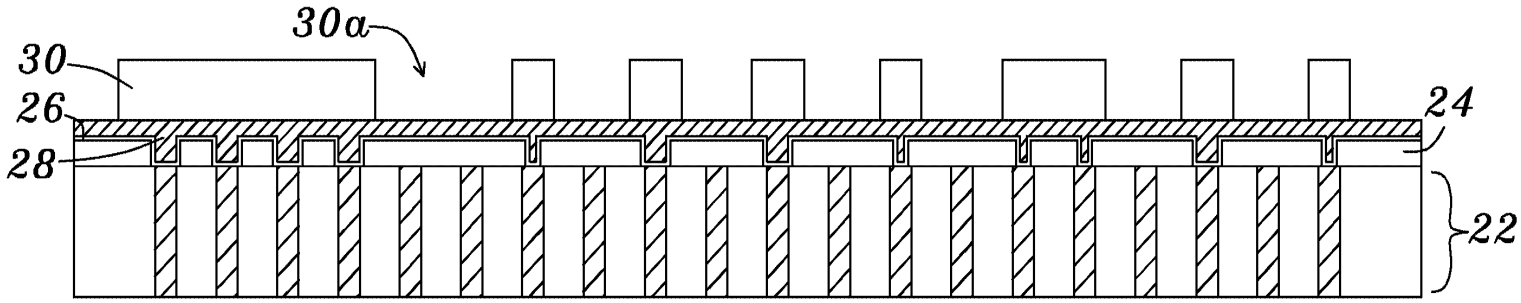



Fig. 9e

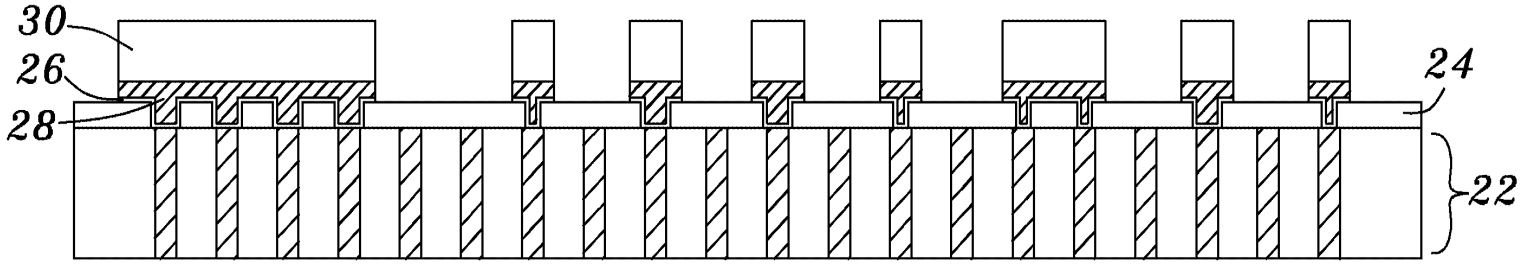



Fig. 9f

IPR2026-00067
TSMC EX1002 Page 201

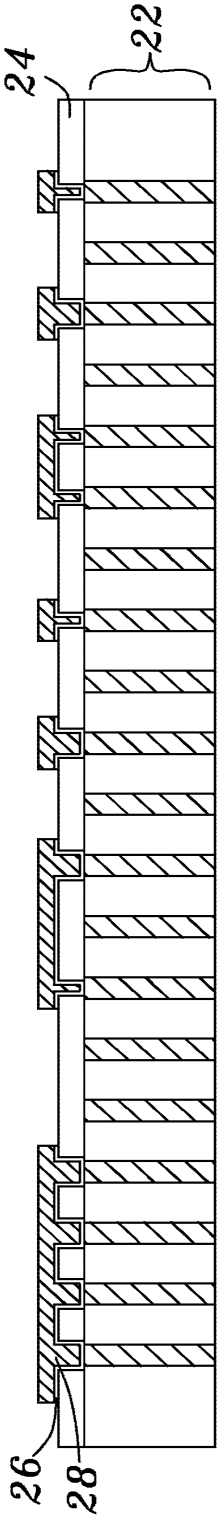



Fig. 9g

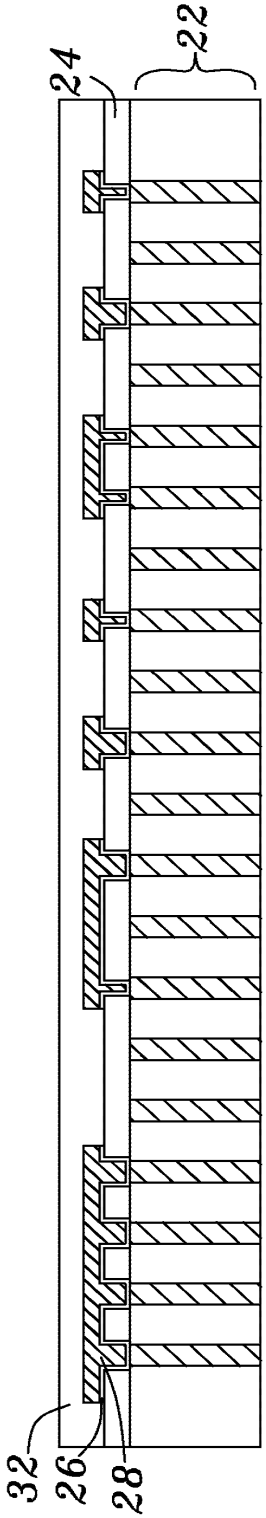



Fig. 9h

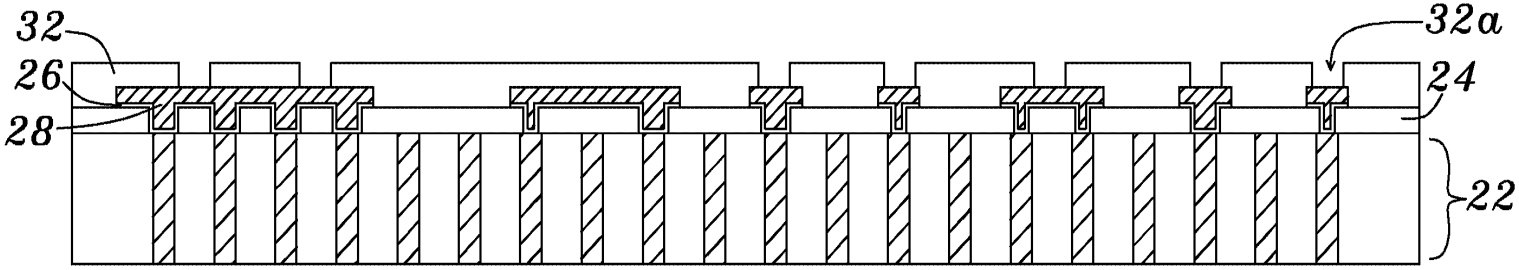



Fig. 9i

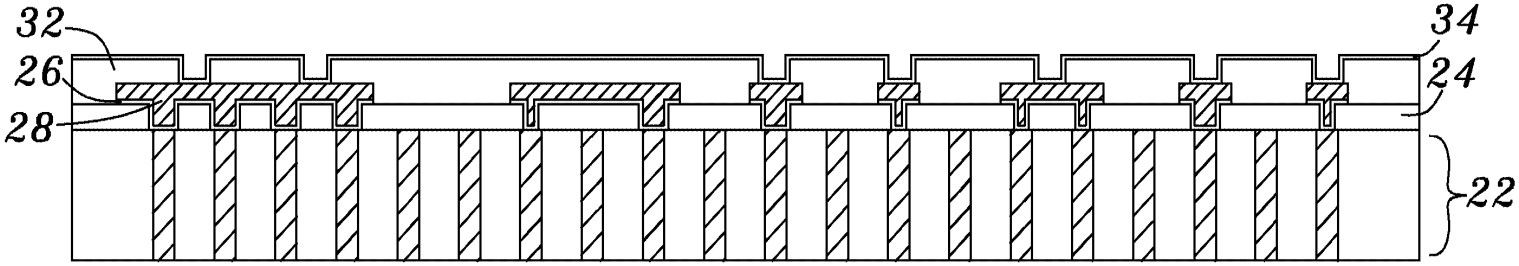



Fig. 9j

IPR2026-00067
TSMC EX1002 Page 203

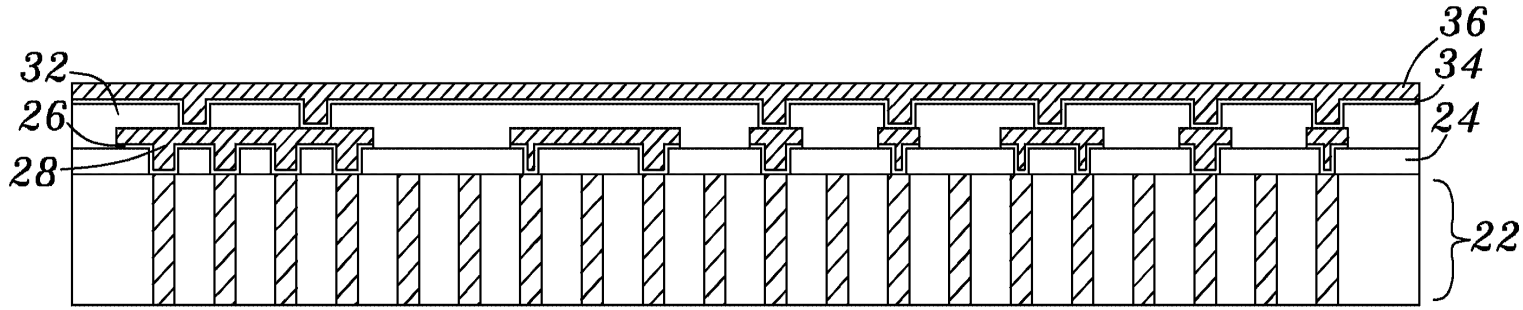



Fig. 9k

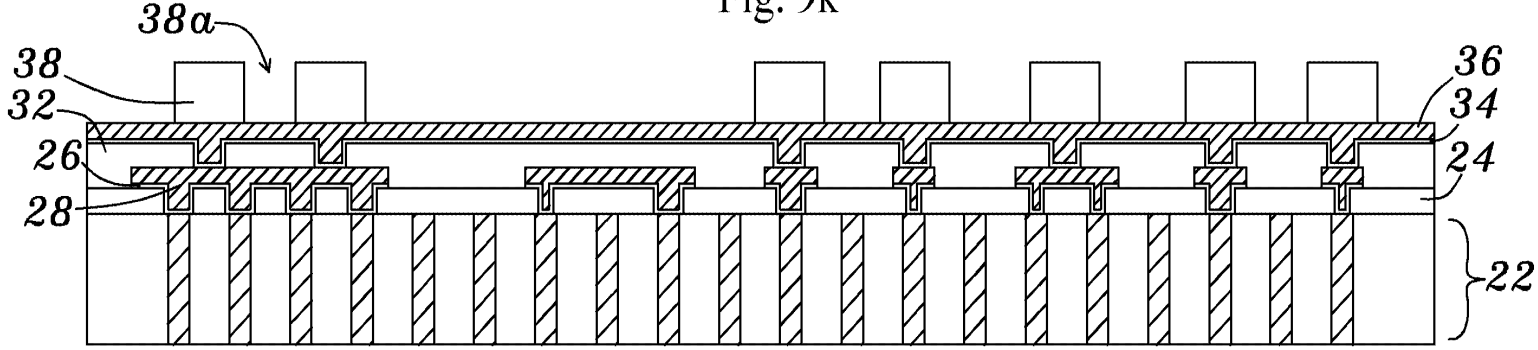



Fig. 9l

IPR2026-00067
TSMC EX1002 Page 204

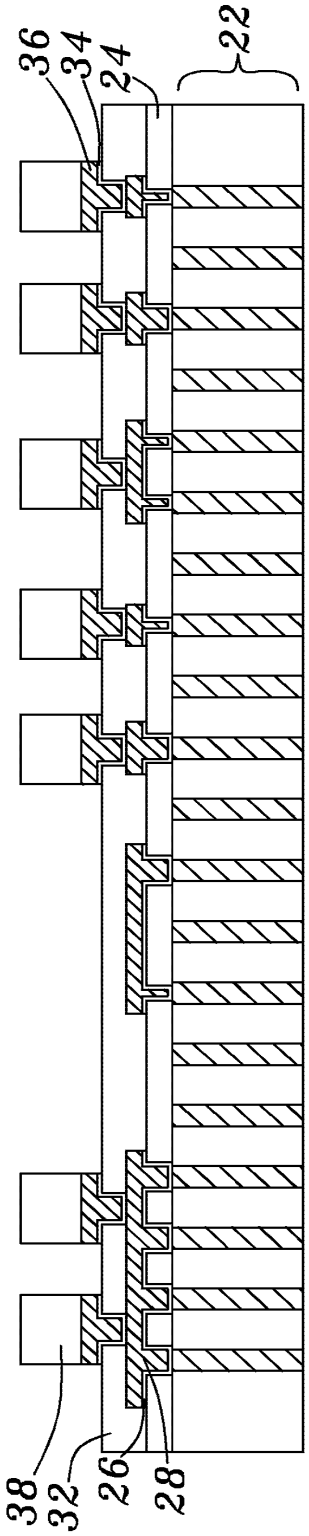



Fig. 9m

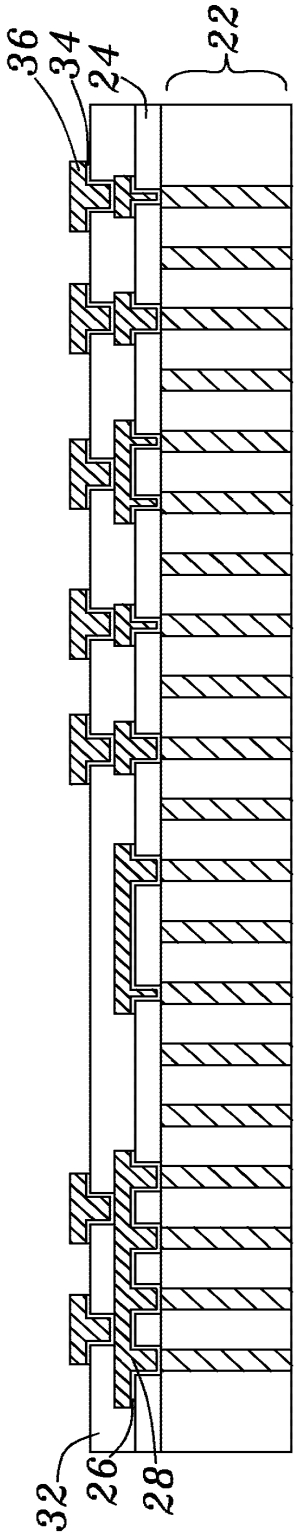



Fig. 9n

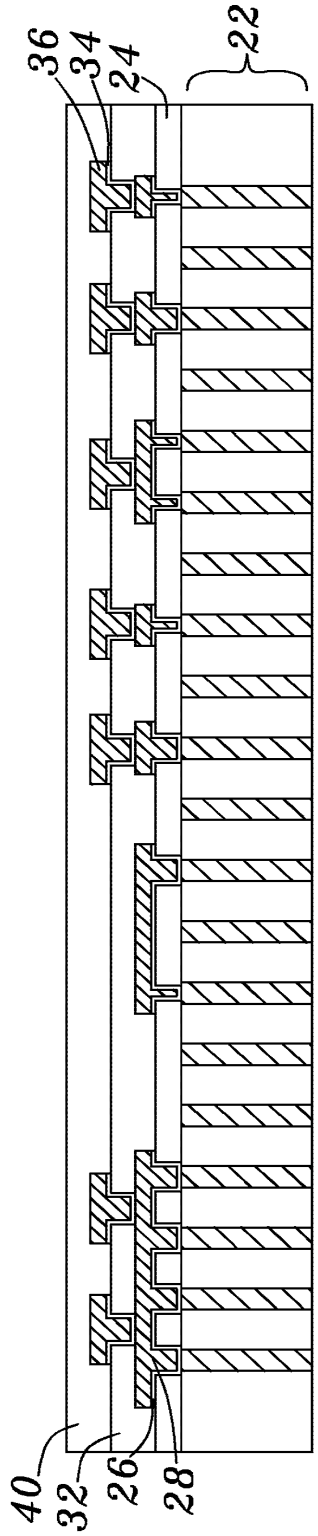



Fig. 9o

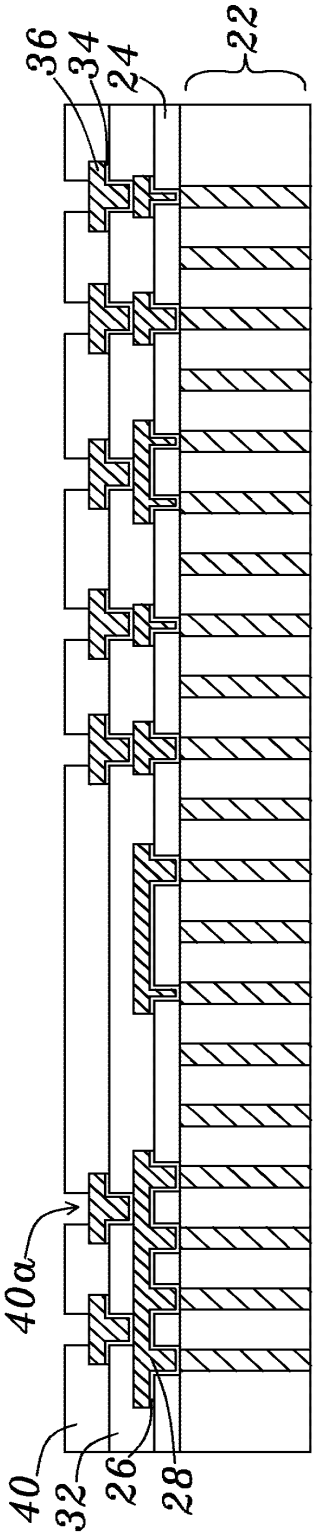



Fig. 9p

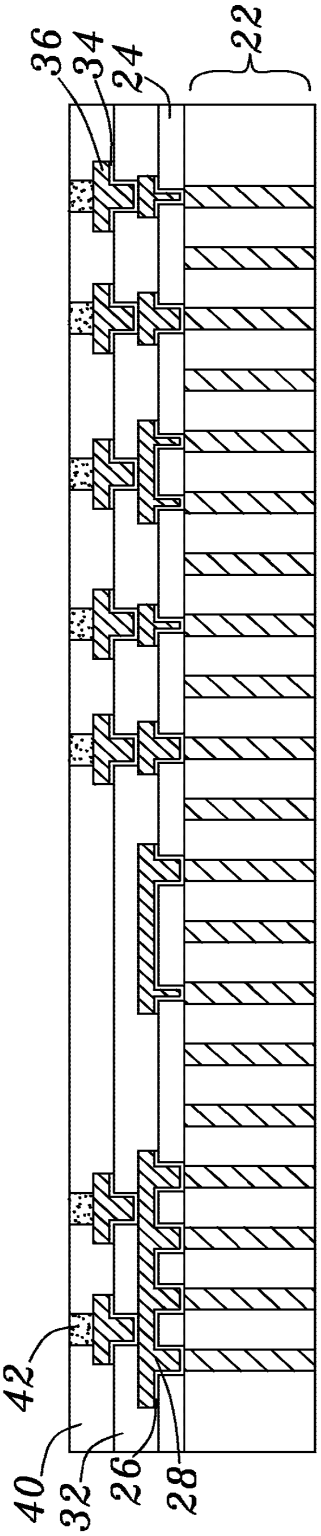

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Fig. 9q

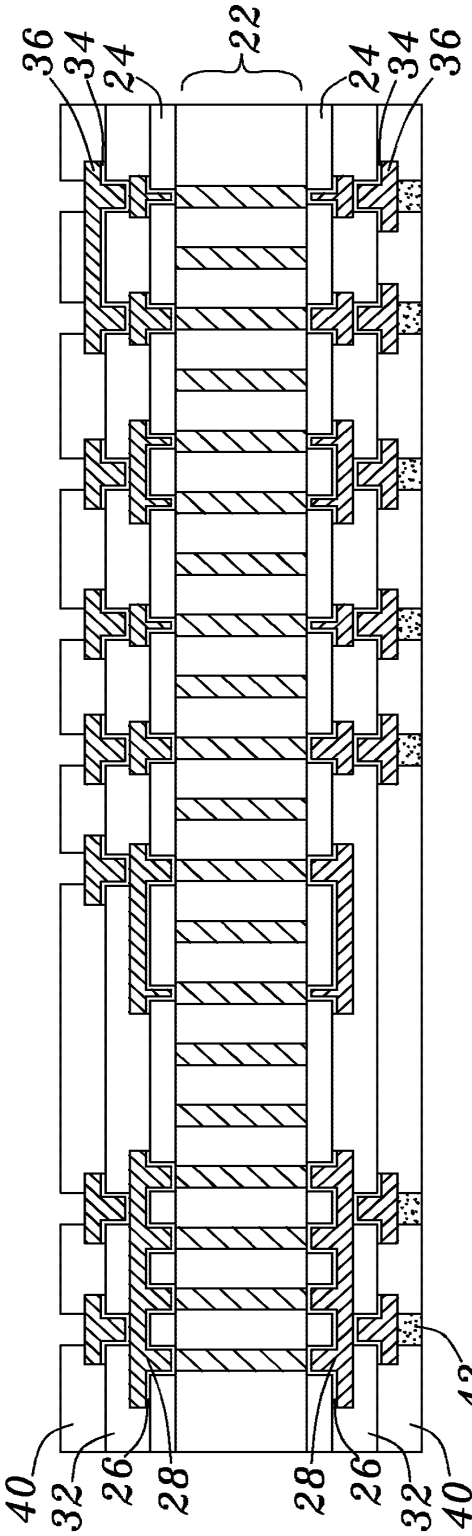

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Fig. 9r

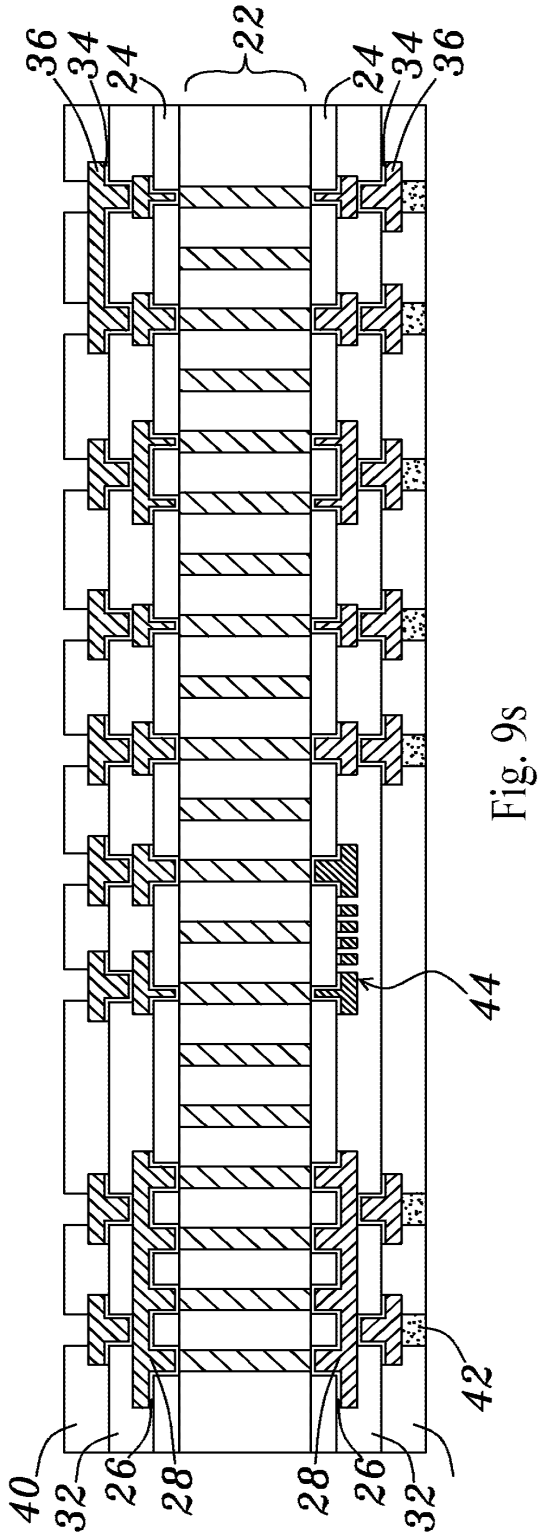



Fig. 9s

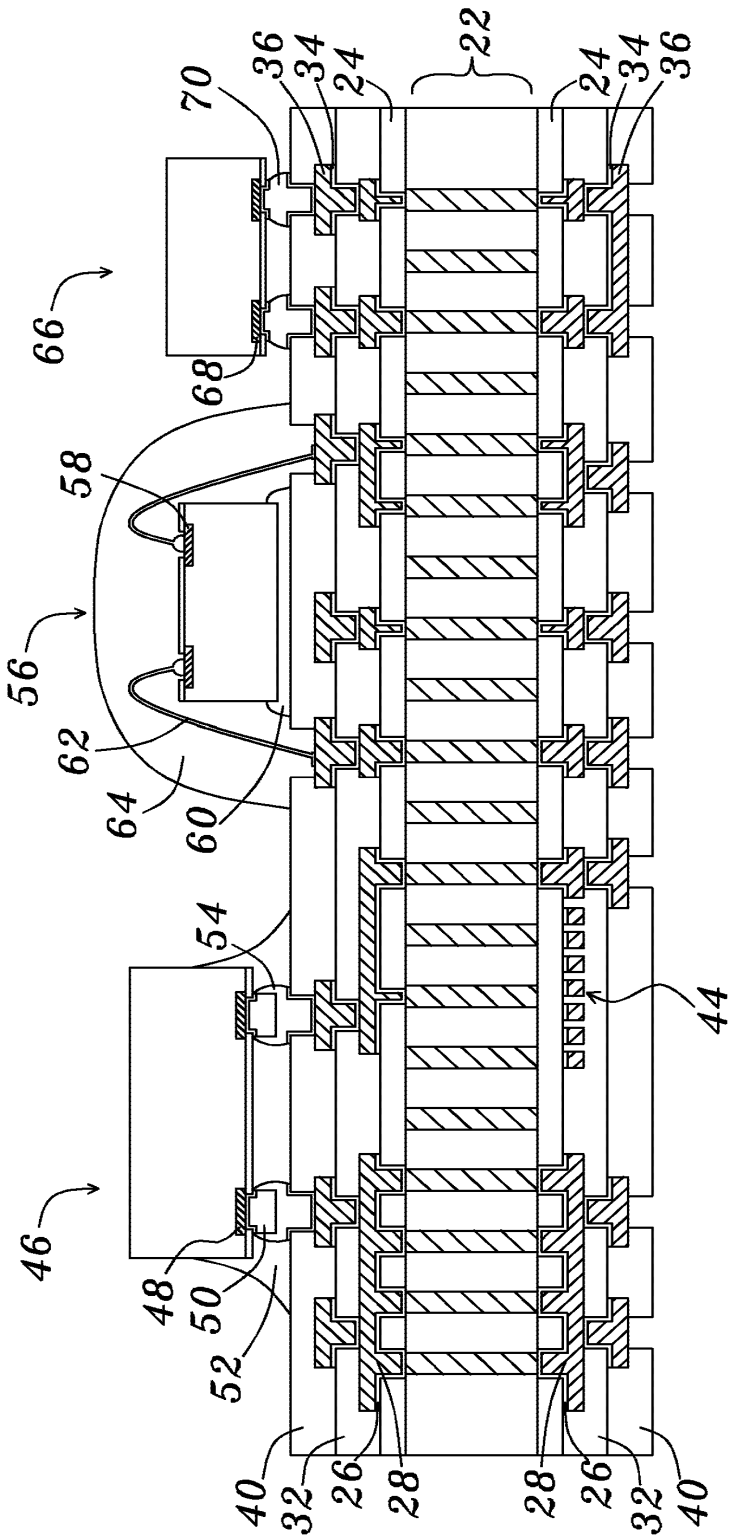

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Fig. 9t

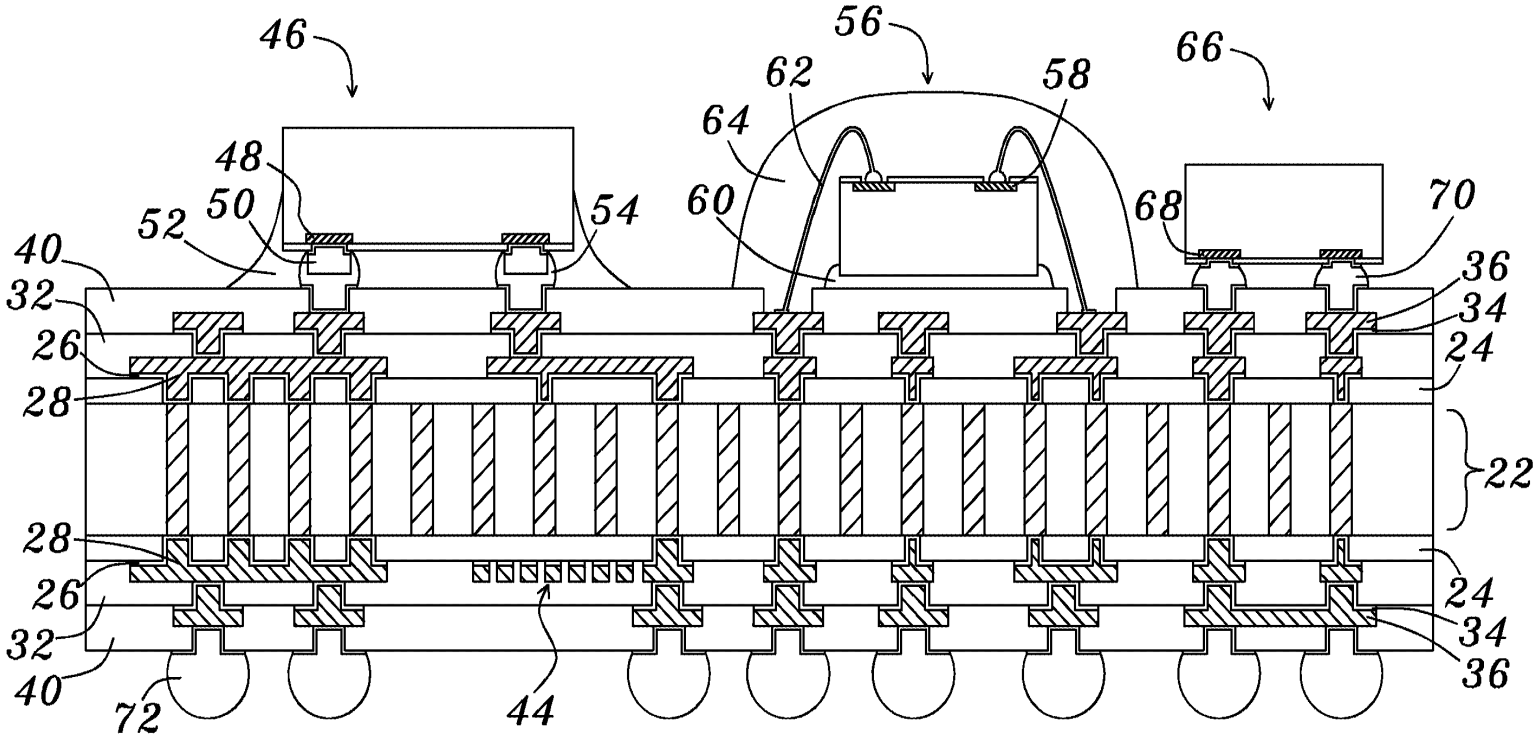



Fig. 9u

IPR2026-00067
TSMC EX1002 Page 210

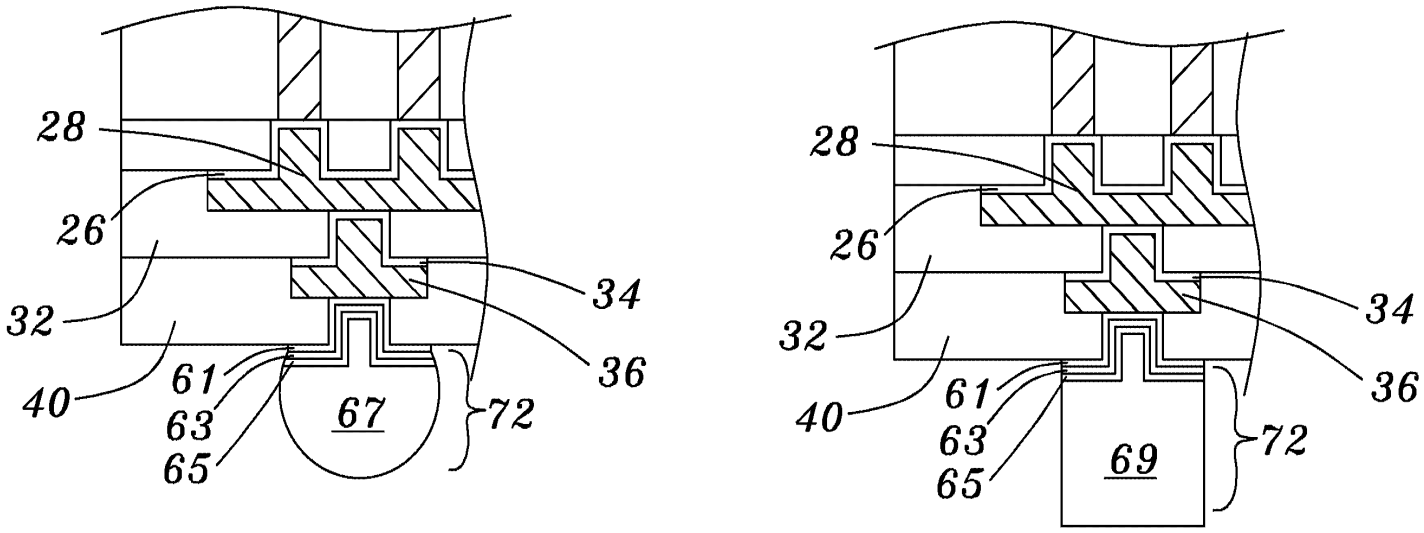



Fig. 9v

IPR2026-00067
TSMC EX1002 Page 211

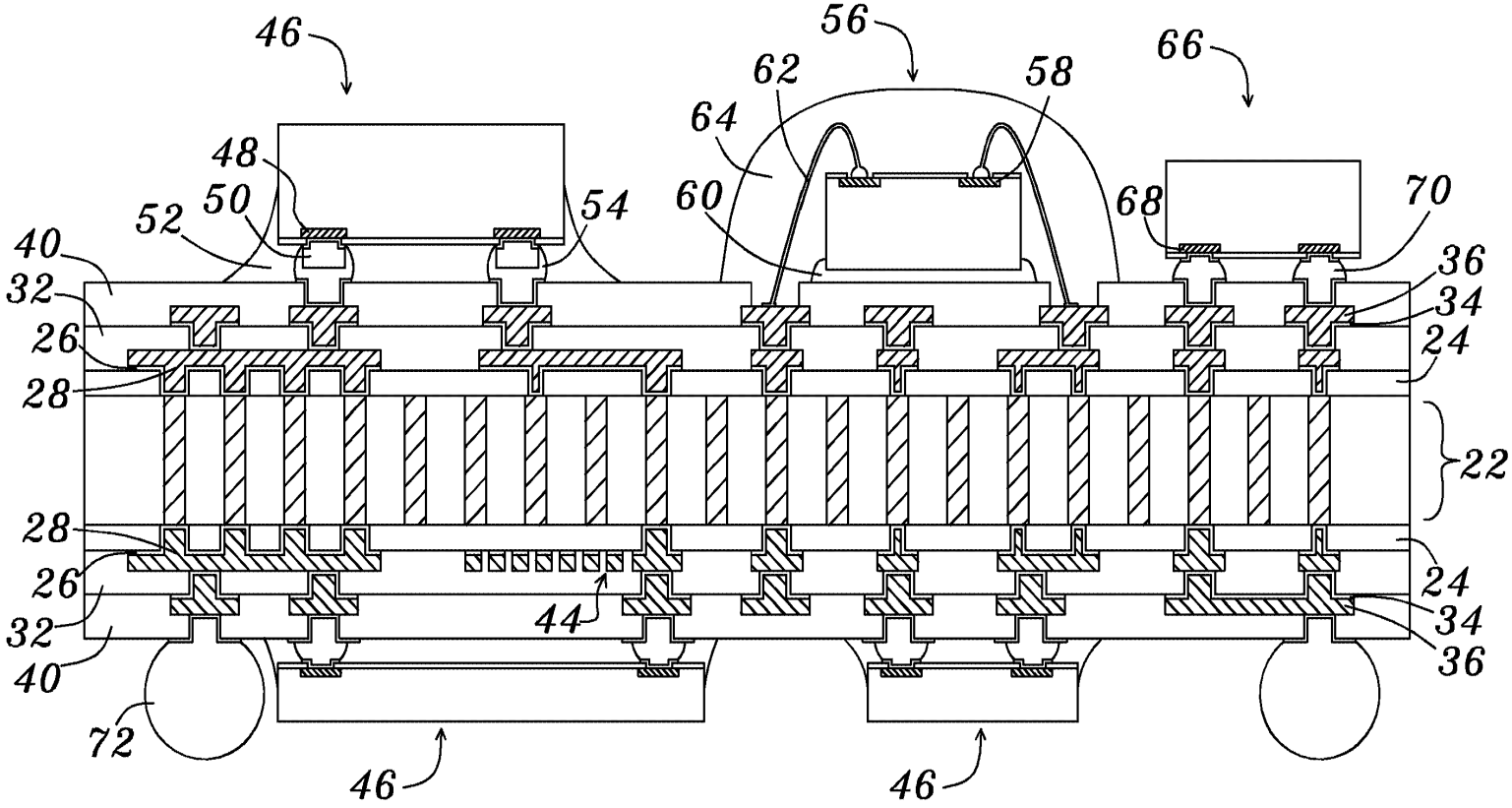



Fig. 9w

IPR2026-00067
TSMC EX1002 Page 212

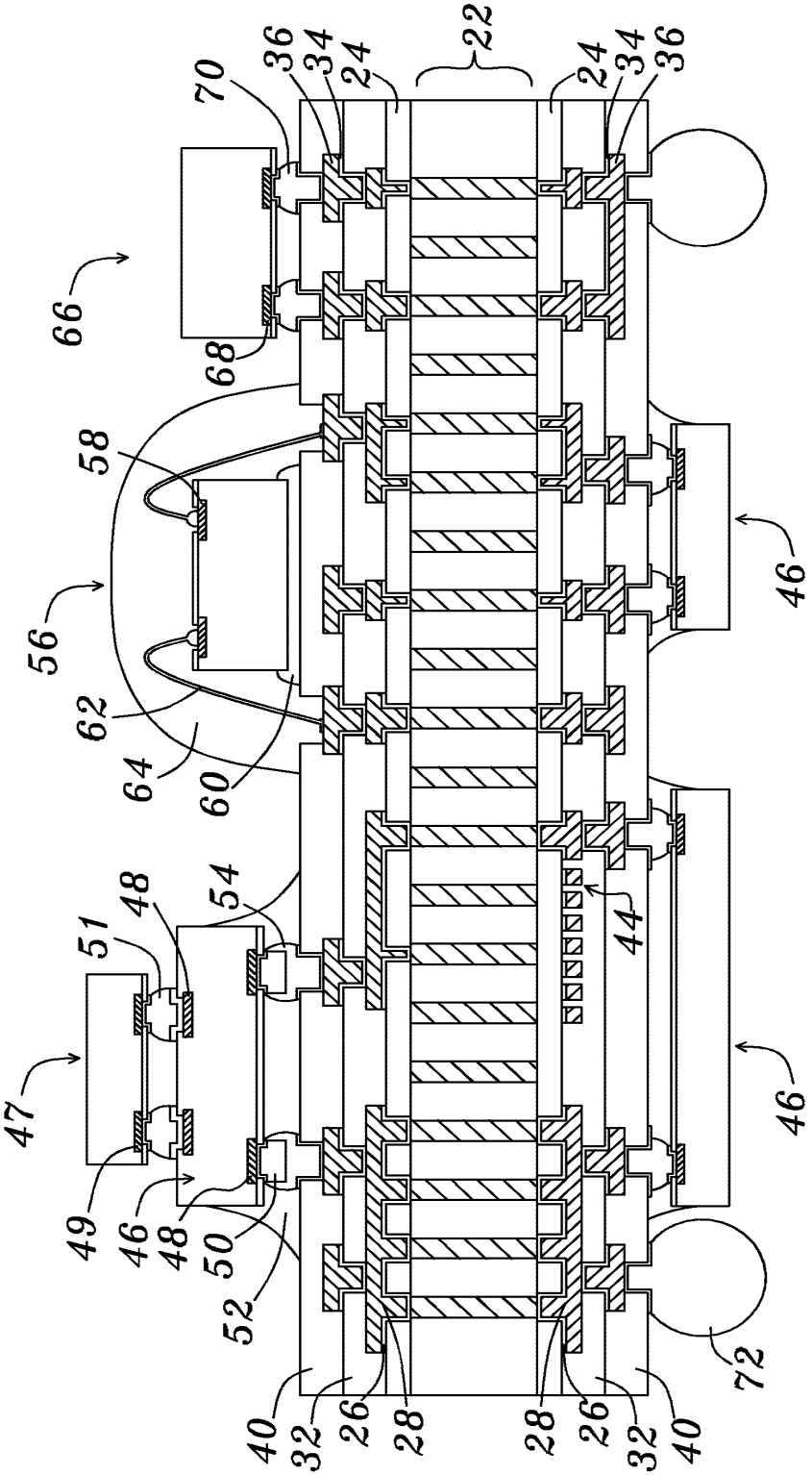

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Fig. 9x

IPR2026-00067
TSMC EX1002 Page 214

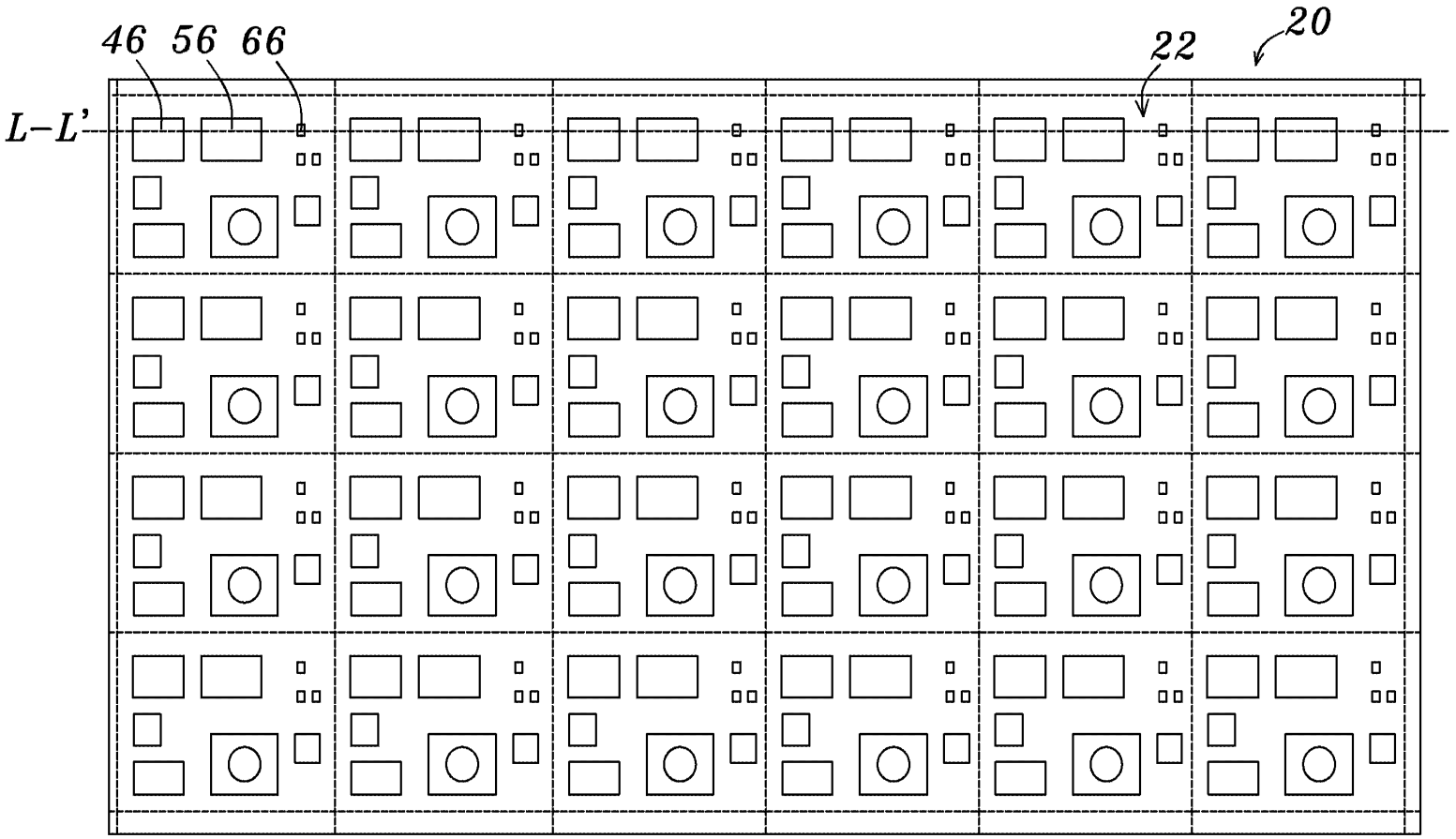



Fig. 9y

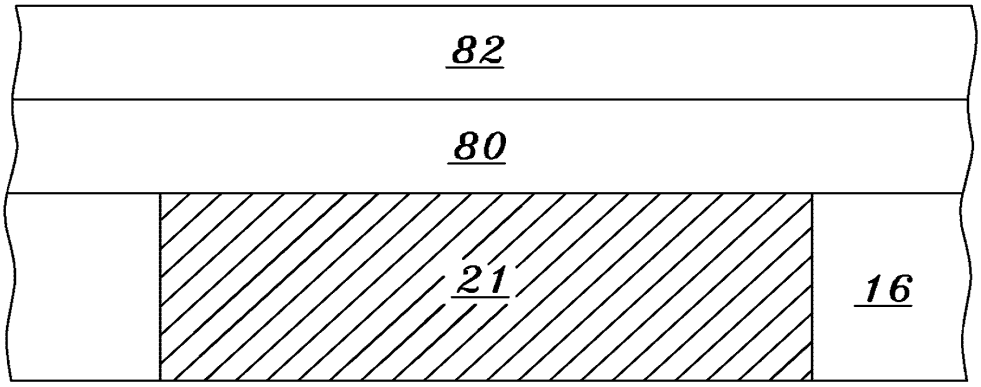



Fig. 10a

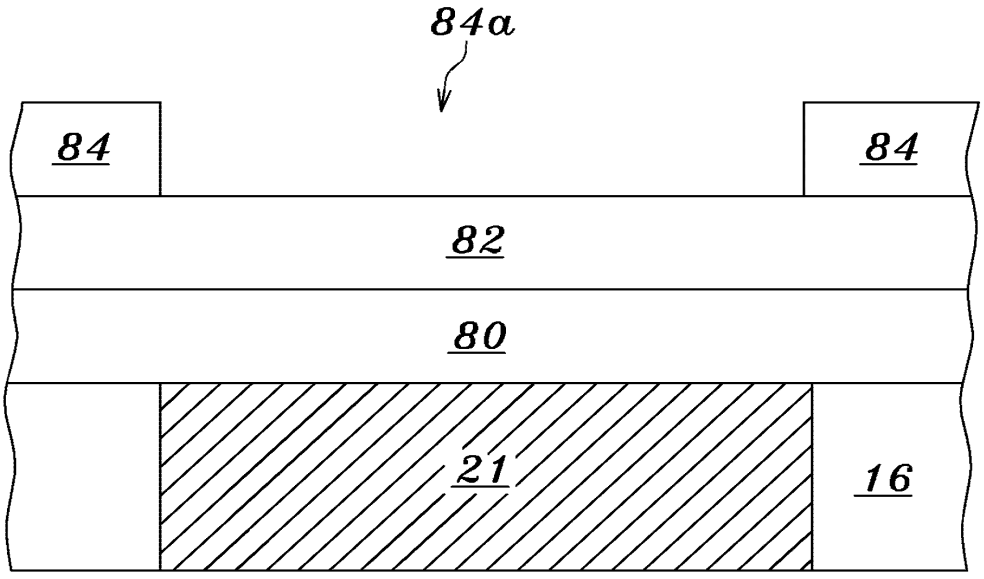



Fig. 10b

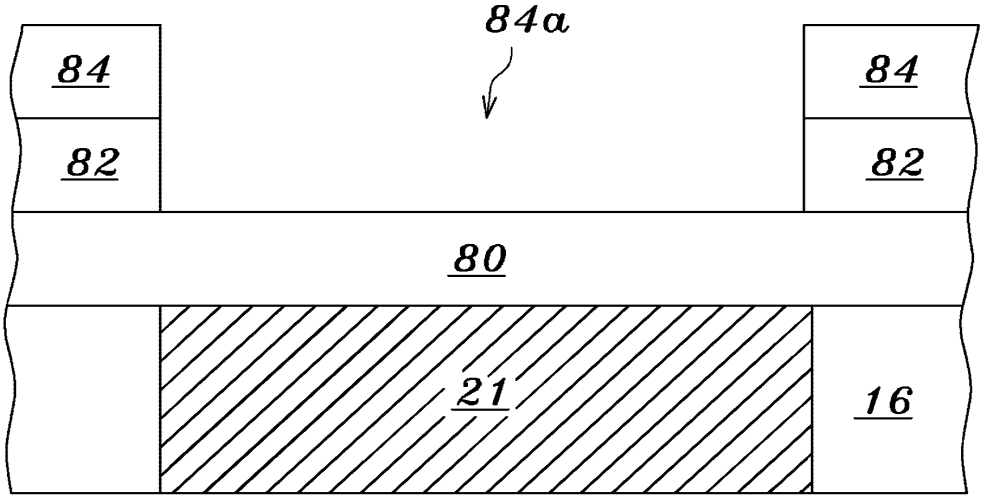



Fig. 10c

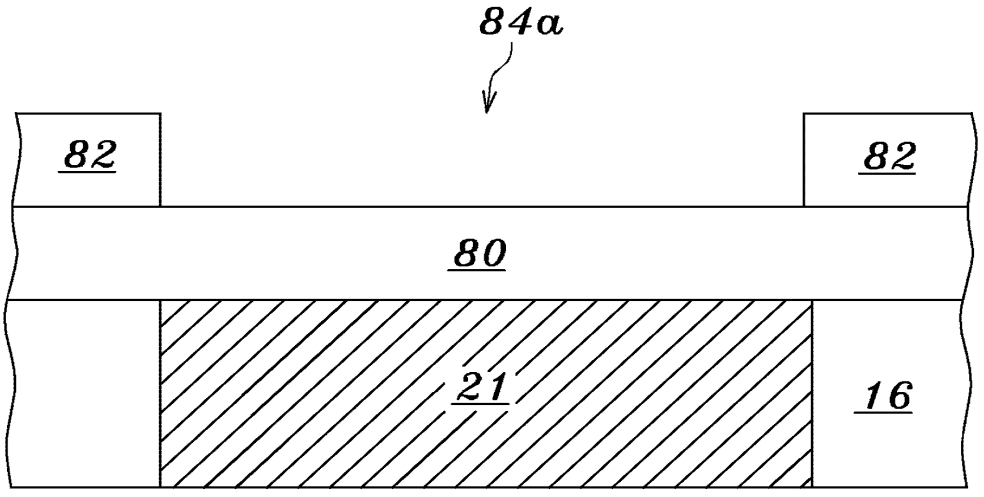



Fig. 10d

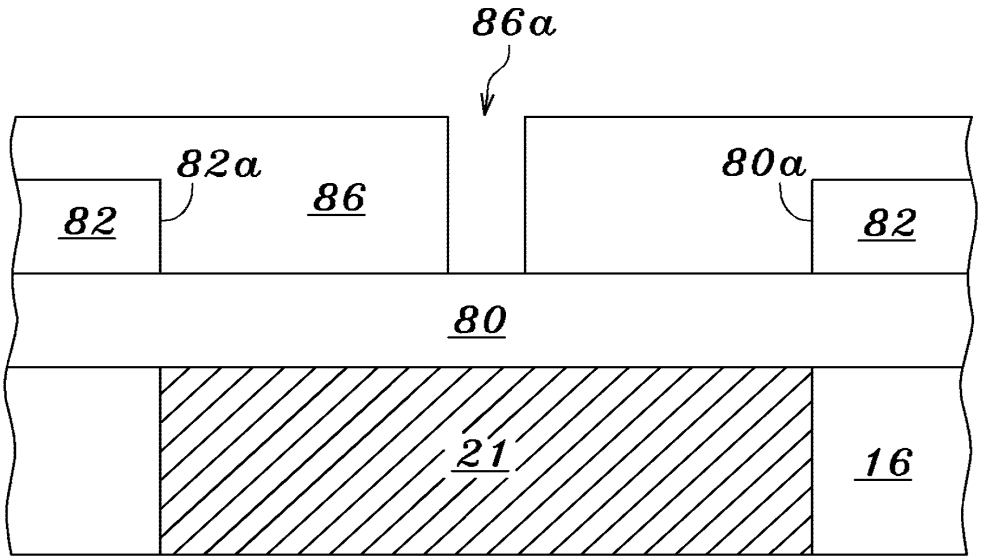



Fig. 10e

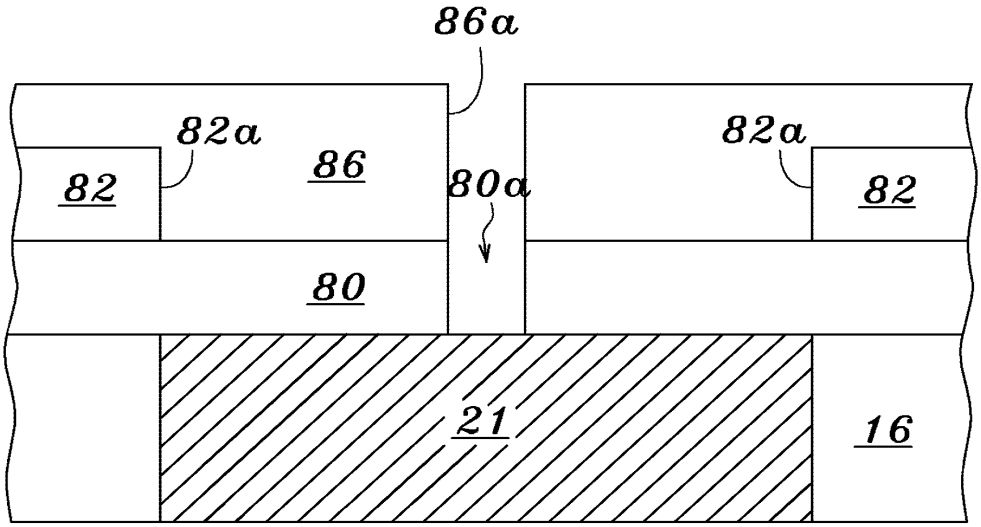



Fig. 10f

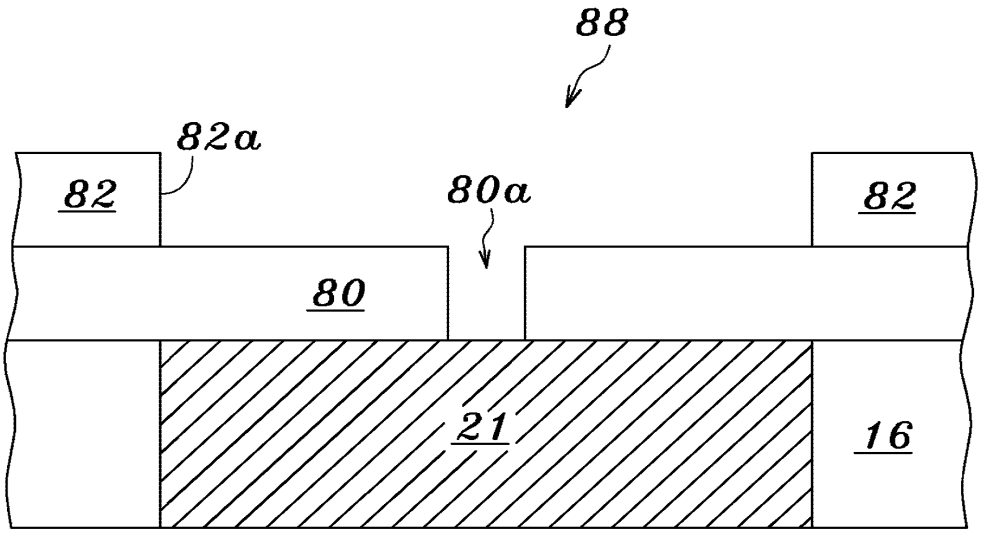



Fig. 10g

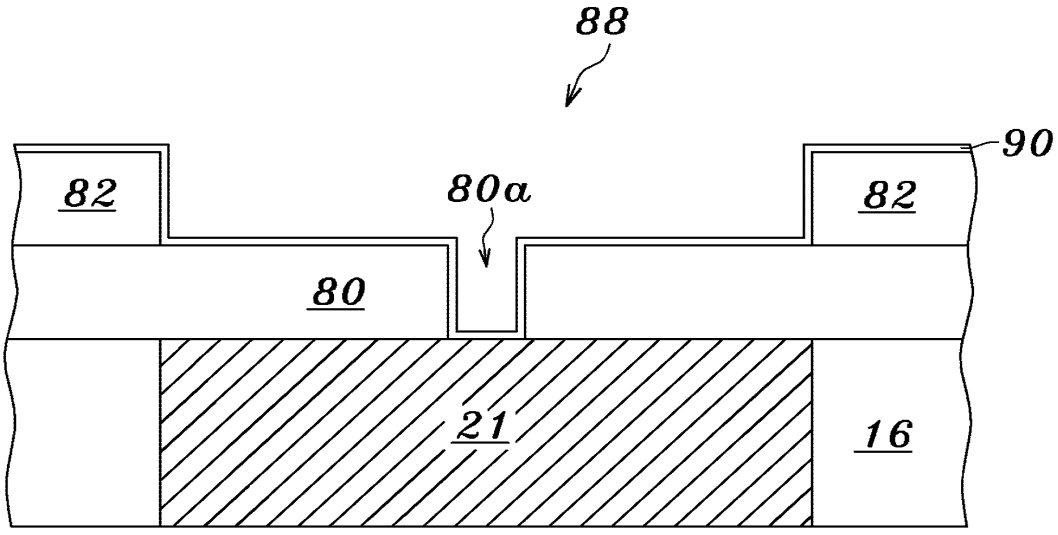



Fig. 10h

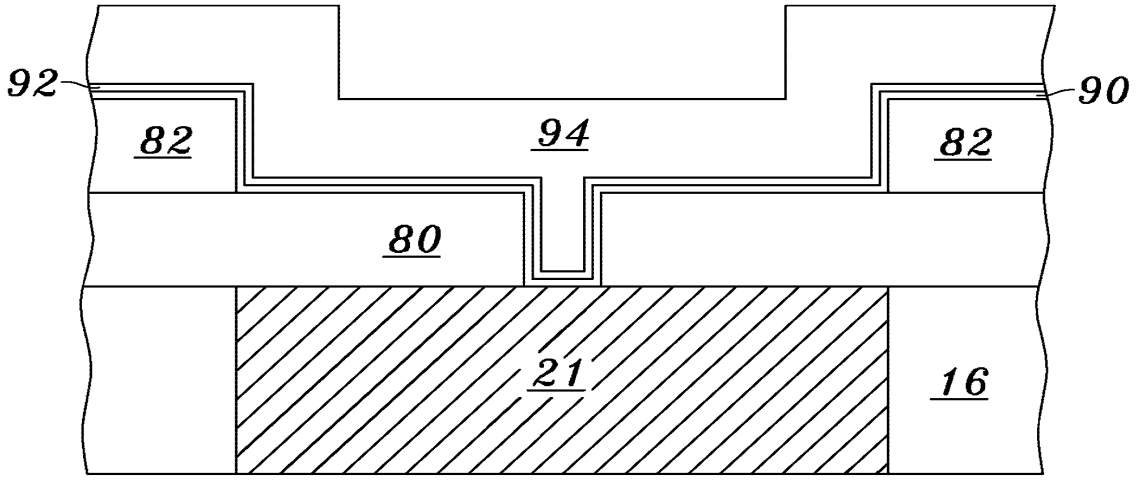



Fig. 10i

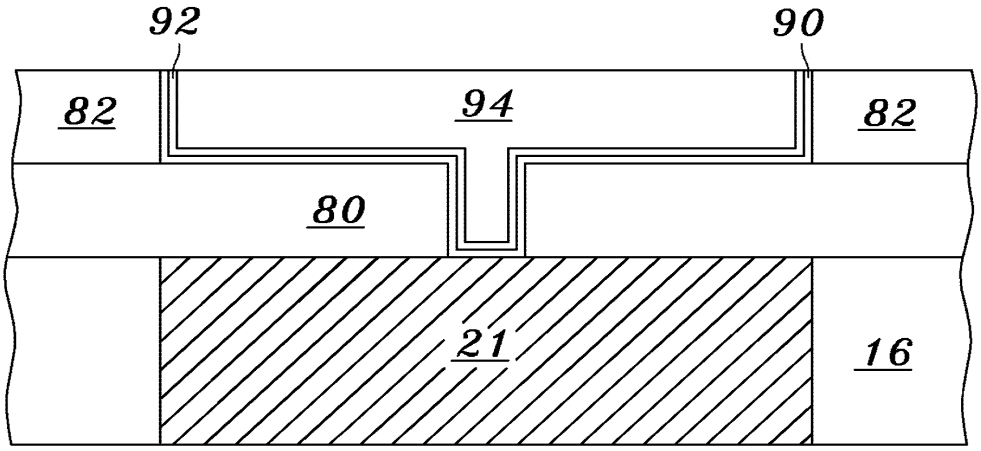



Fig. 10j

IPR2026-00067
TSMC EX1002 Page 220

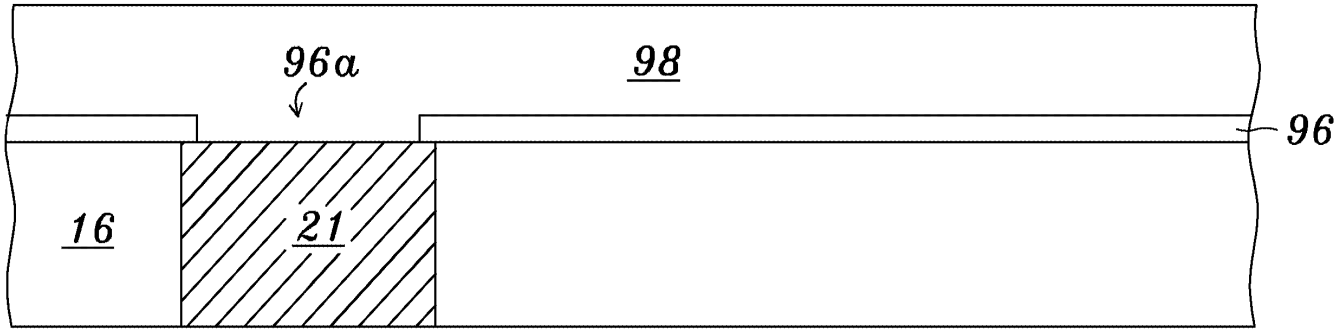



Fig. 11a

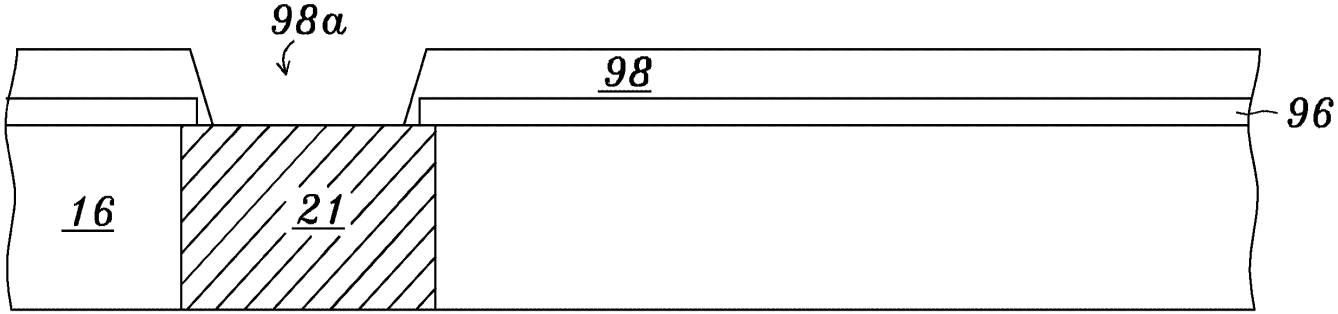



Fig. 11b

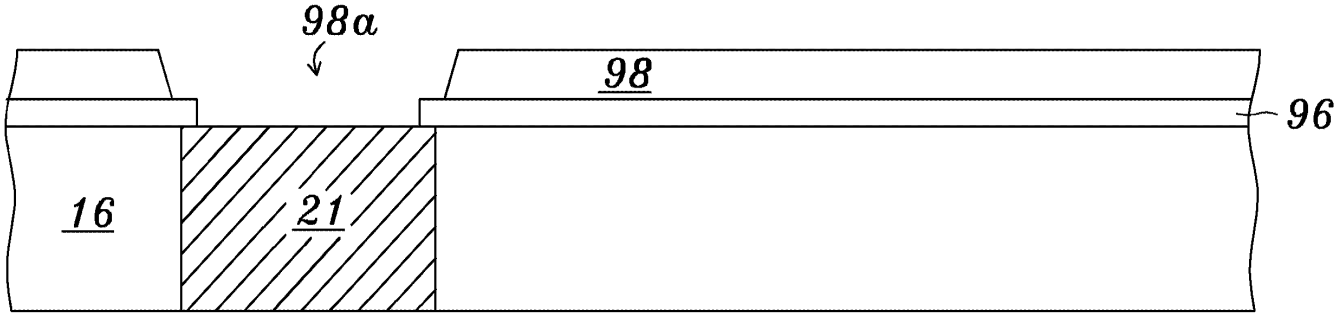



Fig. 11c

IPR2026-00067
TSMC EX1002 Page 221

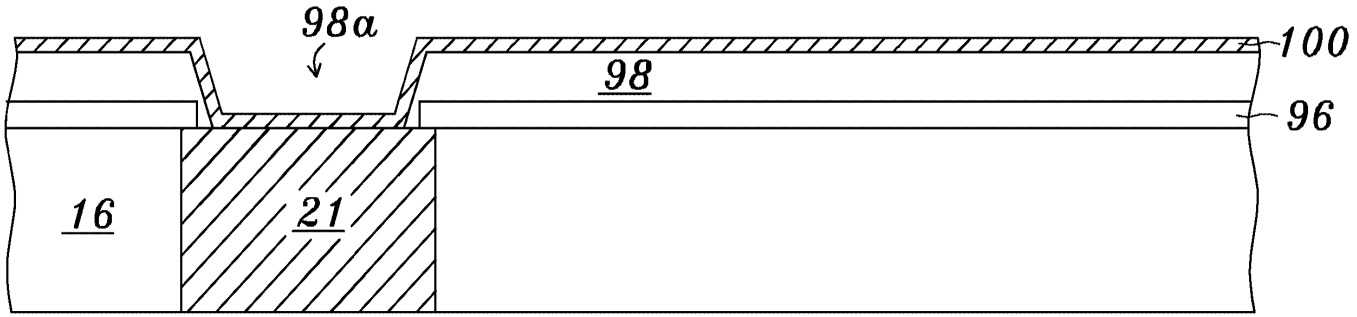



Fig. 11d

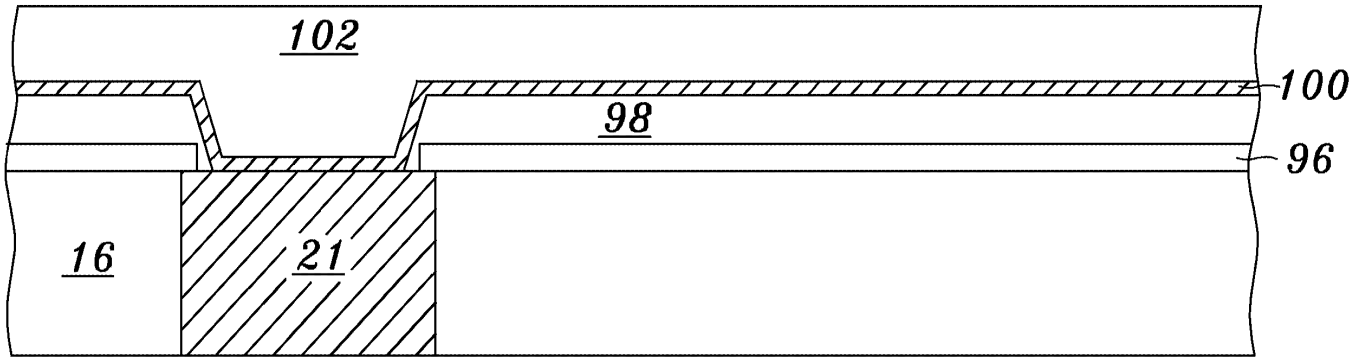



Fig. 11e

IPR2026-00067
TSMC EX1002 Page 222

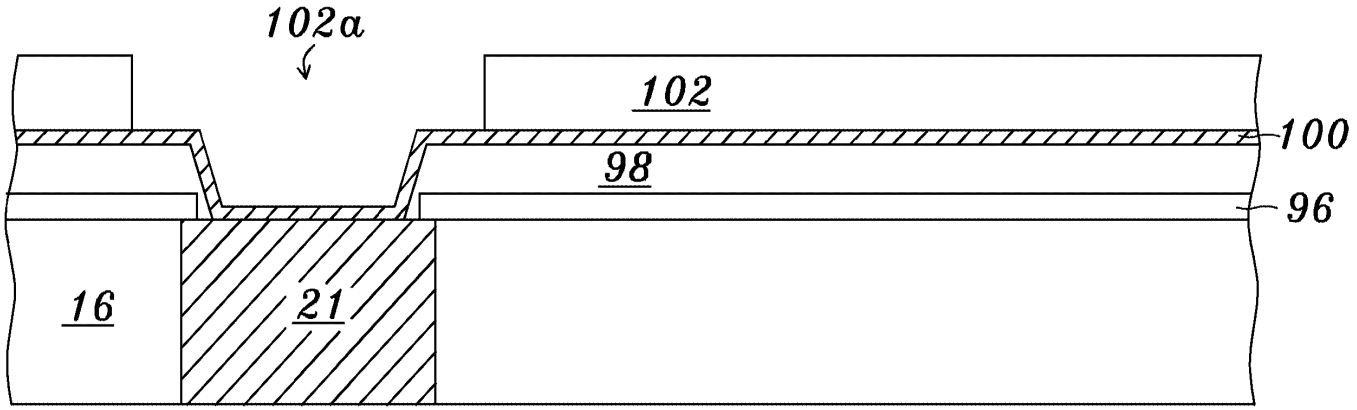



Fig. 11f

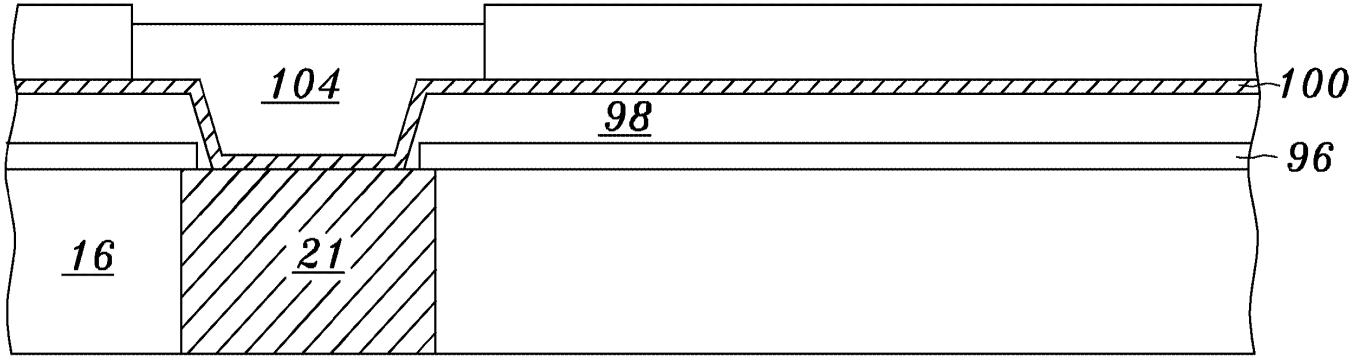



Fig. 11g

IPR2026-00067
TSMC EX1002 Page 223

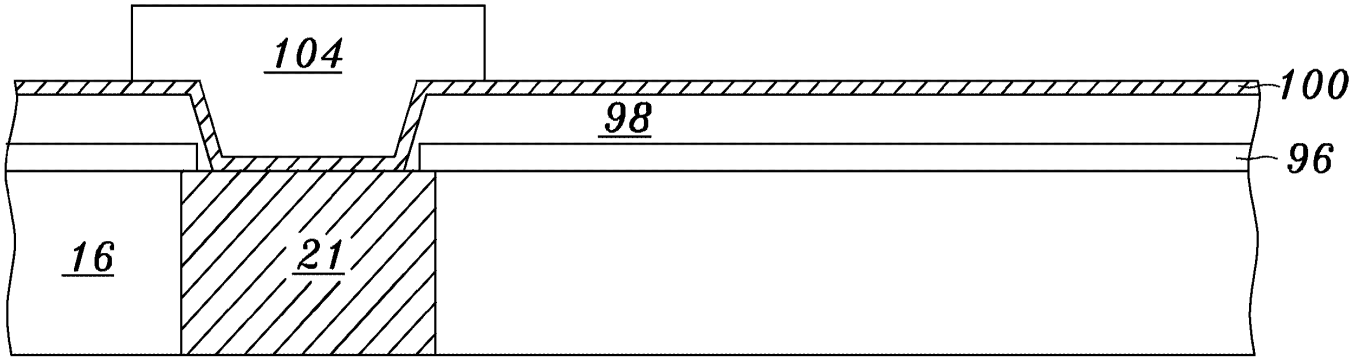



Fig. 11h

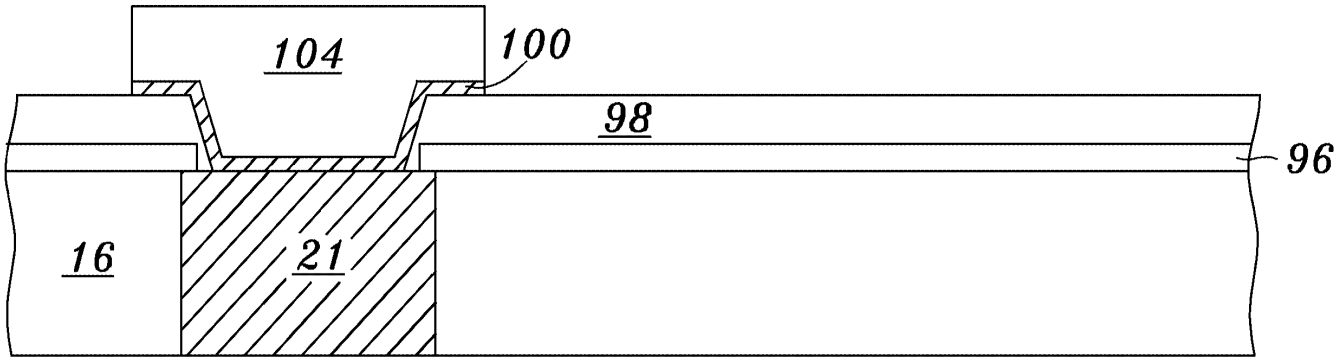



Fig. 11i

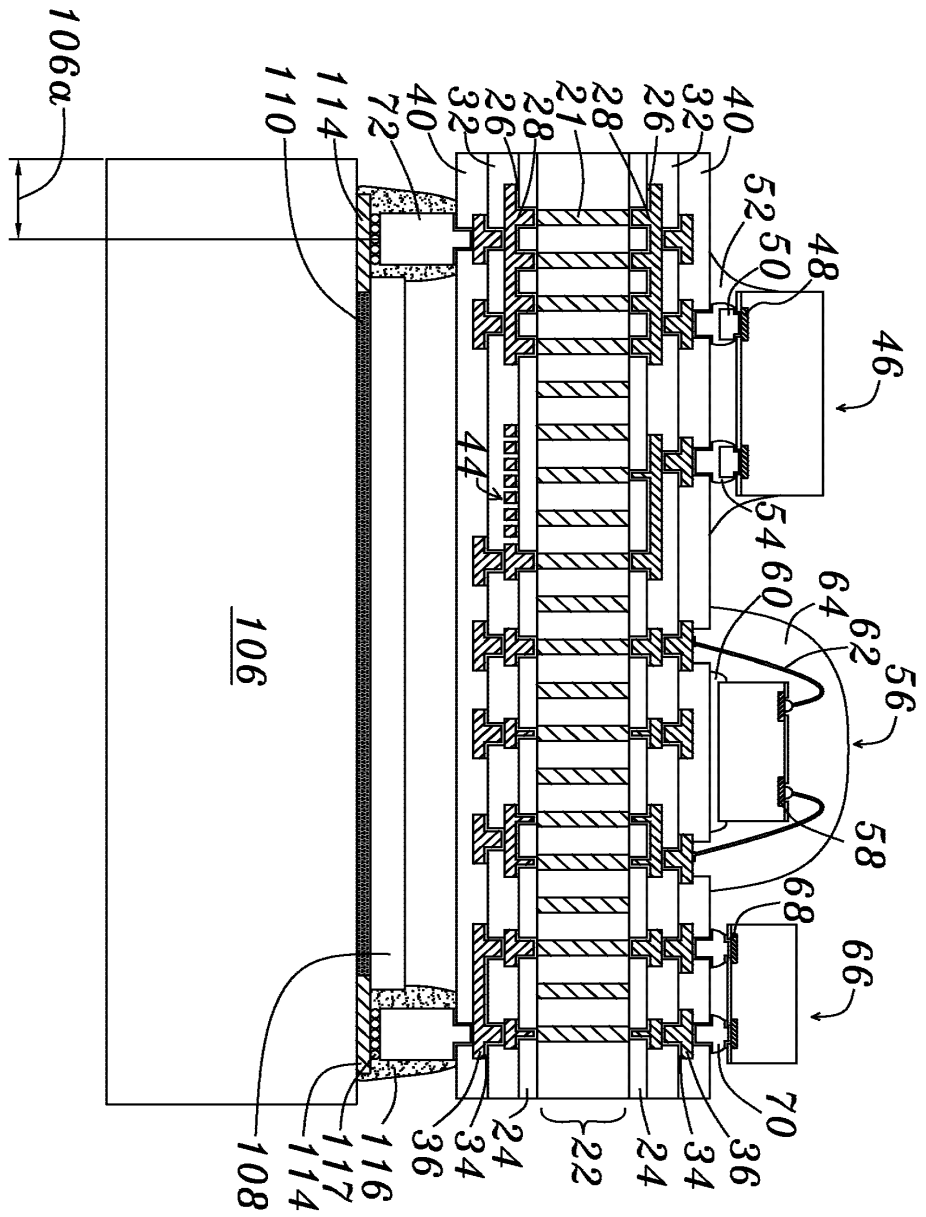

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Fig. 12

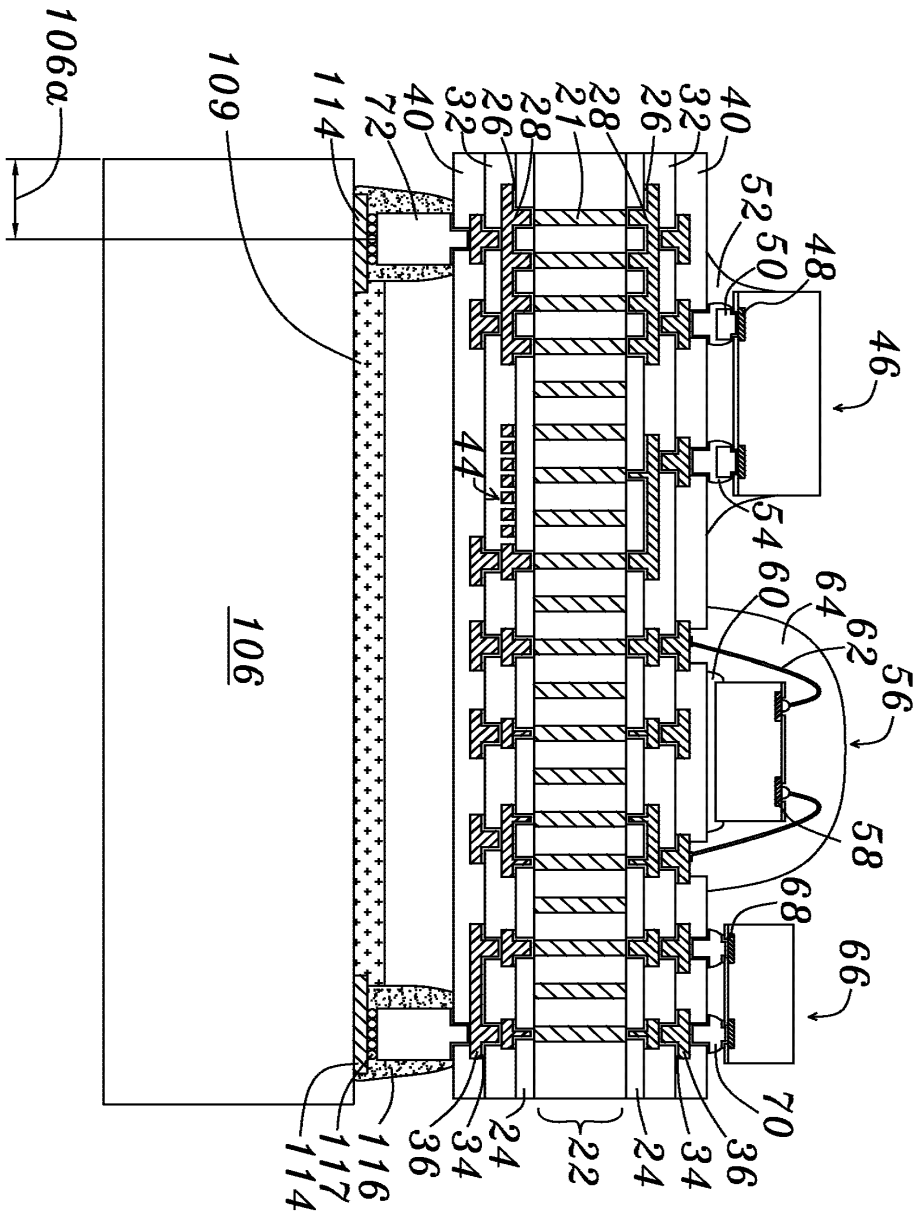

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Fig. 13

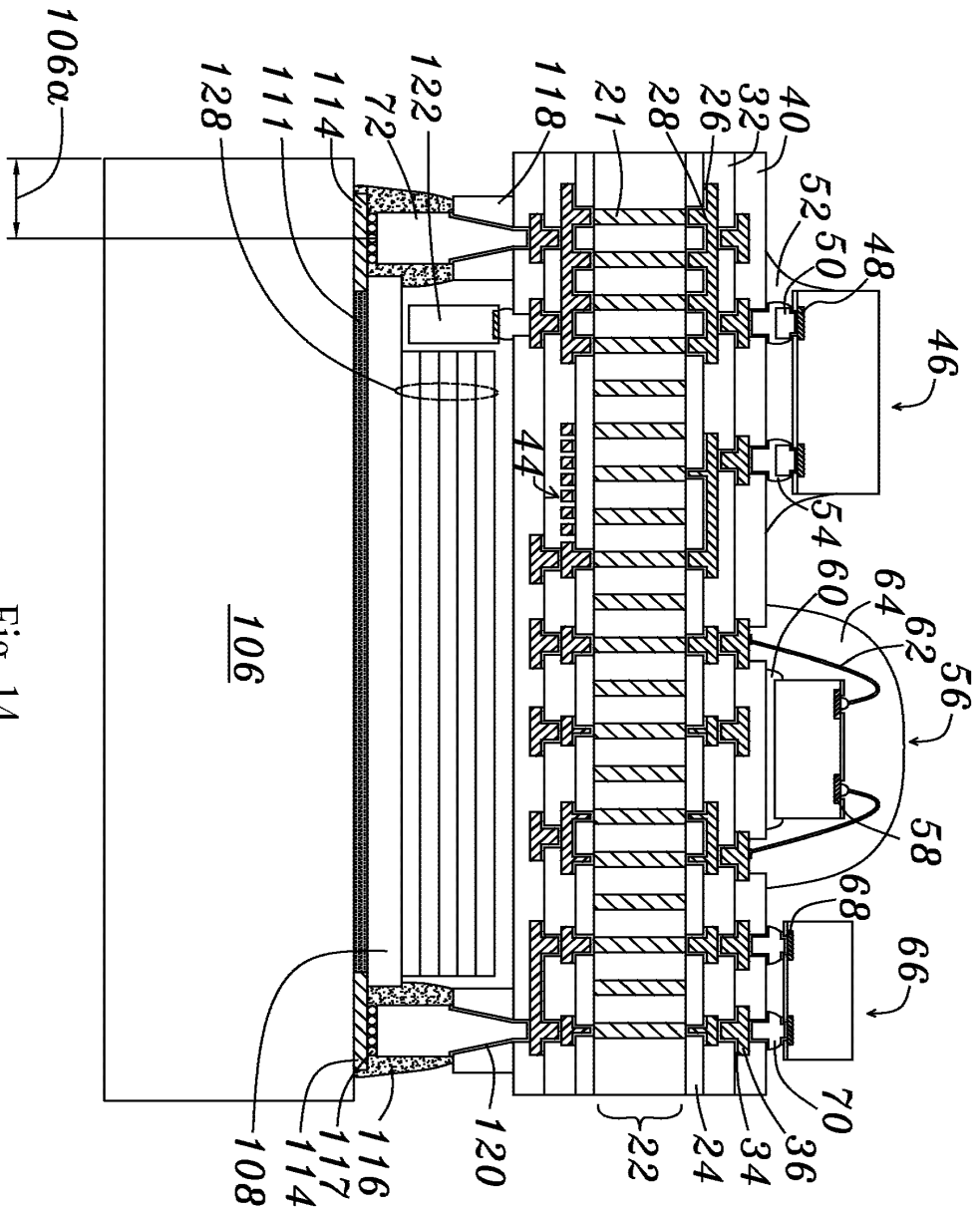

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Fig. 14

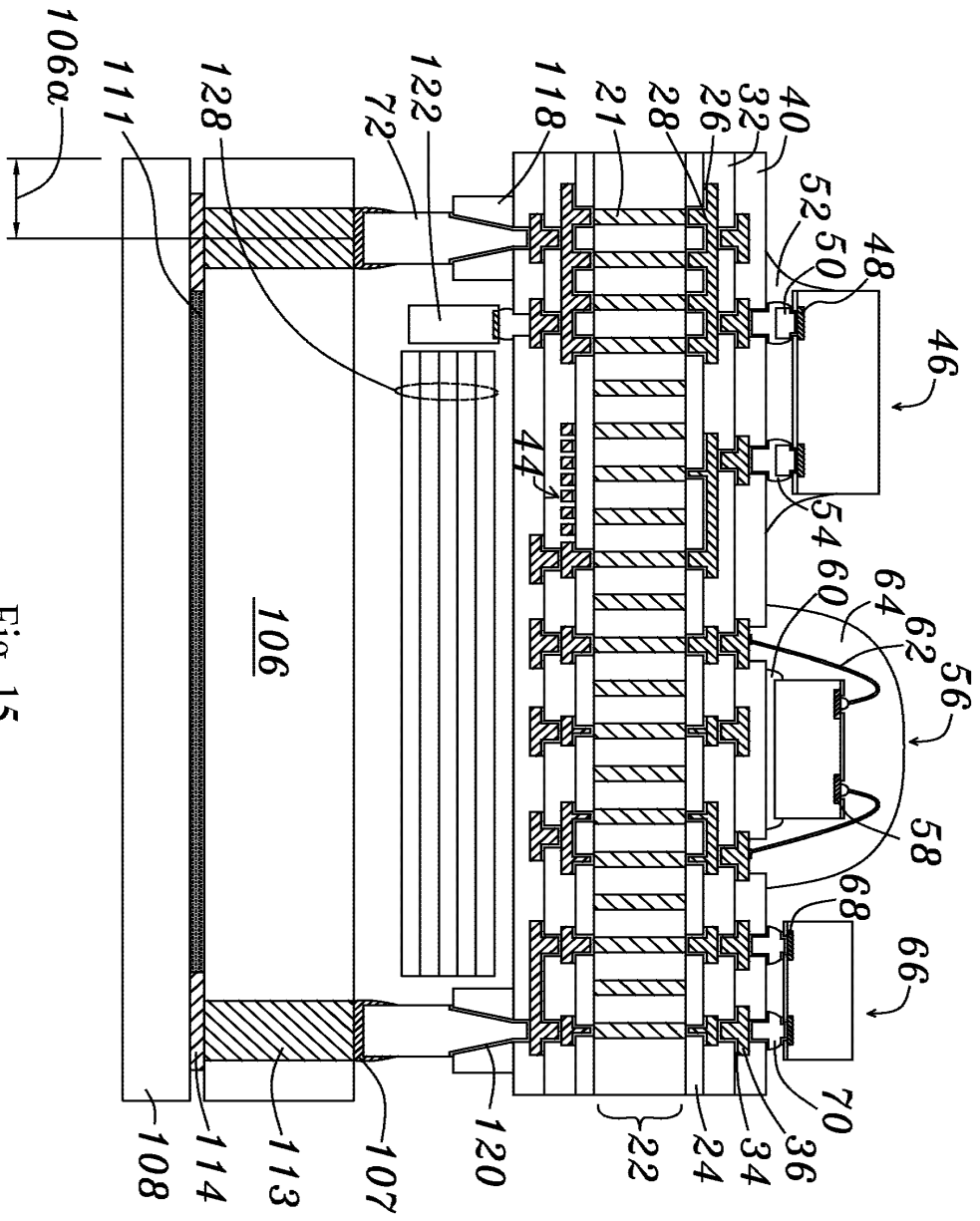

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Fig. 15

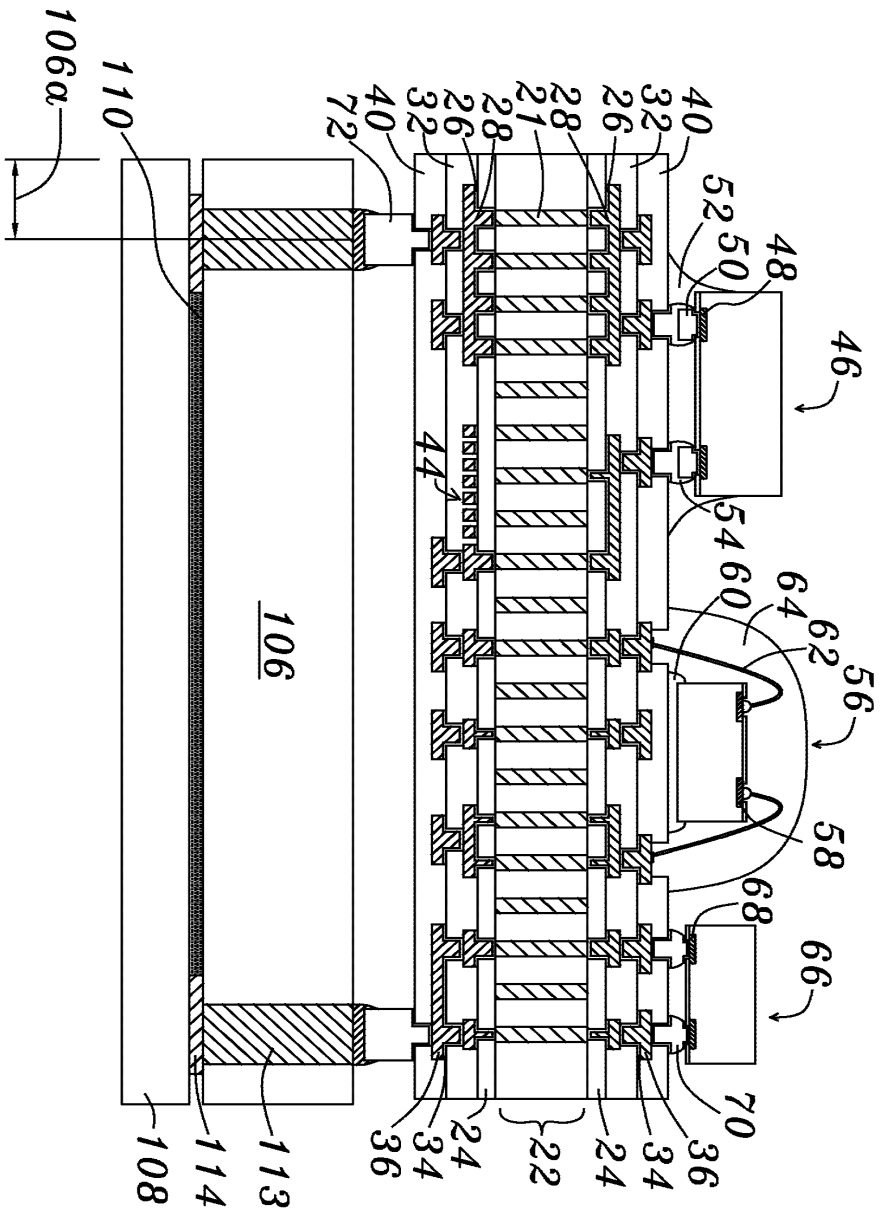

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Fig. 16

IPR2026-00067
TSMC EX1002 Page 229

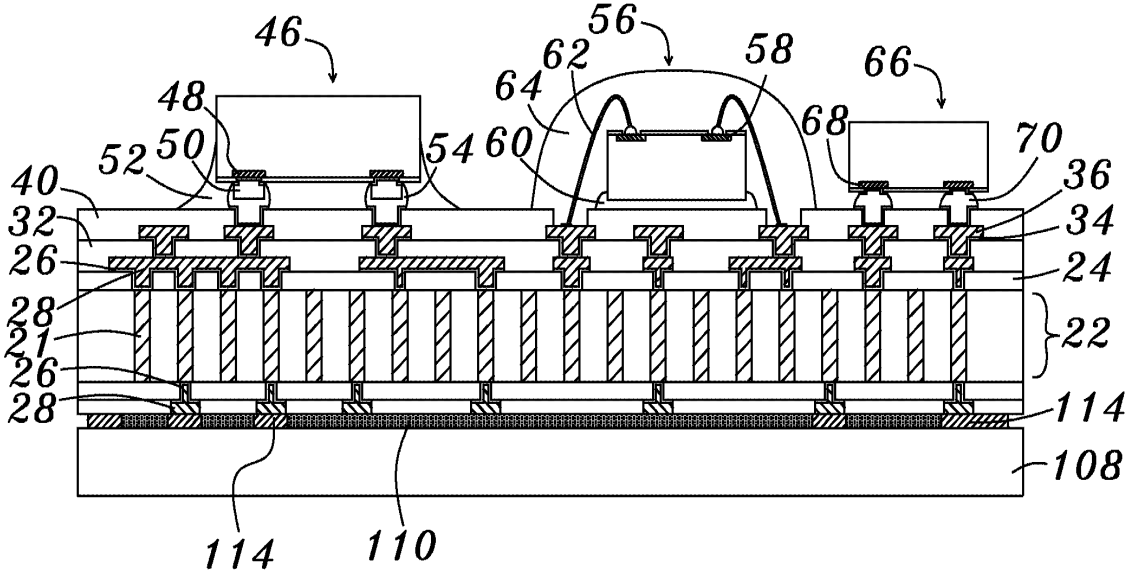



Fig. 17a

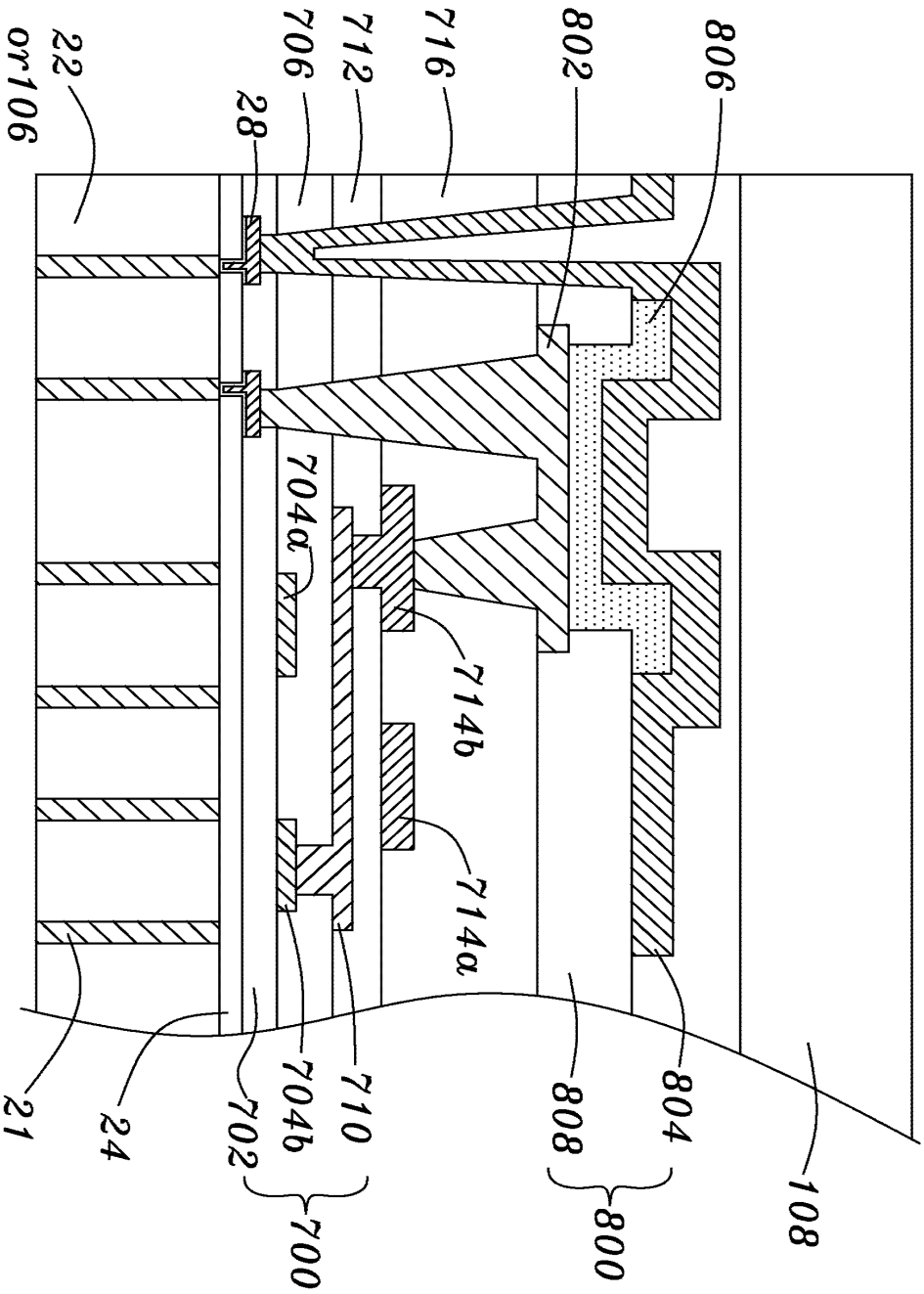

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Fig. 17b

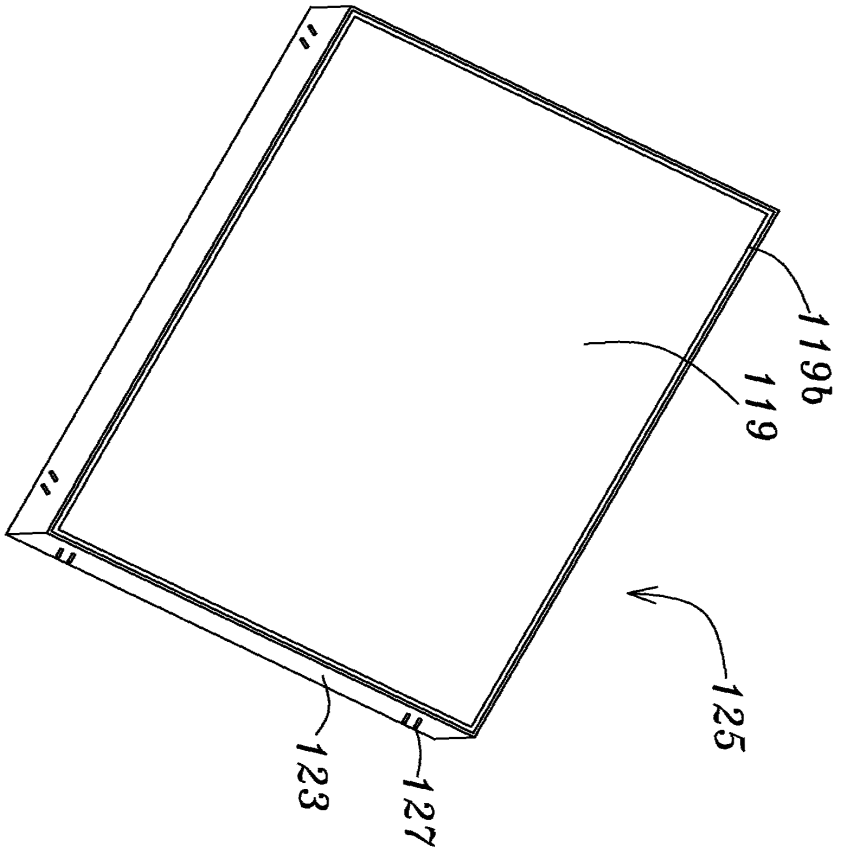



Fig. 18

IPR2026-00067
TSMC EX1002 Page 232

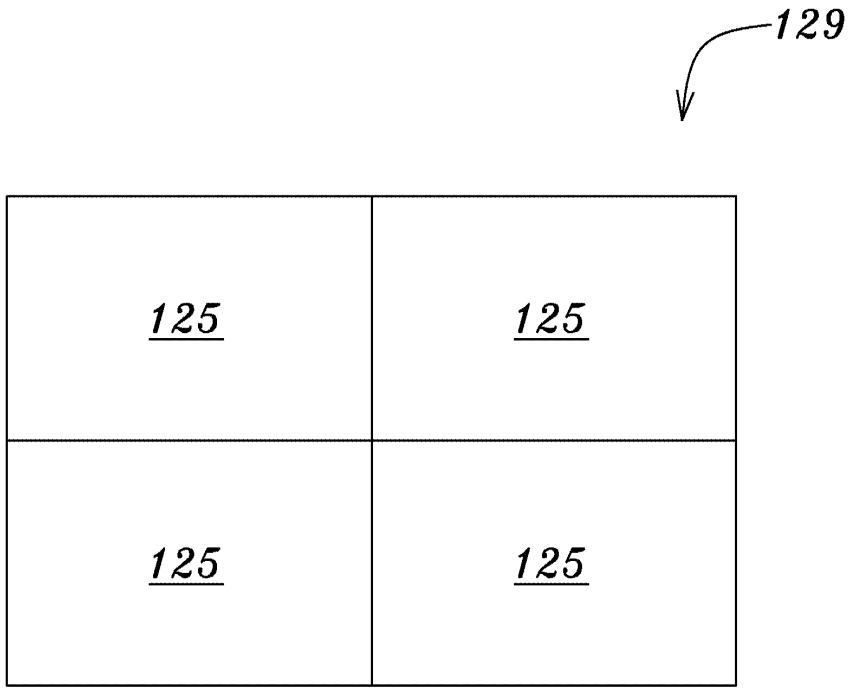



Fig. 19

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| Application Data Sheet 37 CFR 1.76 | Attorney Docket Number | Mars16-001-US-C03 |
|---|---|---|
| | Application Number | |
| Title of Invention | CHIP PACKAGE | |

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

## Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

## Inventor Information:

**Inventor** 1 — Remove

**Legal Name**

| Prefix | Given Name | Middle Name | Family Name | Suffix |
|---|---|---|---|---|
| Mr. | Ping-Jung | | Yang | |

**Residence Information (Select One)** US Residency ● Non US Residency Active US Military Service

| City | Hsinchu City | Country of Residence [i] | TW |
|---|---|---|---|

**Mailing Address of Inventor:**

| | | | |
|---|---|---|---|
| **Address 1** | No. 52, Ln. 97, Shengjun Rd., North Dist. | | |
| **Address 2** | | | |
| **City** | Hsinchu city | **State/Province** | |
| **Postal Code** | 300 | **Country** [i] | TW |

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

## Correspondence Information:

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**For further information see 37 CFR 1.33(a).**

☐ **An Address is being provided for the correspondence Information of this application.**

| | | | |
|---|---|---|---|
| **Customer Number** | 102851 | | |
| **Email Address** | semars3898@gmail.com | Add Email | Remove Email |

## Application Information:

| | | | |
|---|---|---|---|
| **Title of the Invention** | CHIP PACKAGE | | |
| **Attorney Docket Number** | Mars16-001-US-C03 | **Small Entity Status Claimed** | ☒ |
| **Application Type** | Nonprovisional | | |
| **Subject Matter** | Utility | | |
| **Total Number of Drawing Sheets (if any)** | | **Suggested Figure for Publication (if any)** | |

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| Application Data Sheet 37 CFR 1.76 | Attorney Docket Number | Mars16-001-US-C03 |
|---|---|---|
| | Application Number | |
| Title of Invention | CHIP PACKAGE | |

## Filing By Reference :

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

| Application number of the previously filed application | Filing date (YYYY-MM-DD) | Intellectual Property Authority or Country |
|---|---|---|
| | | |

## Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

## Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

| Please Select One: | ● Customer Number | US Patent Practitioner | ○ Limited Recognition (37 CFR 11.9) |
|---|---|---|---|
| Customer Number | 102851 | | |

## Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the application number blank.

| Prior Application Status | Pending | | Remove |
|---|---|---|---|
| Application Number | Continuity Type | Prior Application Number | Filing Date (YYYY-MM-DD) |
| | Continuation of | 17372459 | 2021-07-11 |
| Prior Application Status | Patented | | Remove |

| Application Number | Continuity Type | Prior Application Number | Filing Date (YYYY-MM-DD) | Patent Number | Issue Date (YYYY-MM-DD) |
|---|---|---|---|---|---|
| 17372459 | Continuation of | 16752650 | 2020-01-26 | 11107768 | 2021-08-31 |

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| Application Data Sheet 37 CFR 1.76 | Attorney Docket Number | Mars16-001-US-C03 |
|---|---|---|
| | Application Number | |
| Title of Invention | CHIP PACKAGE | |

| Prior Application Status | Patented | | | | Remove |
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| 16752650 | Continuation of | 15261956 | 2016-09-11 | 10622310 | 2020-04-14 |
| Prior Application Status | Expired | | | | Remove |
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| 15261956 | Claims benefit of provisional | 62/219249 | 2015-09-16 | | |
| Prior Application Status | Patented | | | | Remove |
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| 15261956 | Continuation in part of | 14/036256 | 2013-09-25 | 9615453 | 2017-04-04 |
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| 14/036256 | Claims benefit of provisional | 61705649 | 2012-09-26 | | |
| Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. | | | | | Add |

## Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

| | | | Remove |
|---|---|---|---|
| Application Number | Country[i] | Filing Date (YYYY-MM-DD) | Access Code[i] (if applicable) |
| | | | |
| Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. | | | Add |

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| Application Data Sheet 37 CFR 1.76 | Attorney Docket Number | Mars16-001-US-C03 |
|---|---|---|
| | Application Number | |
| Title of Invention | CHIP PACKAGE | |

## Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

## Authorization to Permit Access:

☐ Authorization to Permit Access to the Instant Application by the Participating Offices

If checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application.

In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date o f filing this Authorization.

## Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

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| **Application Data Sheet 37 CFR 1.76** | Attorney Docket Number | Mars16-001-US-C03 |
|---|---|---|
| | Application Number | |
| Title of Invention | CHIP PACKAGE | |

**Applicant** 1 Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

| Assignee | Legal Representative under 35 U.S.C. 117 | ● Joint Inventor |
|---|---|---|
| Person to whom the inventor is obligated to assign. | Person who shows sufficient proprietary interest | |

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor :

If the Applicant is an Organization check here. ☐

| Prefix | **Given Name** | Middle Name | **Family Name** | Suffix |
|---|---|---|---|---|
| | Ping-Jung | | Yang | |

**Mailing Address Information For Applicant:**

| | | | |
|---|---|---|---|
| **Address 1** | No. 52, Ln. 97, Shengjun Rd., North Dist. | | |
| Address 2 | | | |
| **City** | Hsin-Chu City | **State/Province** | |
| **Country** | TW | Postal Code | |
| Phone Number | 886-913635863 | Fax Number | |
| Email Address | semars3898@gmail.com | | |

Additional Applicant Data may be generated within this form by selecting the Add button. Add

## Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not subsitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

**Assignee** 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication . An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

Remove

PTO/AIA/14 (12-13)
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| **Application Data Sheet 37 CFR 1.76** | Attorney Docket Number | Mars16-001-US-C03 |
|---|---|---|
| | Application Number | |
| Title of Invention | CHIP PACKAGE | |

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

| Prefix | **Given Name** | Middle Name | **Family Name** | Suffix |
|---|---|---|---|---|
| | | | | |

**Mailing Address Information For Assignee including Non-Applicant Assignee:**

| | | | |
|---|---|---|---|
| **Address 1** | | | |
| Address 2 | | | |
| **City** | | **State/Province** | |
| **Country** i | | Postal Code | |
| Phone Number | | Fax Number | |
| Email Address | | | |

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

## Signature:

Remove

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications.

| **Signature** | /Ping-Jung Yang/ | | | Date (YYYY-MM-DD) | 2022-11-12 |
|---|---|---|---|---|---|
| First Name | Ping-Jung | Last Name | Yang | Registration Number | |

Additional Signature may be generated within this form by selecting the Add button. Add

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

# Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent C o o p eration Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.



IPR2026-00067
TSMC EX1002 Page 239

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# DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

| **Title of Invention** | CHIP PACKAGE |
|---|---|

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [■] The attached application, or
- [ ] United States application or PCT international application number _____

  filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

## WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Ping-Jung Yang  Date (Optional): 2022-11-12

Signature: Ping-Jung Yang

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

*If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.*

## Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant ( *i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

DocCode - SCORE

# SCORE Placeholder Sheet for IFW Content

Application Number: 17985827 Document Date: 11/12/2022

The presence of this form in the IFW record indicates that the following document type was received in electronic format on the date identified above. This content is stored in the SCORE database.

Since this was an electronic submission, there is no physical artifact folder, no artifact folder is recorded in PALM, and no paper documents or physical media exist. The TIFF images in the IFW record were created from the original documents that are stored in SCORE.

- Drawing

At the time of document entry (noted above):

- USPTO employees may access SCORE content via DAV or via the SCORE web page.
- External customers may access SCORE content via PAIR using the Supplemental Content tab.

Form Revision Date: March 1, 2019

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United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

| APPLICATION NUMBER | FILING or 371(c) DATE | GRP ART UNIT | FIL FEE REC'D | ATTY.DOCKET.NO | TOT CLAIMS | IND CLAIMS |
|---|---|---|---|---|---|---|
| 17/985,827 | 11/12/2022 | | 830 | Mars16-001-US-C03 | 20 | 2 |

**CONFIRMATION NO. 1762**

102851
PING-JUNG YANG
NO 2, NIOUPU SOUTH RD., SIANGSHAN DISTRICT
HSINCHU CITY, 30091
TAIWAN

**FILING RECEIPT**




Date Mailed: 11/29/2022

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

**Please verify the accuracy of the data presented on this receipt.** If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

**Inventor(s)**

Ping-Jung Yang, Hsinchu City, TAIWAN;

**Applicant(s)**

Ping-Jung Yang, Hsin-Chu City, TAIWAN;

**Power of Attorney:** None

**Domestic Priority data as claimed by applicant**

This application is a CON of 17/372,459 07/11/2021
which is a CON of 16/752,650 01/26/2020 PAT 11,107,768
which is a CON of 15/261,956 09/11/2016 PAT 10,622,310
which claims benefit of 62/219,249 09/16/2015
and is a CIP of 14/036,256 09/25/2013 PAT 9,615,453
which claims benefit of 61/705,649 09/26/2012

**Foreign Applications** for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
*Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.*

**Permission to Access Application via Priority Document Exchange:** Yes

**Permission to Access Search Results:** Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

**If Required, Foreign Filing License Granted:** 11/28/2022

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 17/985,827**

**Projected Publication Date:** 03/09/2023

**Non-Publication Request:** No

**Early Publication Request:** No
**** SMALL ENTITY ****
**Title**

CHIP PACKAGE

**Preliminary Class**

**Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications:** No

## PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific

countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

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## Title 35, United States Code, Section 184

## Title 37, Code of Federal Regulations, 5.11 & 5.15

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This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

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IPR2026-00067
TSMC EX1002 Page 246

| PATENT APPLICATION FEE DETERMINATION RECORD<br>Substitute for Form PTO-875 | Application or Docket Number<br>17/985,827 |
|---|---|

## APPLICATION AS FILED - PART I

| | (Column 1) | (Column 2) | SMALL ENTITY | | OR | OTHER THAN SMALL ENTITY | |
|---|---|---|---|---|---|---|---|
| FOR | NUMBER FILED | NUMBER EXTRA | RATE($) | FEE($) | | RATE($) | FEE($) |
| BASIC FEE (37 CFR 1.16(a), (b), or (c)) | N/A | N/A | N/A | 80 | | N/A | |
| SEARCH FEE (37 CFR 1.16(k), (i), or (m)) | N/A | N/A | N/A | 350 | | N/A | |
| EXAMINATION FEE (37 CFR 1.16(o), (p), or (q)) | N/A | N/A | N/A | 400 | | N/A | |
| TOTAL CLAIMS (37 CFR 1.16(i)) | 20 minus 20 = | * 0 | x = | 0 | OR | | |
| INDEPENDENT CLAIMS (37 CFR 1.16(h)) | 2 minus 3 = | * | x = | 0 | | | |
| APPLICATION SIZE FEE (37 CFR 1.16(s)) | If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s). | | | 0 | | | |
| MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j)) | | | | 0 | | | |
| * If the difference in column 1 is less than zero, enter "0" in column 2. | | | TOTAL | 830 | | TOTAL | |

## APPLICATION AS AMENDED - PART II

| | | (Column 1) | | (Column 2) | (Column 3) | SMALL ENTITY | | OR | OTHER THAN SMALL ENTITY | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | CLAIMS REMAINING AFTER AMENDMENT | | HIGHEST NUMBER PREVIOUSLY PAID FOR | PRESENT EXTRA | RATE($) | ADDITIONAL FEE($) | | RATE($) | ADDITIONAL FEE($) |
| AMENDMENT A | Total (37 CFR 1.16(i)) | * | Minus | ** | = | x = | | OR | x = | |
| | Independent (37 CFR 1.16(h)) | * | Minus | *** | = | x = | | OR | x = | |
| | Application Size Fee (37 CFR 1.16(s)) | | | | | | | | | |
| | FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j)) | | | | | | | OR | | |
| | | | | | | TOTAL ADD'L FEE | | OR | TOTAL ADD'L FEE | |

| | | (Column 1) | | (Column 2) | (Column 3) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | CLAIMS REMAINING AFTER AMENDMENT | | HIGHEST NUMBER PREVIOUSLY PAID FOR | PRESENT EXTRA | RATE($) | ADDITIONAL FEE($) | | RATE($) | ADDITIONAL FEE($) |
| AMENDMENT B | Total (37 CFR 1.16(i)) | * | Minus | ** | = | x = | | OR | x = | |
| | Independent (37 CFR 1.16(h)) | * | Minus | *** | = | x = | | OR | x = | |
| | Application Size Fee (37 CFR 1.16(s)) | | | | | | | | | |
| | FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j)) | | | | | | | OR | | |
| | | | | | | TOTAL ADD'L FEE | | OR | TOTAL ADD'L FEE | |

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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www.uspto.gov

| APPLICATION NUMBER | FILING OR 371(C) DATE | FIRST NAMED APPLICANT | ATTY. DOCKET NO./TITLE |
|---|---|---|---|
| 17/985,827 | 11/12/2022 | Ping-Jung Yang | Mars16-001-US-C03 |

**CONFIRMATION NO. 1762**

102851
PING-JUNG YANG
NO 2, NIOUPU SOUTH RD., SIANGSHAN DISTRICT
HSINCHU CITY, 30091
TAIWAN

**PUBLICATION NOTICE**

*OC000000137542450*

**Title:**CHIP PACKAGE

**Publication No.**US-2023-0073104-A1
**Publication Date:**03/09/2023

## NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

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Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101



IPR2026-00067
TSMC EX1002 Page 248

Docket No.: Mars-16-001-US-C03 **PATENT**

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

| | | |
|---|---|---|
| In re Application of | : | Customer Number: 102851 |
| Ping-Jung Yang | : | Confirmation Number: 1762 |
| Application No.: 17985827 | : | Group Art Unit: 2812 |
| Filed: Nov. 12, 2022 | : | Examiner: XIAOMING LIU |

For: CHIP PACKAGE

**Preliminary Amendment**

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Please amend the above-identified application and consider the remarks as follows:

**Amendments to the Claims** are reflected in the listing of claims which begins on page 2 of this paper.

**Remarks/Arguments** begin on page 10 of this paper.



IPR2026-00067
TSMC EX1002 Page 249

**Amendments to the Claims:**

This listing of claims will replace all prior versions, and listings, of claims in the application.

**Listing of Claims:**

What is claimed is:

1. (Previously presented) A chip package comprising:

a solid layer having a first surface and a second surface opposite to said first surface, wherein said solid layer comprises a compound of silicon and oxygen, wherein said solid layer has a thickness between 50 and 150 micrometers, wherein said solid layer comprises a first region and a second region between said first region and a first edge of said solid layer;

a plurality of metal posts in a plurality of through holes in said second region respectively, wherein one of said plurality of metal posts comprises a first copper layer contacting a sidewall of one of said plurality of through holes, wherein said first region has a width in a direction greater than a shortest distance between said sidewall of one of said plurality of through holes and said first edge in said direction and greater than a pitch between two neighboring metal posts of said plurality of metal posts;

a first interconnection scheme over said first surface, wherein said first interconnection scheme comprises a first metal interconnect over said second surface and a first polymer layer over said first metal interconnect, wherein said first metal interconnect is connected to a first metal post of said plurality of metal posts, wherein said first metal interconnect comprises a first metal layer and a second copper layer over said first metal layer;



IPR2026-00067
TSMC EX1002 Page 250

a first metal bump over said first interconnection scheme, wherein said first metal bump comprises a second metal layer and a tin-containing layer over said second metal layer; and

a first semiconductor chip under said second surface, wherein said first interconnection scheme comprise a second metal interconnect across over a sidewall of the first semiconductor chip, wherein said first semiconductor chip comprises a third metal interconnect on a first metal pad of said first semiconductor chip, wherein said third metal interconnect comprises a third metal layer on said first metal pad and a third copper layer over said third metal layer, wherein said third copper layer has a thickness between 5 and 30 micrometers, wherein said first semiconductor chip is connected to a second metal post of said plurality of metal posts through said third metal interconnect.

2. (Previously presented) The chip package of claim 1, wherein said first semiconductor chip comprises a central-processing-unit (CPU) circuit block and a graphics-processing-unit (GPU) circuit block.

3. (Previously presented) The chip package of claim 1, wherein said first interconnection scheme further comprises a fourth metal interconnect over said first metal interconnect and said first polymer layer, wherein said first polymer is between said first and fourth metal interconnects, wherein said fourth metal interconnect comprises a fourth metal layer and a fourth copper layer over said fourth metal layer.

4. (Previously presented) The chip package of claim 1, wherein said first metal pad is an aluminum pad.



IPR2026-00067
TSMC EX1002 Page 251

Claims 5-6 are cancelled

7. (Previously presented) The chip package of claim 1, wherein said compound comprises a $SiO_2$ compound.

8. (Previously presented) The chip package of claim 1, further comprising a second semiconductor chip over said first semiconductor chip, wherein said second semiconductor chip comprises a second metal bump on a second metal pad of said second semiconductor chip, wherein said second metal bump comprises a tin-containing layer.

9. (Previously presented) The chip package of claim 1, wherein said solid layer further comprises a third region opposite to said second region, wherein said third region is between said first region and a second edge of said solid layer, wherein said plurality of metal posts in said plurality of through holes in said third region respectively.

10. (Previously presented) The chip package of claim 1, wherein said second region is a rectangle region and surrounding said first region.

11. (Currently amended) A chip package comprising:

a solid layer having a first surface and a second surface opposite to said first surface, wherein said solid layer comprises a compound of silicon and oxygen, wherein said solid layer



IPR2026-00067
TSMC EX1002 Page 252

has a thickness between 100 and 300 micrometers, wherein said solid layer comprises a first region and a second region between said first region and a first edge of said solid layer;

a plurality of copper posts in a plurality of through holes in said second region respectively, wherein said first region has a width in a direction greater than a shortest distance between ~~said~~ a sidewall of one of said plurality of through holes and said first edge in said direction and greater than a pitch between two neighboring copper posts of said plurality of copper posts;

a first interconnection scheme over said first surface, wherein said first interconnection scheme comprises a first metal interconnect over said first surface, and a first polymer layer over said first metal interconnect, wherein said first metal interconnect is connected to ~~a first copper post~~ one of said plurality of copper posts, wherein said first metal interconnect comprises a first metal layer and a first copper layer over said first metal layer;

a first metal bumps over said first interconnection scheme, wherein first metal bumps comprises a tin-containing layer;

a second metal bumps over said first interconnection scheme;

a first semiconductor chip over said first interconnection scheme and between said first and second metal bumps, wherein said first semiconductor chip has a height between a backside surface of said first semiconductor chip and a top surface of said first polymer layer is smaller than a thickness of said first metal bump, wherein said first semiconductor chip comprises a third metal bump on a first metal pad of said first semiconductor chip, wherein said third metal bump comprises a tin-containing layer; and



IPR2026-00067
TSMC EX1002 Page 253

a second semiconductor chip over said first interconnection scheme, wherein said second semiconductor chip comprises a fourth metal bump on a second metal pad of said second semiconductor chip, wherein said fourth metal bump comprises a tin-containing layer.

12. (Previously presented) The chip package of claim 11, wherein said compound comprises a $SiO_2$ compound.

Claim 13 is cancelled

14. (Currently amended) The chip package of claim 11, wherein no any ~~metal~~ copper post in said first region.

15. (Previously presented) The chip package of claim 11, further comprising a third semiconductor chip under said first interconnection scheme, wherein said third semiconductor chip comprises a second metal interconnect on a third metal pad of said third semiconductor chip, wherein said second metal interconnect comprises a second metal layer on said third metal pad and a second copper layer over said second metal layer, wherein said second copper layer has a thickness between 5 and 30 micrometers.

16. (Previously presented) The chip package of claim 11, further comprising a third semiconductor chip under said first interconnection scheme, wherein said third semiconductor chip comprises a second metal interconnect on a third metal pad of said third semiconductor chip, wherein said second metal interconnect comprises a second metal layer on said third metal pad



IPR2026-00067
TSMC EX1002 Page 254

and a second copper layer over said second metal layer, wherein said third semiconductor chip comprises a central-processing-unit (CPU) circuit block and a graphics-processing-unit (GPU) circuit block.

Claim 17 is cancelled

18. (Previously presented) The chip package of claim 11, wherein said solid layer further comprises a third region opposite to said second region, wherein said third region is between said first region and a second edge of said solid layer, wherein said plurality of copper posts in said plurality of through holes in said third region respectively.

19. (Previously presented) The chip package of claim 11, wherein said second region is a rectangle region and surrounding said first region.

20. (Previously presented) The chip package of claim 11, further comprising an electrical device under said second surface, wherein said electrical device comprise a third semiconductor chip and a metal wire connected to a third metal pad of said third semiconductor chip, wherein said third semiconductor chip is a DRAM chip.

21. (Newly added)A chip package comprising:

a solid layer having a first surface and a second surface opposite to said first surface, wherein said solid layer comprises a compound of silicon and oxygen, wherein said solid layer



IPR2026-00067
TSMC EX1002 Page 255

has a thickness between 50and 150 micrometers, wherein said solid layer comprises a first region and a second region between said first region and a first edge of said solid layer;

a plurality of copper posts in a plurality of through holes in said second region respectively, wherein said first region has a width in a direction greater than a shortest distance between a sidewall of one of said plurality of through holes and said first edge in said direction and greater than a pitch between two neighboring copper posts of said plurality of copper posts;

a first interconnection scheme over said first surface, wherein said first interconnection scheme comprises first and second metal interconnects over said first surface, and a first polymer layer over said first and second metal interconnects, wherein said first metal interconnect is connected to a first copper post of said plurality of copper posts, wherein said first metal interconnect comprises a first metal layer and a first copper layer over said first metal layer;

a first semiconductor chip over said first interconnection scheme, wherein said first semiconductor chip comprises a third metal interconnect under a first metal pad of said first semiconductor chip, wherein said third metal interconnect comprises a second metal layer under said first metal pad and a second copper layer under said second metal layer, wherein said second copper layer has a thickness between 5 and 30 micrometers, wherein said first semiconductor chip is connected to a second copper post of said plurality of copper posts through said third metal interconnect;

a second semiconductor chip over said first interconnection scheme, wherein said second semiconductor chip comprises a second metal pad coupled to said second metal interconnect;

a third semiconductor chip under said first interconnection scheme; and

a plurality of metal bumps under said second surface, wherein one of said plurality of metal bumps comprises a tin-containing layer.



IPR2026-00067
TSMC EX1002 Page 256

22. (Newly added) The chip package of claim 21, wherein said compound comprises a $SiO_2$ compound.

23. (Newly added) The chip package of claim 21, wherein said solid layer further comprises a third region opposite to said second region, wherein said third region is between said first region and a second edge of said solid layer, wherein said plurality of copper posts in said plurality of through holes in said third region respectively.

24. (Newly added) The chip package of claim 21, wherein said second region is a rectangle region and surrounding said first region.

25. (Newly added) The chip package of claim 21, wherein said first semiconductor chip is a graphics-processing-unit (GPU) chip.

26. (Newly added) The chip package of claim 21, wherein said second semiconductor chip is a memory chip.



IPR2026-00067
TSMC EX1002 Page 257

## REMARKS/ARGUMENTS

Claims 1-25 are pending in the application, of which claims 1, 11 and 21 are the pending independent claims. Claims 5-6, 13 and 17 are cancelled. Claims 21-26 are newly added. Claims 11 and 14 are currently amended herein. No new matter is believed to be added into the application by this paper.

Accordingly, no new matter is believed to be added into the application by this paper.

In view of the Amendments, Applicants submit that the claims are in condition for allowance and respectfully request a notice to this effect.

Respectfully submitted,



Date: __2023-05-17_____ Ping-Jung Yang



IPR2026-00067
TSMC EX1002 Page 258

| Electronic Patent Application Fee Transmittal | | | | |
|---|---|---|---|---|
| **Application Number:** | 17985827 | | | |
| **Filing Date:** | 12-Nov-2022 | | | |
| **Title of Invention:** | CHIP PACKAGE | | | |
| **First Named Inventor/Applicant Name:** | Ping-Jung Yang | | | |
| **Filer:** | Ping-Jung. Yang | | | |
| **Attorney Docket Number:** | Mars16-001-US-C03 | | | |
| Filed as Small Entity | | | | |
| **Filing Fees for Utility under 35 USC 111(a)** | | | | |
| **Description** | **Fee Code** | **Quantity** | **Amount** | **Sub-Total in USD($)** |
| **Basic Filing:** | | | | |
| **Pages:** | | | | |
| **Claims:** | | | | |
| CLAIMS IN EXCESS OF 20 | 2202 | 2 | 40 | 80 |
| **Miscellaneous-Filing:** | | | | |
| **Petition:** | | | | |
| **Patent-Appeals-and-Interference:** | | | | |
| **Post-Allowance-and-Post-Issuance:** | | | | |

| Description | Fee Code | Quantity | Amount | Sub-Total in USD($) |
|---|---|---|---|---|
| **Extension-of-Time:** | | | | |
| **Miscellaneous:** | | | | |
| | | **Total in USD ($)** | | **80** |

| Electronic Acknowledgement Receipt | |
|---|---|
| **EFS ID:** | 48015909 |
| **Application Number:** | 17985827 |
| **International Application Number:** | |
| **Confirmation Number:** | 1762 |
| **Title of Invention:** | CHIP PACKAGE |
| **First Named Inventor/Applicant Name:** | Ping-Jung Yang |
| **Customer Number:** | 102851 |
| **Filer:** | Ping-Jung. Yang |
| **Filer Authorized By:** | |
| **Attorney Docket Number:** | Mars16-001-US-C03 |
| **Receipt Date:** | 17-MAY-2023 |
| **Filing Date:** | 12-NOV-2022 |
| **Time Stamp:** | 11:48:55 |
| **Application Type:** | Utility under 35 USC 111(a) |

## Payment information:

| | |
|---|---|
| Submitted with Payment | yes |
| Payment Type | CARD |
| Payment was successfully received in RAM | $80 |
| RAM confirmation Number | E20235GB51169901 |
| Deposit Account | |
| Authorized User | |
| The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: | |

## File Listing:

| Document Number | Document Description | File Name | File Size(Bytes)/ Message Digest | Multi Part /.zip | Pages (if appl.) |
|---|---|---|---|---|---|
| 1 | | Mars16-001-US-C03-PA-05172023.pdf | 113453<br>aa9bc4a1749b39681caa2a909c3c92bb0b9ed890 | yes | 10 |
| | Multipart Description/PDF files in .zip description | | | | |
| | Document Description | | Start | End | |
| | Preliminary Amendment | | 1 | 1 | |
| | Claims | | 2 | 9 | |
| | Applicant Arguments/Remarks Made in an Amendment | | 10 | 10 | |
| Warnings: | | | | | |
| Information: | | | | | |
| 2 | Fee Worksheet (SB06) | fee-info.pdf | 37775<br>0d9c4a39ece04aca5a5794e3ad5b071342cb162c | no | 2 |
| Warnings: | | | | | |
| Information: | | | | | |
| | | Total Files Size (in bytes): | 151228 | | |

**This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.**

**New Applications Under 35 U.S.C. 111**

**If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.**

**National Stage of an International Application under 35 U.S.C. 371**

**If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.**

**New International Application Filed with the USPTO as a Receiving Office**

**If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.**

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

| PATENT APPLICATION FEE DETERMINATION RECORD<br>Substitute for Form PTO-875 | Application or Docket Number<br>17/985,827 | Filing Date<br>11/12/2022 | ☐ To be Mailed |
|---|---|---|---|

**ENTITY:** ☐ LARGE ☑ SMALL ☐ MICRO

## APPLICATION AS FILED - PART I

| FOR | (Column 1)<br>NUMBER FILED | (Column 2)<br>NUMBER EXTRA | | RATE ($) | FEE ($) |
|---|---|---|---|---|---|
| ☐ BASIC FEE<br>(37 CFR 1.16(a), (b), or (c)) | N/A | N/A | | N/A | |
| ☐ SEARCH FEE<br>(37 CFR 1.16(k), (i), or (m)) | N/A | N/A | | N/A | |
| ☐ EXAMINATION FEE<br>(37 CFR 1.16(o), (p), or (q)) | N/A | N/A | | N/A | |
| TOTAL CLAIMS<br>(37 CFR 1.16(i)) | minus 20 = | * | | x $50 = | |
| INDEPENDENT CLAIMS<br>(37 CFR 1.16(h)) | minus 3 = | * | | x $240 = | |
| ☐ APPLICATION SIZE FEE (37 CFR 1.16(s)) | If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s). | | | | |
| ☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j)) | | | | | |
| * If the difference in column 1 is less than zero, enter "0" in column 2. | | | | TOTAL | |

## APPLICATION AS AMENDED - PART II

| | | (Column 1) | | (Column 2) | (Column 3) | | | |
|---|---|---|---|---|---|---|---|---|
| AMENDMENT | 05/17/2023 | CLAIMS REMAINING AFTER AMENDMENT | | HIGHEST NUMBER PREVIOUSLY PAID FOR | PRESENT EXTRA | | RATE ($) | ADDITIONAL FEE ($) |
| | Total<br>(37 CFR 1.16(i)) | * 22 | Minus | ** 20 | = 2 | | x $40 = | 80 |
| | Independent<br>(37 CFR 1.16(h)) | * 3 | Minus | *** 3 | = 0 | | x $192 = | 0 |
| | ☐ Application Size Fee (37 CFR 1.16(s)) | | | | | | | |
| | ☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j)) | | | | | | | |
| | | | | | | | TOTAL ADD'L FEE | 80 |

| | | (Column 1) | | (Column 2) | (Column 3) | | | |
|---|---|---|---|---|---|---|---|---|
| AMENDMENT | 07/29/2023 | CLAIMS REMAINING AFTER AMENDMENT | | HIGHEST NUMBER PREVIOUSLY PAID FOR | PRESENT EXTRA | | RATE ($) | ADDITIONAL FEE ($) |
| | Total<br>(37 CFR 1.16(i)) | * 22 | Minus | ** 22 | = 0 | | x $40 = | 0 |
| | Independent<br>(37 CFR 1.16(h)) | * 3 | Minus | *** 3 | = 0 | | x $192 = | 0 |
| | ☐ Application Size Fee (37 CFR 1.16(s)) | | | | | | | |
| | ☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j)) | | | | | | | |
| | | | | | | | TOTAL ADD'L FEE | 0 |

| | |
|---|---|
| * If the entry in column 1 is less than the entry in column 2, write "0" in column 3. | LIE |
| ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". | /ANITA JOHNSON/ |
| *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". | |
| The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1. | |

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

*If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.*

Docket No.: Mars-16-001-US-C03 **PATENT**

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

| | | |
|---|---|---|
| In re Application of | : | Customer Number: 102851 |
| Ping-Jung Yang | : | Confirmation Number: 1762 |
| Application No.: 17985827 | : | Group Art Unit: 2812 |
| Filed: Nov. 12, 2022 | : | Examiner: XIAOMING LIU |

For: CHIP PACKAGE

**Preliminary Amendment**

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Please amend the above-identified application and consider the remarks as follows:

**Amendments to the Claims** are reflected in the listing of claims which begins on page 2 of this paper.

**Remarks/Arguments** begin on page 10 of this paper.



IPR2026-00067
TSMC EX1002 Page 265

**Amendments to the Claims:**

This listing of claims will replace all prior versions, and listings, of claims in the application.

**Listing of Claims:**

What is claimed is:

1. (Previously presented) A chip package comprising:

a solid layer having a first surface and a second surface opposite to said first surface, wherein said solid layer comprises a compound of silicon and oxygen, wherein said solid layer has a thickness between 50 and 150 micrometers, wherein said solid layer comprises a first region and a second region between said first region and a first edge of said solid layer;

a plurality of metal posts in a plurality of through holes in said second region respectively, wherein one of said plurality of metal posts comprises a first copper layer contacting a sidewall of one of said plurality of through holes, wherein said first region has a width in a direction greater than a shortest distance between said sidewall of one of said plurality of through holes and said first edge in said direction and greater than a pitch between two neighboring metal posts of said plurality of metal posts;

a first interconnection scheme over said first surface, wherein said first interconnection scheme comprises a first metal interconnect over said second surface and a first polymer layer over said first metal interconnect, wherein said first metal interconnect is connected to a first metal post of said plurality of metal posts, wherein said first metal interconnect comprises a first metal layer and a second copper layer over said first metal layer;



IPR2026-00067
TSMC EX1002 Page 266

a first metal bump over said first interconnection scheme, wherein said first metal bump comprises a second metal layer and a tin-containing layer over said second metal layer; and

a first semiconductor chip under said second surface, wherein said first interconnection scheme comprise a second metal interconnect across over a sidewall of the first semiconductor chip, wherein said first semiconductor chip comprises a third metal interconnect on a first metal pad of said first semiconductor chip, wherein said third metal interconnect comprises a third metal layer on said first metal pad and a third copper layer over said third metal layer, wherein said third copper layer has a thickness between 5 and 30 micrometers, wherein said first semiconductor chip is connected to a second metal post of said plurality of metal posts through said third metal interconnect.

2. (Previously presented) The chip package of claim 1, wherein said first semiconductor chip comprises a central-processing-unit (CPU) circuit block and a graphics-processing-unit (GPU) circuit block.

3. (Previously presented) The chip package of claim 1, wherein said first interconnection scheme further comprises a fourth metal interconnect over said first metal interconnect and said first polymer layer, wherein said first polymer is between said first and fourth metal interconnects, wherein said fourth metal interconnect comprises a fourth metal layer and a fourth copper layer over said fourth metal layer.

4. (Previously presented) The chip package of claim 1, wherein said first metal pad is an aluminum pad.



IPR2026-00067
TSMC EX1002 Page 267

Claims 5-6 are cancelled

7. (Previously presented) The chip package of claim 1, wherein said compound comprises a $SiO_2$ compound.

8. (Previously presented) The chip package of claim 1, further comprising a second semiconductor chip over said first semiconductor chip, wherein said second semiconductor chip comprises a second metal bump on a second metal pad of said second semiconductor chip, wherein said second metal bump comprises a tin-containing layer.

9. (Previously presented) The chip package of claim 1, wherein said solid layer further comprises a third region opposite to said second region, wherein said third region is between said first region and a second edge of said solid layer, wherein said plurality of metal posts in said plurality of through holes in said third region respectively.

10. (Previously presented) The chip package of claim 1, wherein said second region is a rectangle region and surrounding said first region.

11. (Previously presented) A chip package comprising:

a solid layer having a first surface and a second surface opposite to said first surface, wherein said solid layer comprises a compound of silicon and oxygen, wherein said solid layer



IPR2026-00067
TSMC EX1002 Page 268

has a thickness between 100 and 300 micrometers, wherein said solid layer comprises a first region and a second region between said first region and a first edge of said solid layer;

a plurality of copper posts in a plurality of through holes in said second region respectively, wherein said first region has a width in a direction greater than a shortest distance between a sidewall of one of said plurality of through holes and said first edge in said direction and greater than a pitch between two neighboring copper posts of said plurality of copper posts;

a first interconnection scheme over said first surface, wherein said first interconnection scheme comprises a first metal interconnect over said first surface, and a first polymer layer over said first metal interconnect, wherein said first metal interconnect is connected to one of said plurality of copper posts, wherein said first metal interconnect comprises a first metal layer and a first copper layer over said first metal layer;

a first metal bumps over said first interconnection scheme, wherein first metal bumps comprises a tin-containing layer;

a second metal bumps over said first interconnection scheme;

a first semiconductor chip over said first interconnection scheme and between said first and second metal bumps, wherein said first semiconductor chip has a height between a backside surface of said first semiconductor chip and a top surface of said first polymer layer is smaller than a thickness of said first metal bump, wherein said first semiconductor chip comprises a third metal bump on a first metal pad of said first semiconductor chip, wherein said third metal bump comprises a tin-containing layer; and

a second semiconductor chip over said first interconnection scheme, wherein said second semiconductor chip comprises a fourth metal bump on a second metal pad of said second semiconductor chip, wherein said fourth metal bump comprises a tin-containing layer.



IPR2026-00067
TSMC EX1002 Page 269

12. (Previously presented) The chip package of claim 11, wherein said compound comprises a $SiO_2$ compound.

Claim 13 is cancelled

14. (Previously presented) The chip package of claim 11, wherein no any copper post in said first region.

15. (Previously presented) The chip package of claim 11, further comprising a third semiconductor chip under said first interconnection scheme, wherein said third semiconductor chip comprises a second metal interconnect on a third metal pad of said third semiconductor chip, wherein said second metal interconnect comprises a second metal layer on said third metal pad and a second copper layer over said second metal layer, wherein said second copper layer has a thickness between 5 and 30 micrometers.

16. (Previously presented) The chip package of claim 11, further comprising a third semiconductor chip under said first interconnection scheme, wherein said third semiconductor chip comprises a second metal interconnect on a third metal pad of said third semiconductor chip, wherein said second metal interconnect comprises a second metal layer on said third metal pad and a second copper layer over said second metal layer, wherein said third semiconductor chip comprises a central-processing-unit (CPU) circuit block and a graphics-processing-unit (GPU) circuit block.



IPR2026-00067
TSMC EX1002 Page 270

Claim 17 is cancelled

18. (Previously presented) The chip package of claim 11, wherein said solid layer further comprises a third region opposite to said second region, wherein said third region is between said first region and a second edge of said solid layer, wherein said plurality of copper posts in said plurality of through holes in said third region respectively.

19. (Previously presented) The chip package of claim 11, wherein said second region is a rectangle region and surrounding said first region.

20. (Previously presented) The chip package of claim 11, further comprising an electrical device under said second surface, wherein said electrical device comprise a third semiconductor chip and a metal wire connected to a third metal pad of said third semiconductor chip, wherein said third semiconductor chip is a DRAM chip.

21. (Currently amended) A chip package comprising:

a solid layer having a first surface and a second surface opposite to said first surface, wherein said solid layer comprises a compound of silicon and oxygen, wherein said solid layer has a thickness between 50and 150 micrometers, wherein said solid layer comprises a first region and a second region between said first region and a first edge of said solid layer;

a plurality of copper posts in a plurality of through holes in said second region respectively~~, wherein said first region has a width in a direction greater than a shortest distance~~



IPR2026-00067
TSMC EX1002 Page 271

~~between a sidewall of one of said plurality of through holes and said first edge in said direction and greater than a pitch between two neighboring copper posts of said plurality of copper posts~~;

a first interconnection scheme over said first surface, wherein said first interconnection scheme comprises first and second metal interconnects over said first surface, and a first polymer layer over said first and second metal interconnects, wherein said first metal interconnect is connected to a first copper post of said plurality of copper posts, wherein said first metal interconnect comprises a first metal layer and a first copper layer over said first metal layer;

a first semiconductor chip over said first interconnection scheme, wherein said first semiconductor chip comprises a third metal interconnect under a first metal pad of said first semiconductor chip, wherein said third metal interconnect comprises a second metal layer under said first metal pad and a second copper layer under said second metal layer, wherein said second copper layer has a thickness between 5 and 30 micrometers, wherein said first semiconductor chip is ~~connected~~ coupled to a second copper post of said plurality of copper posts through said third metal interconnect;

a second semiconductor chip over said first interconnection scheme, wherein said second semiconductor chip comprises a second metal pad coupled to said second metal interconnect;

a third semiconductor chip under said first interconnection scheme; and

a plurality of metal bumps under said second surface, wherein one of said plurality of metal bumps comprises a tin-containing layer.

22. (Previously presented) The chip package of claim 21, wherein said compound comprises a $SiO_2$ compound.



IPR2026-00067
TSMC EX1002 Page 272

23. (Previously presented) The chip package of claim 21, wherein said solid layer further comprises a third region opposite to said second region, wherein said third region is between said first region and a second edge of said solid layer, wherein said plurality of copper posts in said plurality of through holes in said third region respectively.

24. (Currently amended) The chip package of claim 21, further comprising a fourth semiconductor chip over said first semiconductor chip, wherein said fourth semiconductor chip comprises a third metal pad at a bottom surface of said fourth semiconductor chip, wherein said first semiconductor chip further comprising a plurality of through-silicon-via metal layers and a fourth metal pad at a top surface of said first semiconductor chip, wherein said first metal pad is at a bottom surface of said first semiconductor chip, wherein said first metal pad is coupled to said fourth metal pad through one of said plurality of through-silicon-via metal layers, wherein said third metal pad is coupled to said fourth metal pad through a solder layer. ~~second region is a rectangle region and surrounding said first region.~~

25. (Previously presented) The chip package of claim 21, wherein said first semiconductor chip is a graphics-processing-unit (GPU) chip.

26. (Previously presented) The chip package of claim 21, wherein said second semiconductor chip is a memory chip.



IPR2026-00067
TSMC EX1002 Page 273

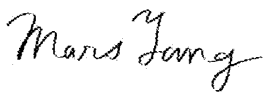
## REMARKS/ARGUMENTS

Claims 1-26 are pending in the application, of which claims 1, 11 and 21 are the pending independent claims. Claims 5-6, 13 and 17 are cancelled. Claims 21 and 24 are currently amended herein. No new matter is believed to be added into the application by this paper.

Accordingly, no new matter is believed to be added into the application by this paper.

In view of the Amendments, Applicants submit that the claims are in condition for allowance and respectfully request a notice to this effect.

Respectfully submitted,



Date: __2023-07-29_____ Ping-Jung Yang



IPR2026-00067
TSMC EX1002 Page 274

| Electronic Acknowledgement Receipt | |
|---|---|
| **EFS ID:** | 48368174 |
| **Application Number:** | 17985827 |
| **International Application Number:** | |
| **Confirmation Number:** | 1762 |
| **Title of Invention:** | CHIP PACKAGE |
| **First Named Inventor/Applicant Name:** | Ping-Jung Yang |
| **Customer Number:** | 102851 |
| **Filer:** | Ping-Jung. Yang |
| **Filer Authorized By:** | |
| **Attorney Docket Number:** | Mars16-001-US-C03 |
| **Receipt Date:** | 29-JUL-2023 |
| **Filing Date:** | 12-NOV-2022 |
| **Time Stamp:** | 09:17:23 |
| **Application Type:** | Utility under 35 USC 111(a) |

## Payment information:

| Submitted with Payment | no |
|---|---|

## File Listing:

| Document Number | Document Description | File Name | File Size(Bytes)/ Message Digest | Multi Part /.zip | Pages (if appl.) |
|---|---|---|---|---|---|
| 1 | | Mars16-001-US-C03-PA-07292023.pdf | 114619<br>0a25d8b1e8b9716a20147ade4314f60ff9379bfd | yes | 10 |

| | Multipart Description/PDF files in .zip description | | |
|---|---|---|---|
| | **Document Description** | **Start** | **End** |
| | Preliminary Amendment | 1 | 1 |
| | Claims | 2 | 9 |
| | Applicant Arguments/Remarks Made in an Amendment | 10 | 10 |
| **Warnings:** | | | |
| **Information:** | | | |
| | **Total Files Size (in bytes):** | 114619 | |

**This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.**

**New Applications Under 35 U.S.C. 111**
**If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.**
**National Stage of an International Application under 35 U.S.C. 371**
**If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.**
**New International Application Filed with the USPTO as a Receiving Office**
**If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.**

| Notice of References Cited | Application/Control No. 17/985,827 | Applicant(s)/Patent Under Reexamination Yang, Ping-Jung | |
|---|---|---|---|
| | Examiner XIAOMING LIU | Art Unit 2812 | Page 1 of 1 |

**U.S. PATENT DOCUMENTS**

| * | | Document Number Country Code-Number-Kind Code | Date MM-YYYY | Name | CPC Classification | US Classification |
|---|---|---|---|---|---|---|
| * | A | US-11538763-B2 | 12-2022 | Yang; Ping-Jung | H01L23/15 | 1/1 |
| | B | | | | | |
| | C | | | | | |
| | D | | | | | |
| | E | | | | | |
| | F | | | | | |
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**FOREIGN PATENT DOCUMENTS**

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| | P | | | | | |
| | Q | | | | | |
| | R | | | | | |
| | S | | | | | |
| | T | | | | | |

**NON-PATENT DOCUMENTS**

| * | | Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages) |
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| | U | |
| | V | |
| | W | |
| | X | |

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.



IPR2026-00067
TSMC EX1002 Page 277

| Index of Claims | Application/Control No. | Applicant(s)/Patent Under Reexamination |
|---|---|---|
| | 17/985,827 | Yang, Ping-Jung |
| | Examiner | Art Unit |
| | XIAOMING LIU | 2812 |

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|---|---|---|---|---|---|---|---|
| ✓ | Rejected | - | Cancelled | N | Non-Elected | A | Appeal |
| = | Allowed | ÷ | Restricted | I | Interference | O | Objected |

| CLAIMS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ☐ Claims renumbered in the same order as presented by applicant | | | | | | ☐ CPA | ☐ T.D. | ☐ R.1.47 | | |
| CLAIM | | DATE | | | | | | | | |
| Final | Original | 11/04/2023 | | | | | | | | |
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| | 3 | ✓ | | | | | | | | |
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| | 8 | ✓ | | | | | | | | |
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| | 10 | ✓ | | | | | | | | |
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| | 24 | ✓ | | | | | | | | |
| | 25 | ✓ | | | | | | | | |
| | 26 | ✓ | | | | | | | | |



IPR2026-00067
TSMC EX1002 Page 278

| Search Notes | Application/Control No. | Applicant(s)/Patent Under Reexamination |
|---|---|---|
| | 17/985,827 | Yang, Ping-Jung |
| | Examiner | Art Unit |
| | XIAOMING LIU | 2812 |

| CPC - Searched* | | |
|---|---|---|
| **Symbol** | **Date** | **Examiner** |
| H01L23/49827 \| H01L23/5384 \| H01L2224/08165 \| H01L2224/16165 \| H01L2224/16235 \| H01L2224/32165 \| H01L2224/32235 \| H01L2224/40165 \| H01L2224/40235 \| H01L2224/48165 \| H01L2224/48235 with date and text | 11/03/2023 | XL |

| CPC Combination Sets - Searched* | | |
|---|---|---|
| **Symbol** | **Date** | **Examiner** |
| | | |

| US Classification - Searched* | | | |
|---|---|---|---|
| **Class** | **Subclass** | **Date** | **Examiner** |
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* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

| Search Notes | | |
|---|---|---|
| **Search Notes** | **Date** | **Examiner** |
| Searched: (USPAT, USPGPUB, USOCR, FPRS, EPO, JPO, DERWENT, IBMTDB) | 11/04/2023 | XL |
| Inventor search Conducted, limited with text | 11/04/2023 | XL |
| Inventor search Conducted, limited with text | 11/04/2023 | XL |
| Google text search conducted | 11/04/2023 | XL |
| Non-Patent Literature searched: science direct, TC2800 | 11/04/2023 | XL |

| /XIAOMING LIU/<br>Examiner, Art Unit 2812 | |
|---|---|



IPR2026-00067
TSMC EX1002 Page 279

| Search Notes | Application/Control No. | Applicant(s)/Patent Under Reexamination |
|---|---|---|
| | 17/985,827 | Yang, Ping-Jung |
| | Examiner | Art Unit |
| | XIAOMING LIU | 2812 |

| Interference Search | | | |
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| US Class/CPC Symbol | US Subclass/CPC Group | Date | Examiner |
| | | | |

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| /XIAOMING LIU/<br>Examiner, Art Unit 2812 | |



IPR2026-00067
TSMC EX1002 Page 280

## Bibliographic Data

Application No: 17/985,827

Foreign Priority claimed: ○ Yes ◉ No

35 USC 119 (a-d) conditions met: ☐ Yes ☑ No ☐ Met After Allowance

Verified and Acknowledged: /XIAOMING LIU/ (Examiner's Signature) | (Initials)

Title: CHIP PACKAGE

| FILING or 371(c) DATE | CLASS | GROUP ART UNIT | ATTORNEY DOCKET NO. |
|---|---|---|---|
| 11/12/2022 | 257 | 2812 | Mars16-001-US-C03 |
| RULE | | | |

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**INVENTORS**

Ping-Jung Yang, Hsinchu City, TAIWAN

**CONTINUING DATA**

This application is a CON of 17372459 07/11/2021 PAT 11538763

17372459 is a CON of 16752650 01/26/2020 PAT 11107768

16752650 is a CON of 15261956 09/11/2016 PAT 10622310

15261956 has PRO of 62219249 09/16/2015

15261956 is a CIP of 14036256 09/25/2013 PAT 9615453

14036256 has PRO of 61705649 09/26/2012

**FOREIGN APPLICATIONS**

**IF REQUIRED, FOREIGN LICENSE GRANTED****

11/28/2022

**** SMALL ENTITY ****

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HSINCHU CITY, 30091
TAIWAN

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$830

## PE2E SEARCH - Search History (Prior Art)

| Ref # | Hits | Search Query | DBs | Default Operator | Plurals | British Equivalents | Time Stamp |
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IPR2026-00067
TSMC EX1002 Page 282

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IPR2026-00067
TSMC EX1002 Page 283

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IPR2026-00067
TSMC EX1002 Page 284

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| L24 | 2 | "20130242493" | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | OFF | OFF | 2020/09/10 06:34 PM |
| L25 | 32 | ("2013/0242493").URPN. | (USPAT) | OR | OFF | OFF | 2020/09/10 06:36 PM |
| L27 | 21 | "ppm/.degree.C" | (USPAT) | OR | OFF | OFF | 2020/09/10 06:42 PM |
| L28 | 1788 | polymer same | (USPAT) | OR | OFF | OFF | 2020/09/10 |



IPR2026-00067
TSMC EX1002 Page 287

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| | | expansion adj coefficient | | | | | 06:45 PM |
| L29 | 446 | polymer near10 expansion adj coefficient | (USPAT) | OR | OFF | OFF | 2020/09/10 06:45 PM |
| L34 | 3 | "20110257716" | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | OFF | OFF | 2020/09/10 06:55 PM |
| L35 | 46 | (US-20110304008-$ or US-20120313207-$ or US-20120241938-$ or US-20120193785-$ or US-20120052631-$ or US-20110297434-$ or US-20110026232-$ or US-20100290191-$ or US-20100207154-$ or US-20100200898-$ or US-20100102457-$ or US-20100044850-$ or US-20090315171-$ or US-20110110061-$ or US-20100123257-$ or US-20100052119-$ or US-20090184403-$ or US-20120326170-$ or US-20130050228-$ or US-20130049217-$ or US-20120313209-$ or US-20120306096-$ or US-20120228749-$ or US-20140124777-$ or US-20140042637-$ or US-20130328211-$).did. or (US-20130292844-$ or US-20130119562-$ or US-20100258944-$ or US-20100258946-$ or US-20100252937-$ or US-20080149384-$ or US-20130277855-$ or US-20170373004-$ or US-20170345761-$ or US-20130242493-$).did. or (US-9437534-$ or US-8247269-$ or US-8614120-$ or US-7968978-$ or US-9627365-$ or US-9817312-$ or US-9615453-$ or US-9363890-$ or US-9161443-$ or US-9030751-$).did. | (US-PGPUB; USPAT) | OR | OFF | OFF | 2020/09/10 06:58 PM |
| L37 | 30 | L35 and polyimide | (US-PGPUB; USPAT) | OR | ON | ON | 2020/09/10 |



IPR2026-00067
TSMC EX1002 Page 288

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| | | | | | | | 07:00 PM |
| L38 | 65 | (US-20160181184-$ or US-20170062361-$ or US-20160163666-$ or US-20150206934-$ or US-20140021618-$ or US-20120208129-$ or US-20180062386-$ or US-20160173039-$ or US-20160087588-$ or US-20110241793-$ or US-20110057742-$ or US-20100032818-$ or US-20100001363-$ or US-20130147540-$ or US-20190259758-$ or US-20190252306-$ or US-20150179591-$ or US-20140346663-$ or US-20140312362-$ or US-20140077362-$ or US-20130200528-$ or US-20130026658-$ or US-20100165585-$ or US-20160071820-$).did. or (US-6659663-$ or US-10153553-$ or US-6829152-$ or US-10580726-$ or US-10090266-$ or US-9972555-$ or US-8168470-$ or US-9954028-$ or US-10177115-$).did. | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | OFF | OFF | 2020/09/10 10:50 PM |
| L39 | 1659 | ((("STATS") near3 ("CHIPPAC") near3 ("LTD"))).AS,AANM. | (USPAT) | OR | OFF | OFF | 2020/09/10 10:51 PM |
| L40 | 3 | "20090230517" | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | OFF | OFF | 2020/09/10 10:57 PM |
| L41 | 3 | "20090155959" | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | OFF | OFF | 2020/09/10 11:20 PM |
| L42 | 3 | "20130049217" | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | OFF | OFF | 2020/09/11 10:28 AM |
| L44 | 3 | "20090155959" | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | OFF | OFF | 2020/09/11 10:34 AM |
| L45 | 2 | "20090155959" and passive | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | OFF | OFF | 2020/09/11 10:35 AM |
| L46 | 3 | "20090230517" | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | OFF | OFF | 2020/09/11 10:57 AM |
| L47 | 20179 | (H01L23/49827 \| H01L23/5384 \| | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2020/09/11 11:06 AM |

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|---|---|---|---|---|---|---|---|
| | | H01L2224/08165 \| H01L2224/16165 \| H01L2224/16235 \| H01L2224/32165 \| H01L2224/32235 \| H01L2224/40165 \| H01L2224/40235 \| H01L2224/48165 \| H01L2224/48235).CPC. | | | | | |
| L48 | 537 | L47 and cpu same gpu same DRAM | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2020/09/11 11:06 AM |
| L49 | 127 | L47 and cpu same gpu same DRAM and integration | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2020/09/11 11:06 AM |
| L50 | 20179 | (H01L23/49827 \| H01L23/5384 \| H01L2224/08165 \| H01L2224/16165 \| H01L2224/16235 \| H01L2224/32165 \| H01L2224/32235 \| H01L2224/40165 \| H01L2224/40235 \| H01L2224/48165 \| H01L2224/48235).CPC. | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2020/09/11 01:47 PM |
| L51 | 146 | L50 and tsv same layout | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2020/09/11 01:47 PM |
| L52 | 6 | "20130049217" "20090155959" "20090230517" "20130277801" "20110257716" "20100252934" | (US-PGPUB) | OR | OFF | OFF | 2020/09/17 04:44 PM |
| L53 | 71 | (US-20110304008-$ or US-20120313207-$ or US-20120241938-$ or US-20120193785-$ or US-20120052631-$ or US-20110297434-$ or US-20110026232-$ or US-20100290191-$ or US-20100207154-$ or US-20100200898-$ or US-20100102457-$ or US-20100044850-$ or US-20090315171-$ or US-20110110061-$ or US-20100123257-$ or US-20100052119-$ or US-20090184403-$ or US-20120326170-$ or US-20130050228-$ or US-20130049217-$ or US-20120313209-$ or US-20120306096-$ or US-20120228749-$ or | (US-PGPUB; USPAT) | OR | ON | ON | 2021/04/22 11:47 AM |

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|---|---|---|---|---|---|---|---|
| | | US-20140124777-$ or US-20140042637-$ or US-20130328211-$).did. or (US-20130292844-$ or US-20130119562-$ or US-20100258944-$ or US-20100258946-$ or US-20100252937-$ or US-20080149384-$ or US-20130277855-$ or US-20170373004-$ or US-20170345761-$ or US-20130242493-$ or US-20100252934-$).did. or (US-9437534-$ or US-8247269-$ or US-8614120-$ or US-7968978-$ or US-9627365-$ or US-9817312-$ or US-9615453-$ or US-9363890-$ or US-9161443-$ or US-9030751-$ or US-8354304-$ or US-8273602-$ or US-8270176-$ or US-8263434-$ or US-8217514-$ or US-8193036-$ or US-8133762-$ or US-8110440-$ or US-8110908-$ or US-8105915-$ or US-8080445-$ or US-8067308-$ or US-8067828-$ or US-8067275-$ or US-8063477-$ or US-8034661-$).did. or (US-8008121-$ or US-7977802-$ or US-7935570-$ or US-7880293-$ or US-7858441-$ or US-7842542-$ or US-7838337-$ or US-7790503-$).did. | | | | | |
| L54 | 21477 | (H01L23/49827 \| H01L23/5384 \| H01L2224/08165 \| H01L2224/16165 \| H01L2224/16235 \| H01L2224/32165 \| H01L2224/32235 \| H01L2224/40165 \| H01L2224/40235 \| | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2021/04/22 11:47 AM |



IPR2026-00067
TSMC EX1002 Page 291

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|---|---|---|---|---|---|---|---|
| | | H01L2224/48165 \| H01L2224/48235).CPC. | | | | | |
| L55 | 166 | L54 and tsv same layout | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2021/04/22 11:47 AM |
| L56 | 2 | ("20200161245").PN. | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | ON | ON | 2021/04/22 11:48 AM |
| L57 | 2 | ("20140085842").PN. | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | ON | ON | 2021/04/22 12:22 PM |
| L58 | 3 | "20110147055" | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | ON | ON | 2021/04/22 12:24 PM |
| L63 | 31 | (US-20040238945-$ \| US-20050098891-$ \| US-20060292851-$ \| US-20110278736-$ \| US-20110285005-$ \| US-20120193785-$ \| US-10490521-$ \| US-6002592-$ \| US-6423570-$ \| US-7019406-$ \| US-7569422-$ \| US-8193555-$ \| US-8431977-$ \| US-8445323-$ \| US-8456856-$ \| US-8837872-$).DID. | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | OFF | OFF | 2021/06/03 01:46 AM |
| L64 | 2 | ("20200161245").PN. | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | ON | ON | 2021/06/03 01:52 AM |
| L67 | 7 | L63 and cpu same gpu | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | OFF | OFF | 2021/06/03 02:18 AM |
| L68 | 10 | ("20060193691" \| "20090014826" \| "20090042338" \| "20090057868" \| "6777767" \| "7582556" \| "8193555").PN. OR ("8431977").URPN. | (US-PGPUB; USPAT; USOCR) | OR | ON | ON | 2021/06/03 02:48 AM |
| L69 | 3 | "20110304008" | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2021/06/04 02:18 PM |
| L70 | 13 | ("2011/0304008").URPN. | (USPAT) | OR | ON | ON | 2021/06/04 02:21 PM |
| L71 | 130 | ("2012/0193785").URPN. | (USPAT) | OR | ON | ON | 2021/06/04 05:27 PM |
| L73 | 3 | "20120170887" | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | OFF | OFF | 2021/06/05 05:28 PM |
| L75 | 3 | "20110304008" | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | OFF | OFF | 2021/06/05 05:58 PM |
| L76 | 33 | ("20040238941" \| "20040262735" \| "20050130368" \| "20070096292" \| | (US-PGPUB; USPAT; USOCR) | OR | ON | ON | 2021/06/05 07:41 PM |

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|---|---|---|---|---|---|---|---|
| | | "20080001285" \| "20080099911" \| "20080136004" \| "20090170242" \| "20090294899" \| "20090302435" \| "20100006994" \| "20100059876" \| "5250843" \| "5353498" \| "5841193" \| "6495912" \| "6828670" \| "6905912" \| "7214565" \| "7619901" \| "7772081" \| "7790503" \| "7858441" \| "8193604").PN. OR ("8445323").URPN. | | | | | |
| L77 | 5 | "20100140779" | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2021/06/05 07:45 PM |
| L78 | 3 | "20110304008" "20100140779" "20120170887" | (US-PGPUB) | OR | OFF | OFF | 2021/06/05 11:31 PM |
| L79 | 1 | "10622310".pn. | (US-PGPUB; USPAT) | OR | OFF | OFF | 2021/06/05 11:41 PM |
| L80 | 2 | ("2013/0328211").urpn. AND (PGPB \| USPT \| USOC).dbnm. | (US-PGPUB; USPAT; USOCR) | OR | ON | ON | 2021/11/02 03:42 PM |
| L81 | 2 | "20210335714" | (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, CA, CH, CN, DD, DE, EA, EP, ES, FR, GB, JP, KR, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2022/09/15 02:02 PM |
| L82 | 22 | ((("YANG") near3 ("Ping-Jung"))).INV. | (US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT) | OR | OFF | OFF | 2022/09/15 02:03 PM |
| L83 | 31 | (Artificial Intelligence) More like doc: US-20210335714-A1 Text: (US-11107768-B2 OR US-20200161245-A1 OR US-10622310-B2 OR US-20170047313-A1 OR US-9615453-B2 OR US-20170207188-A1 OR US-20190027459-A1 OR US-10096565-B2 OR US-10453819-B2 OR US-20140085842-A1 OR CN-107046018-B | (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2022/09/15 02:34 PM |

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|---|---|---|---|---|---|---|---|
| | | OR TW-201712812-A OR TW-I675440-B OR CN-107046018-A OR CN-111968959-A OR US-20140117534-A1 OR CN-109411482-A OR US-20190057938-A1 OR US-9673125-B2 OR US-10692815-B2).did. | | | | | |
| L84 | 34 | (Artificial Intelligence) More like doc: US-20140085842-A1 Text: (US-20170207188-A1 OR US-10453819-B2 OR US-9615453-B2 OR US-20190027459-A1 OR US-10096565-B2 OR US-10622310-B2 OR US-20170047313-A1 OR US-20200161245-A1 OR US-20210335714-A1 OR US-11107768-B2 OR US-20160284637-A1 OR US-8207453-B2 OR DE-112010004890-B4 OR US-20120192413-A1 OR TW-201714500-A OR US-10070524-B2 OR US-20140085846-A1 OR CN-107926110-B OR WO-2017034958-A1 OR EP-3338520-A1).did. | (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2022/09/15 02:36 PM |
| L85 | 71 | ((US-20100102457-A1 OR US-20120241938-A1 OR US-20120193785-A1 OR US-20120052631-A1 OR US-20110297434-A1 OR US-20110026232-A1 OR US-20100290191-A1 OR US-20100207154-A1 OR US-20090184403-A1 OR US-20120313207-A1 OR US-20100044850-A1 OR US-20090315171-A1 OR US-20110110061-A1 OR US-20100123257-A1 OR US-20100052119-A1 OR | (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | OFF | OFF | 2022/09/15 02:45 PM |

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|---|---|---|---|---|---|---|---|
| | | US-20100200898-A1 OR US-20140124777-A1 OR US-20120326170-A1 OR US-20130050228-A1 OR US-20130049217-A1 OR US-20120313209-A1 OR US-20120306096-A1 OR US-20110304008-A1 OR US-20140042637-A1 OR US-20130328211-A1 OR US-20130292844-A1 OR US-20130119562-A1 OR US-20100258944-A1 OR US-20100258946-A1 OR US-20100252937-A1 OR US-20120228749-A1 OR US-20130277855-A1 OR US-20170373004-A1 OR US-20170345761-A1 OR US-20130242493-A1 OR US-20080149384-A1 OR US-20100252934-A1).did. AND PGPB.dbnm.) OR ((US-9437534-B2 OR US-8247269-B1 OR US-8614120-B2 OR US-7968978-B2 OR US-8110908-B2 OR US-8110440-B2 OR US-9627365-B1 OR US-9817312-B2 OR US-9615453-B2 OR US-9363890-B2 OR US-8008121-B2 OR US-9030751-B2 OR US-8354304-B2 OR US-8273602-B2 OR US-8270176-B2 OR US-8263434-B2 OR US-8217514-B2 OR US-8193036-B2 OR US-8133762-B2 OR US-7977802-B2 OR US-8105915-B2 OR US-8080445-B1 OR US-8067308-B2 OR US-8067828-B2 OR US-8067275-B2 OR US-8063477-B2 OR US-8034661-B2 OR US- | | | | | |

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|---|---|---|---|---|---|---|---|
| | | 9161443-B2 OR US-7935570-B2 OR US-7880293-B2 OR US-7858441-B2 OR US-7842542-B2 OR US-7838337-B2 OR US-7790503-B2).did. AND USPT.dbnm.) | | | | | |
| L86 | 2 | ("2013/0328211").urpn. AND (PGPB \| USPT \| USOC).dbnm. | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2022/09/15 02:53 PM |
| L87 | 33 | (Artificial Intelligence) More like doc: US-20120228749-A1 Text: (US-8268677-B1 OR US-9685403-B2 OR US-20140319661-A1 OR US-20120299165-A1 OR US-8810011-B2 OR US-9391046-B2 OR US-10643952-B2 OR US-20120292745-A1 OR US-20100276792-A1 OR US-20110298101-A1 OR US-9484279-B2 OR US-20170018507-A1 OR US-20140291820-A1 OR US-9437482-B2 OR US-8791015-B2 OR US-20120273926-A1 OR US-20110298109-A1 OR US-20120112327-A1 OR US-20130001762-A1 OR US-8581370-B2).did. | (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | OFF | OFF | 2022/09/15 02:53 PM |
| L88 | 34 | (Artificial Intelligence) More like doc: US-20120193785-A1 Text: (WO-2012106183-A1 OR US-8503186-B2 OR US-8804360-B2 OR US-20130292849-A1 OR TW-I416693-B OR US-9099540-B2 OR US-8487444-B2 OR US-20100225002-A1 OR TW-201034157-A OR JP-2010219526-A OR US-20110248396-A1 OR US-20130230985-A1 OR CN-101840912-B OR CN-101840912-A OR | (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | OFF | OFF | 2022/09/15 02:54 PM |



IPR2026-00067
TSMC EX1002 Page 296

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|---|---|---|---|---|---|---|---|
| | | KR-20170018813-A OR KR-20100100629-A OR JP-2017518634-A OR CN-109801897-B OR CN-106463467-A OR TW-202002188-A).did. | | | | | |
| L89 | 30 | ("2008/0149384").urpn. AND (PGPB \| USPT \| USOC).dbnm. | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2022/09/15 02:55 PM |
| L90 | 56 | ("4221047" \| "4639543" \| "4975103" \| "5294238" \| "5705855" \| "6156413" \| "6177707" \| "6194762" \| "6309901" \| "6339197" \| "6539750" \| "6673698" \| "6691409" \| "6772514" \| "6799438" \| "6839946" \| "6894358" \| "6989604" \| "7038309" \| "7071521" \| "7072018" \| "7091589" \| "7259080" \| "7279771" \| "7285834" \| "7337540" \| "7362403" \| "7476623" \| "7749900" \| "7993510" \| "20020038725" \| "20020145197" \| "20020159243" \| "20050012217" \| "20080149384" \| "20080283277" \| "20090174065" \| "20090273073" \| "20100164030").pn. OR ("8207453").urpn. AND (PGPB \| USPT \| USOC).dbnm. | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2022/09/15 02:55 PM |
| L91 | 34 | (Artificial Intelligence) More like doc: US-8207453-B2<br>Text: (KR-20140041933-A OR WO-2011084235-A2 OR TW-I467716-B OR US-20120192413-A1 OR TW-201138032-A OR US-10070524-B2 OR US-20110147055-A1 OR KR-101389626-B1 OR US-20160284637-A1 OR US-9686861-B2 OR KR-101531482-B1 OR KR-20120095426-A OR DE-112010004890-B4 OR DE-112010004890-T5 OR CN-102668068-A OR CN-102668068-B | (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | OFF | OFF | 2022/09/15 02:56 PM |



IPR2026-00067
TSMC EX1002 Page 297

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|---|---|---|---|---|---|---|---|
| | | OR US-20110147059-A1 OR KR-101466582-B1 OR WO-2011084216-A2 OR US-20160322290-A1).did. | | | | | |
| L92 | 32 | (Artificial Intelligence) Similar to: 17/372,459 with 0 CPC Selections and 0 Text Selections<br>Text: (SE-8202170-L OR ES-8304363-A1 OR ES-8503920-A1 OR IE-853216-L OR JP-S61168940-A OR JP-S568855-A OR IE-57063-B1 OR JP-S60244053-A OR EP-0380914-B1 OR JP-S56120147-A OR US-4871583-A OR JP-S61287131-A OR JP-S5979594-A OR JP-S6292353-A OR CA-1189196-A OR WO-9917361-A3 OR US-6054652-A OR JP-S62222661-A OR JP-S62242346-A OR JP-S62195162-A OR JP-S6035543-A OR JP-S59182548-A OR JP-S62173742-A OR EP-0004556-A1 OR EP-0188838-B1 OR US-4161817-A OR JP-S60165746-A OR JP-H0247892-A OR JP-H0466105-B2 OR GB-2324415-A OR JP-S60241238-A OR US-11164818-B2 OR CN-2652088-Y OR US-4882657-A OR TW-I765532-B OR JP-S62123743-A OR JP-S59117142-A OR CN-1496212-A OR CN-100352319-C OR JP-S61242047-A OR JP-S59103360-A OR JP-S59188949-A OR JP-2505739-B2 OR EP-0004556-B1 OR DE-19747609-A1 OR DE- | (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, CA, CH, CN, DD, DE, EA, EP, ES, FR, GB, JP, KR, OA, RU, SU, WO)) | OR | ON | ON | 2022/10/21 08:02 PM |

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## PE2E SEARCH - Search History (Interference)

| Ref # | Hits | Search Query | DBs | Default Operator | Plurals | British Equivalents | Time Stamp |
|---|---|---|---|---|---|---|---|
| N59 | 10057 | (H01L23/49827 \| H01L23/5384 \| H01L2224/08165 \| H01L2224/16165 \| H01L2224/16235 \| H01L2224/32165 \| H01L2224/32235 \| H01L2224/40165 \| H01L2224/40235 \| H01L2224/48165 \| H01L2224/48235).CPC. | (USPAT) | OR | OFF | OFF | 2021/04/22 11:37 AM |
| N60 | 8 | N59 and (copper and pitch and (coeffcient or expansion) and thickness).clm. | (USPAT) | OR | OFF | OFF | 2021/04/22 11:44 AM |

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| N61 | 22 | N59 and (pitch and (coeffcient or expansion) and thickness).clm. | (USPAT) | OR | OFF | OFF | 2021/04/22 11:45 AM |
| N62 | 242 | (pitch and (coeffcient or expansion) and thickness).clm. | (USPAT) | OR | OFF | OFF | 2021/04/22 11:45 AM |
| N80 | 244 | (pitch and (coeffcient or expansion) and thickness).clm. | (USPAT) | OR | OFF | OFF | 2021/06/17 11:20 AM |
| N81 | 10183 | (H01L23/49827 \| H01L23/5384 \| H01L2224/08165 \| H01L2224/16165 \| H01L2224/16235 \| H01L2224/32165 \| H01L2224/32235 \| H01L2224/40165 \| H01L2224/40235 \| H01L2224/48165 \| H01L2224/48235).CPC. | (USPAT) | OR | OFF | OFF | 2021/06/17 11:20 AM |
| N82 | 22 | N81 and (pitch and (coeffcient or expansion) and thickness).clm. | (USPAT) | OR | OFF | OFF | 2021/06/17 11:20 AM |
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| N84 | 22 | N83 and (pitch and (coeffcient or expansion) and thickness).clm. | (USPAT) | OR | OFF | OFF | 2021/07/02 04:25 PM |
| N85 | 244 | (pitch and (coeffcient or expansion) and thickness).clm. | (USPAT) | OR | OFF | OFF | 2021/07/02 04:25 PM |
| N86 | 11 | N59 AND (copper AND pitch AND polymer AND thickness).clm. | (USPAT) | OR | OFF | OFF | 2022/09/15 02:42 PM |
| N87 | 85 | (copper AND pitch AND polymer AND thickness).clm. | (USPAT) | OR | OFF | OFF | 2022/09/15 02:42 PM |
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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
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| | Application Number | |
| | Filing Date | |
| | First Named Inventor | Ping-Jung Yang |
| | Art Unit | |
| | Examiner Name | |
| | Attorney Docket Number | Mars16-001-US-C03 |

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| | Application Number | |
| | Filing Date | |
| | First Named Inventor | Ping-Jung Yang |
| | Art Unit | |
| | Examiner Name | |
| | Attorney Docket Number | Mars16-001-US-C03 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 25 | 20070045841 | | 2007-03-01 | Cho; Won Gu ; et al. | |
| | 26 | 20110065250 | | 2011-03-17 | Semiconductor Energy Laboratory Co., Ltd. | |
| | 27 | 20130292846 | | 2013-11-07 | Lee; Seok-hyun et al. | |
| | 28 | 20130307140 | | 2013-11-21 | HUANG; Hui-Min et al. | |
| | 29 | 20140103488 | | 2014-04-17 | Chen; Hsu-Hsien et al. | |
| | 30 | 20140210101 | | 2014-07-31 | Lin; Jing-Cheng et al. | |
| | 31 | 20140252646 | | 2014-09-11 | Hung; Jui-Pin et al. | |
| | 32 | 20140264839 | | 2014-09-18 | Tsai; Po-Hao et al. | |
| | 33 | 20140367160 | | 2014-12-18 | Yu; Chen-Hua et al. | |
| | 34 | 20150166329 | | 2015-06-18 | CHENG; Chun-wen et al. | |
| | 35 | 20170345761 | | 2017-11-30 | Yu; Chen-Hua et al. | |



ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /X.L/

| INFORMATION DISCLOSURE STATEMENT BY APPLICANT ( Not for submission under 37 CFR 1.99) | | |
|---|---|---|
| | Application Number | |
| | Filing Date | |
| | First Named Inventor | Ping-Jung Yang |
| | Art Unit | |
| | Examiner Name | |
| | Attorney Docket Number | Mars16-001-US-C03 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 36 | 20170345764 | | 2017-11-30 | Chang; Chih-Hao et al. | |
| | 37 | 20170373004 | | 2017-12-28 | Yu; Chen-Hua et al. | |
| | 38 | 20110147055 | | 2011-06-23 | Qing Ma. et al. | |
| | 39 | 20110242050 | | 2011-10-06 | San-ho BYUN et al. | |
| | 40 | 20090109655 | | 2009-04-30 | Shinozaki; Kenji | |
| | 41 | 20070268581 | | 2007-11-22 | Palmateer; Lauren | |
| | 42 | 20050098891 | | 2005-05-12 | Wakabayashi, Takeshi, et al. | |
| | 43 | 20040238945 | | 2004-12-02 | Huang, Chien-Ping et al. | |
| | 44 | 20060292851 | | 2006-12-28 | Lin; Mou-Shiung et al. | |
| | 45 | 20110278736 | | 2011-11-17 | Lin; Yaojian et al. | |
| | 46 | 20110285005 | | 2011-11-24 | LIN; Yung-Chi et al. | |



ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /X.L/

| INFORMATION DISCLOSURE STATEMENT BY APPLICANT ( Not for submission under 37 CFR 1.99) | | |
|---|---|---|
| | Application Number | |
| | Filing Date | |
| | First Named Inventor | Ping-Jung Yang |
| | Art Unit | |
| | Examiner Name | |
| | Attorney Docket Number | Mars16-001-US-C03 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 47 | 20120193785 | | 2012-08-02 | Mou-Shiung Lin et al. | |
| | 48 | 20070263364 | | 2010-10-05 | Tadahiko Kawabe et al. | |
| | 49 | 20130303777 | | 2013-11-14 | Ken Okamoto et al. | |
| | 50 | 20120068271 | | 2012-12-25 | Hajime Tokunaga | |
| | 51 | 20110242050 | | 2011-10-06 | San-ho BYUN et al. | |
| | 52 | 20070045841 | | 2007-03-01 | Won ChoHo Kang | |
| | 53 | 20040251045 | | 2005-02-22 | Chin-Long Wu et al. | |

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

**FOREIGN PATENT DOCUMENTS** Remove

| Examiner Initial* | Cite No | Foreign Document Number[3] | Country Code[2] | Kind Code[4] | Publication Date | Name of Patentee or Applicant of cited Document | Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear | T[5] |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2012/0068271 | wo | | 2012-03-22 | Semiconductor Energy Laboratory Co., Ltd. | | |
| | 2 | 2009170941 | JP | | 2009-07-30 | Toshio Gomyo | | |



ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /X.L/

| INFORMATION DISCLOSURE STATEMENT BY APPLICANT ( Not for submission under 37 CFR 1.99) | | |
|---|---|---|
| | Application Number | |
| | Filing Date | |
| | First Named Inventor | Ping-Jung Yang |
| | Art Unit | |
| | Examiner Name | |
| | Attorney Docket Number | Mars16-001-US-C03 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 3 | 1026744A1 | EP | | 2000-08-09 | Yoshinari et al. | | |

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

**NON-PATENT LITERATURE DOCUMENTS** Remove

| Examiner Initials* | Cite No | Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published. | T[5] |
|---|---|---|---|
| | 1 | | |

If you wish to add additional non-patent literature document citation information please click the Add button Add

**EXAMINER SIGNATURE**

| Examiner Signature | /XIAOMING LIU/ | Date Considered | 11/04/2023 |
|---|---|---|---|

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.



ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /X.L/

| INFORMATION DISCLOSURE STATEMENT BY APPLICANT ( Not for submission under 37 CFR 1.99) | | |
|---|---|---|
| | Application Number | |
| | Filing Date | |
| | First Named Inventor | Ping-Jung Yang |
| | Art Unit | |
| | Examiner Name | |
| | Attorney Docket Number | Mars16-001-US-C03 |

**CERTIFICATION STATEMENT**

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

**OR**

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

A certification statement is not submitted herewith.

**SIGNATURE**

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

| Signature | /Ping-Jung Yang/ | Date (YYYY-MM-DD) | 2022-11-12 |
|---|---|---|---|
| Name/Print | Ping-Jung Yang | Registration Number | |

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**



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## Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.



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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 17/985,827 | 11/12/2022 | Ping-Jung Yang | Mars16-001-US-C03 | 1762 |

102851 7590 11/07/2023

PING-JUNG YANG
NO 2, NIOUPU SOUTH RD., SIANGSHAN DISTRICT
HSINCHU CITY, 30091
TAIWAN

| EXAMINER | |
|---|---|
| LIU, XIAOMING | |

| ART UNIT | PAPER NUMBER |
|---|---|
| 2812 | |

| MAIL DATE | DELIVERY MODE |
|---|---|
| 11/07/2023 | PAPER |

**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

| *Office Action Summary* | **Application No.** 17/985,827 | **Applicant(s)** Yang, Ping-Jung | |
|---|---|---|---|
| | **Examiner** XIAOMING LIU | **Art Unit** 2812 | **AIA (FITF) Status** No |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☑ Responsive to communication(s) filed on 7/29/2023.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims***

5) ☑ Claim(s) 1-4,7-12,14-16 and 18-26 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-4,7-12,14-16 and 18-26 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

**Application Papers**

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

**Priority under 35 U.S.C. § 119**

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

**Certified copies:**

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1) ☑ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date 11/12/2022.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

**DETAILED ACTION**

***Notice of Pre-AIA or AIA Status***

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

***Information Disclosure Statement***

The information disclosure statement (IDS) submitted on 11/12/2022. The submission is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

***Claim Objections***

**Claim 21** objected to because of the following informalities: the claim appears to have a typographical error "50and 150 micrometers". For the purpose of examination, the examiner will interpret the above limitation as "50 and 150 micrometers". Appropriate correction is required.

***Double Patenting***

The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the “right to exclude” granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the claims at issue are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); In re Vogel, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the reference application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. See MPEP § 717.02 for applications subject to examination under the first inventor to file provisions of the AIA as explained in MPEP § 2159. See MPEP §§ 706.02(l)(1) - 706.02(l)(3) for applications not subject to examination under the first inventor to file provisions of the AIA. A terminal disclaimer must be signed in compliance with 37 CFR 1.321(b).

The USPTO Internet website contains terminal disclaimer forms which may be used. Please visit www.uspto.gov/forms/. The filing date of the application in which the form is filed determines what form (e.g., PTO/SB/25, PTO/SB/26, PTO/AIA/25, or PTO/AIA/26) should be used. A web-based eTerminal Disclaimer may be filled out completely online using web-screens. An eTerminal Disclaimer that meets all requirements is auto-processed and approved immediately upon submission. For more information about eTerminal Disclaimers, refer to http://www.uspto.gov/patents/process/file/efs/guidance/eTD-info-I.jsp.

**Claims 1-4, 7-12, 14-16, and 18-26 rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-23 of U.S. Patent No. 11538763.** Although the claims at issue are not identical, they are not patentably distinct from each other because the subject matter claimed in the instant application is fully disclosed in the patent and is covered by the patent since the patent and the application are claiming common subject matter.

***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to XIAOMING LIU whose telephone number is (571)270-0384. The examiner can normally be reached Monday-Friday, 9am-8pm, EST.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Charles Garber can be reached on (571)272-2194. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit: https://patentcenter.uspto.gov. Visit https://www.uspto.gov/patents/apply/patent-center for more information about Patent Center and https://www.uspto.gov/patents/docx for information about filing in DOCX format. For additional questions, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

*/XIAOMING LIU/*
*Examiner, Art Unit 2812*

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

| PATENT APPLICATION FEE DETERMINATION RECORD<br>Substitute for Form PTO-875 | Application or Docket Number<br>17/985,827 | Filing Date<br>11/12/2022 | ☐ To be Mailed |
|---|---|---|---|

**ENTITY:** ☐ LARGE ☑ SMALL ☐ MICRO

## APPLICATION AS FILED - PART I

| FOR | (Column 1)<br>NUMBER FILED | (Column 2)<br>NUMBER EXTRA | | RATE ($) | FEE ($) |
|---|---|---|---|---|---|
| ☐ BASIC FEE (37 CFR 1.16(a), (b), or (c)) | N/A | N/A | | N/A | |
| ☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m)) | N/A | N/A | | N/A | |
| ☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q)) | N/A | N/A | | N/A | |
| TOTAL CLAIMS (37 CFR 1.16(i)) | minus 20 = | * | | x $50 = | |
| INDEPENDENT CLAIMS (37 CFR 1.16(h)) | minus 3 = | * | | x $240 = | |
| ☐ APPLICATION SIZE FEE (37 CFR 1.16(s)) | If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s). | | | | |
| ☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j)) | | | | | |
| * If the difference in column 1 is less than zero, enter "0" in column 2. | | | | TOTAL | |

## APPLICATION AS AMENDED - PART II

| | | (Column 1) | | (Column 2) | (Column 3) | | | |
|---|---|---|---|---|---|---|---|---|
| AMENDMENT | 11/08/2023 | CLAIMS REMAINING AFTER AMENDMENT | | HIGHEST NUMBER PREVIOUSLY PAID FOR | PRESENT EXTRA | | RATE ($) | ADDITIONAL FEE ($) |
| | Total (37 CFR 1.16(i)) | * 27 | Minus | ** 22 | = 5 | | x $40 = | 200 |
| | Independent (37 CFR 1.16(h)) | * 3 | Minus | *** 3 | = 0 | | x $192 = | 0 |
| | ☐ Application Size Fee (37 CFR 1.16(s)) | | | | | | | |
| | ☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j)) | | | | | | | |
| | | | | | | | TOTAL ADD'L FEE | 200 |

| | | (Column 1) | | (Column 2) | (Column 3) | | | |
|---|---|---|---|---|---|---|---|---|
| AMENDMENT | | CLAIMS REMAINING AFTER AMENDMENT | | HIGHEST NUMBER PREVIOUSLY PAID FOR | PRESENT EXTRA | | RATE ($) | ADDITIONAL FEE ($) |
| | Total (37 CFR 1.16(i)) | * | Minus | ** | = | | x $0 = | |
| | Independent (37 CFR 1.16(h)) | * | Minus | *** | = | | x $0 = | |
| | ☐ Application Size Fee (37 CFR 1.16(s)) | | | | | | | |
| | ☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j)) | | | | | | | |
| | | | | | | | TOTAL ADD'L FEE | |

| | |
|---|---|
| * If the entry in column 1 is less than the entry in column 2, write "0" in column 3. | SLIE |
| ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". | /AMANDA CHRISTINE LEMUS/ |
| *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". | |
| The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1. | |

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

*If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.*

Docket No.: Mars-16-001-US-C03 **PATENT**

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

| | | |
|---|---|---|
| In re Application of | : | Customer Number: 102851 |
| Ping-Jung Yang | : | Confirmation Number: 1762 |
| Application No.: 17985827 | : | Group Art Unit: 2812 |
| Filed: Nov. 12, 2022 | : | Examiner: XIAOMING LIU |

For: CHIP PACKAGE

**Preliminary Amendment**

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Please amend the above-identified application and consider the remarks as follows:

**Amendments to the Claims** are reflected in the listing of claims which begins on page 2 of this paper.

**Remarks/Arguments** begin on page 11 of this paper.



IPR2026-00067
TSMC EX1002 Page 326

**Amendments to the Claims:**

This listing of claims will replace all prior versions, and listings, of claims in the application.

**Listing of Claims:**

What is claimed is:

1. (Previously presented) A chip package comprising:

a solid layer having a first surface and a second surface opposite to said first surface, wherein said solid layer comprises a compound of silicon and oxygen, wherein said solid layer has a thickness between 50 and 150 micrometers, wherein said solid layer comprises a first region and a second region between said first region and a first edge of said solid layer;

a plurality of metal posts in a plurality of through holes in said second region respectively, wherein one of said plurality of metal posts comprises a first copper layer contacting a sidewall of one of said plurality of through holes, wherein said first region has a width in a direction greater than a shortest distance between said sidewall of one of said plurality of through holes and said first edge in said direction and greater than a pitch between two neighboring metal posts of said plurality of metal posts;

a first interconnection scheme over said first surface, wherein said first interconnection scheme comprises a first metal interconnect over said second surface and a first polymer layer over said first metal interconnect, wherein said first metal interconnect is connected to a first metal post of said plurality of metal posts, wherein said first metal interconnect comprises a first metal layer and a second copper layer over said first metal layer;



IPR2026-00067
TSMC EX1002 Page 327

a first metal bump over said first interconnection scheme, wherein said first metal bump comprises a second metal layer and a tin-containing layer over said second metal layer; and

a first semiconductor chip under said second surface, wherein said first interconnection scheme comprise a second metal interconnect across over a sidewall of the first semiconductor chip, wherein said first semiconductor chip comprises a third metal interconnect on a first metal pad of said first semiconductor chip, wherein said third metal interconnect comprises a third metal layer on said first metal pad and a third copper layer over said third metal layer, wherein said third copper layer has a thickness between 5 and 30 micrometers, wherein said first semiconductor chip is connected to a second metal post of said plurality of metal posts through said third metal interconnect.

2. (Previously presented) The chip package of claim 1, wherein said first semiconductor chip comprises a central-processing-unit (CPU) circuit block and a graphics-processing-unit (GPU) circuit block.

3. (Previously presented) The chip package of claim 1, wherein said first interconnection scheme further comprises a fourth metal interconnect over said first metal interconnect and said first polymer layer, wherein said first polymer is between said first and fourth metal interconnects, wherein said fourth metal interconnect comprises a fourth metal layer and a fourth copper layer over said fourth metal layer.

4. (Previously presented) The chip package of claim 1, wherein said first metal pad is an aluminum pad.



IPR2026-00067
TSMC EX1002 Page 328

Claims 5-6 are cancelled

7. (Previously presented) The chip package of claim 1, wherein said compound comprises a $SiO_2$ compound.

8. (Previously presented) The chip package of claim 1, further comprising a second semiconductor chip over said first semiconductor chip, wherein said second semiconductor chip comprises a second metal bump on a second metal pad of said second semiconductor chip, wherein said second metal bump comprises a tin-containing layer.

9. (Previously presented) The chip package of claim 1, wherein said solid layer further comprises a third region opposite to said second region, wherein said third region is between said first region and a second edge of said solid layer, wherein said plurality of metal posts in said plurality of through holes in said third region respectively.

10. (Previously presented) The chip package of claim 1, wherein said second region is a rectangle region and surrounding said first region.

11. (Previously presented) A chip package comprising:

a solid layer having a first surface and a second surface opposite to said first surface, wherein said solid layer comprises a compound of silicon and oxygen, wherein said solid layer



IPR2026-00067
TSMC EX1002 Page 329

has a thickness between 100 and 300 micrometers, wherein said solid layer comprises a first region and a second region between said first region and a first edge of said solid layer;

a plurality of copper posts in a plurality of through holes in said second region respectively, wherein said first region has a width in a direction greater than a shortest distance between a sidewall of one of said plurality of through holes and said first edge in said direction and greater than a pitch between two neighboring copper posts of said plurality of copper posts;

a first interconnection scheme over said first surface, wherein said first interconnection scheme comprises a first metal interconnect over said first surface, and a first polymer layer over said first metal interconnect, wherein said first metal interconnect is connected to one of said plurality of copper posts, wherein said first metal interconnect comprises a first metal layer and a first copper layer over said first metal layer;

a first metal bumps over said first interconnection scheme, wherein first metal bumps comprises a tin-containing layer;

a second metal bumps over said first interconnection scheme;

a first semiconductor chip over said first interconnection scheme and between said first and second metal bumps, wherein said first semiconductor chip has a height between a backside surface of said first semiconductor chip and a top surface of said first polymer layer is smaller than a thickness of said first metal bump, wherein said first semiconductor chip comprises a third metal bump on a first metal pad of said first semiconductor chip, wherein said third metal bump comprises a tin-containing layer; and

a second semiconductor chip over said first interconnection scheme, wherein said second semiconductor chip comprises a fourth metal bump on a second metal pad of said second semiconductor chip, wherein said fourth metal bump comprises a tin-containing layer.



IPR2026-00067
TSMC EX1002 Page 330

12. (Previously presented) The chip package of claim 11, wherein said compound comprises a $SiO_2$ compound.

Claim 13 is cancelled

14. (Previously presented) The chip package of claim 11, wherein no any copper post in said first region.

15. (Previously presented) The chip package of claim 11, further comprising a third semiconductor chip under said first interconnection scheme, wherein said third semiconductor chip comprises a second metal interconnect on a third metal pad of said third semiconductor chip, wherein said second metal interconnect comprises a second metal layer on said third metal pad and a second copper layer over said second metal layer, wherein said second copper layer has a thickness between 5 and 30 micrometers.

16. (Previously presented) The chip package of claim 11, further comprising a third semiconductor chip under said first interconnection scheme, wherein said third semiconductor chip comprises a second metal interconnect on a third metal pad of said third semiconductor chip, wherein said second metal interconnect comprises a second metal layer on said third metal pad and a second copper layer over said second metal layer, wherein said third semiconductor chip comprises a central-processing-unit (CPU) circuit block and a graphics-processing-unit (GPU) circuit block.



IPR2026-00067
TSMC EX1002 Page 331

Claim 17 is cancelled

18. (Previously presented) The chip package of claim 11, wherein said solid layer further comprises a third region opposite to said second region, wherein said third region is between said first region and a second edge of said solid layer, wherein said plurality of copper posts in said plurality of through holes in said third region respectively.

19. (Previously presented) The chip package of claim 11, wherein said second region is a rectangle region and surrounding said first region.

20. (Previously presented) The chip package of claim 11, further comprising an electrical device under said second surface, wherein said electrical device comprise a third semiconductor chip and a metal wire connected to a third metal pad of said third semiconductor chip, wherein said third semiconductor chip is a DRAM chip.

21. (Currently amended) A chip package comprising:

a solid layer having a first surface and a second surface opposite to said first surface, wherein said solid layer comprises a compound of silicon and oxygen, wherein said solid layer has a thickness between ~~50and~~ 50 and 150 micrometers, wherein said solid layer comprises a first region and a second region between said first region and a first edge of said solid layer;

a plurality of copper posts in a plurality of through holes in said second region respectively;



IPR2026-00067
TSMC EX1002 Page 332

a first interconnection scheme over said first surface, wherein said first interconnection scheme comprises first and second metal interconnects over said first surface, and a first polymer layer over said first and second metal interconnects, wherein said first metal interconnect is connected to a first copper post of said plurality of copper posts, wherein said first metal interconnect comprises a first metal layer and a first copper layer over said first metal layer;

a first semiconductor chip over said first interconnection scheme, wherein said first semiconductor chip comprises a third metal interconnect under a first metal pad of said first semiconductor chip, wherein said third metal interconnect comprises a second metal layer under said first metal pad and a second copper layer under said second metal layer, wherein said second copper layer has a thickness between 5 and 30 micrometers, wherein said first semiconductor chip is coupled to a second copper post of said plurality of copper posts through said third metal interconnect;

a second semiconductor chip over said first interconnection scheme, wherein said second semiconductor chip comprises a second metal pad coupled to said second metal interconnect;

a third semiconductor chip under said first interconnection scheme; and

a plurality of metal bumps under said second surface, wherein one of said plurality of metal bumps comprises a tin-containing layer.

22. (Previously presented) The chip package of claim 21, wherein said compound comprises a $SiO_2$ compound.

23. (Previously presented) The chip package of claim 21, wherein said solid layer further comprises a third region opposite to said second region, wherein said third region is between said



IPR2026-00067
TSMC EX1002 Page 333

first region and a second edge of said solid layer, wherein said plurality of copper posts in said plurality of through holes in said third region respectively.

24. (Previously presented) The chip package of claim 21, further comprising a fourth semiconductor chip over said first semiconductor chip, wherein said fourth semiconductor chip comprises a third metal pad at a bottom surface of said fourth semiconductor chip, wherein said first semiconductor chip further comprising a plurality of through-silicon-via metal layers and a fourth metal pad at a top surface of said first semiconductor chip, wherein said first metal pad is at a bottom surface of said first semiconductor chip, wherein said first metal pad is coupled to said fourth metal pad through one of said plurality of through-silicon-via metal layers, wherein said third metal pad is coupled to said fourth metal pad through a solder layer.

25. (Previously presented) The chip package of claim 21, wherein said first semiconductor chip is a graphics-processing-unit (GPU) chip.

26. (Currently amended) The chip package of claim 21, wherein said second semiconductor chip is a logic ~~memory~~ chip.

27. (Newly added) The chip package of claim 21, wherein said first semiconductor chip is a logic chip.

28. (Newly added) The chip package of claim 21, wherein said third semiconductor chip has a thickness between a backside surface of said third semiconductor chip and a top surface of said third semiconductor chip is smaller than a thickness of one of said plurality of metal bumps.



IPR2026-00067
TSMC EX1002 Page 334

29. (Newly added) The chip package of claim 21, further comprising another said first semiconductor chip over said first interconnection scheme.

30. (Newly added) The chip package of claim 21, further comprising a fourth semiconductor chip under said first interconnection scheme, wherein said fourth semiconductor chip has a thickness between a backside surface of said fourth semiconductor chip and a top surface of said fourth semiconductor chip is smaller than a thickness of one of said plurality of metal bumps..

31. (Newly added) The chip package of claim 1, further comprising another said first semiconductor chip under said second surface.



IPR2026-00067
TSMC EX1002 Page 335

## REMARKS/ARGUMENTS

Claims 1-31 are pending in the application, of which claims 1, 11 and 21 are the pending independent claims. Claims 5-6, 13 and 17 are cancelled. Claims 21 and 26 are currently amended herein. Claims 27-31 are newly added. No new matter is believed to be added into the application by this paper.

### *Newly added claims and Claim Amendments*

For claims 26 and 27 the subject matter that "semiconductor chip is a logic chip" is disclosed and supported in Fig. 9x and paragraph [0097] of the specification, as below:

[0097] ….wherein the chip 46 or 56 comprises ….. a graphics-processing-unit (GPU) chip, a digital-signal-processing (DSP) chip, a baseband chip, a wireless local area network (WLAN) chip, **a logic chip**

For claims 28 and 30 the subject matter that "third semiconductor chip has a thickness between a backside surface of said third semiconductor chip and a top surface of said third semiconductor chip is smaller than a thickness of one of said plurality of metal bumps" is disclosed and supported in Fig. 9x of the specification, as below:

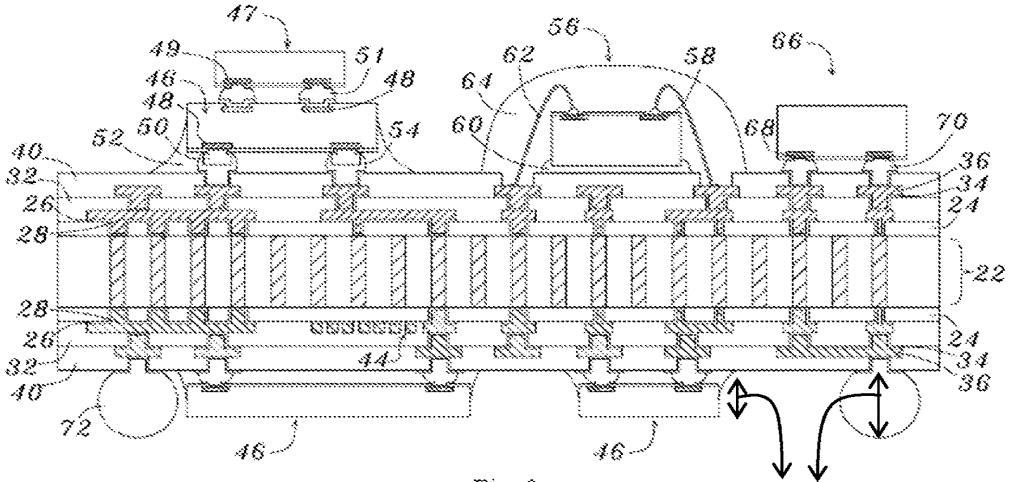



Fig. 9x The thickness of the metal bump 72 is noticeably greater than that of the semiconductor chips 46.



IPR2026-00067
TSMC EX1002 Page 336

For claims 29 and 31 the subject matter that "<u>further comprising another said first semiconductor chip over said first interconnection scheme</u>" and "<u>further comprising another said first semiconductor chip under said second surface</u>" are disclosed and supported in Figs. 9x and 9y and paragraph [0106] of the specification, as below:

[00106] Fig. 9y, illustrates a top view of the first substrate 20. Fig. 9u-Fig. 9w illustrate a cross-section view of Line L-L' in Fig. 9y. **<u>Multiple the chips 46</u>**, the chips 56 and the passive components 66 may also be **<u>provided in or on the first substrate 20</u>**.

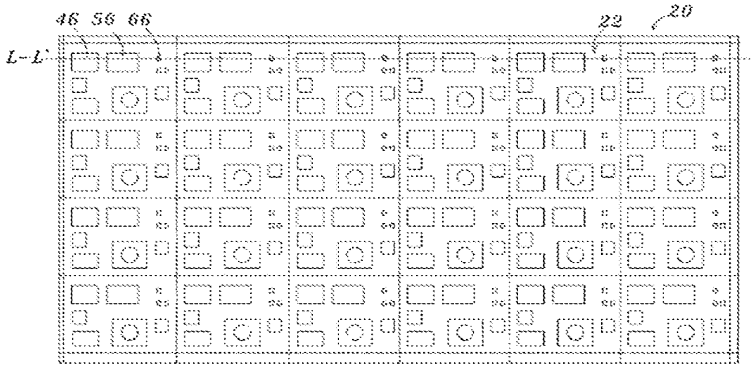


Fig. 9y

Accordingly, no new matter is believed to be added into the application by this paper.

In view of the Amendments, Applicants submit that the claims are in condition for allowance and respectfully request a notice to this effect.

Respectfully submitted,

Mars Yang

Date: __2023-11-09_____ Ping-Jung Yang



IPR2026-00067
TSMC EX1002 Page 337

PTO/AIA/26 (04-14)
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| TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT | Docket Number (Optional) Mars16-001-US-C03 |
|---|---|

In re Application of: Ping-Jung Yang

Application No.: 17985827

Filed: Nov. 12, 2022

For: CHIP PACKAGE

The applicant, Ping-Jung Yang, owner of 100 percent interest in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of **prior patent** No. 11538763 as the term of said **prior patent** is presently shortened by any terminal disclaimer. The applicant hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the **prior patent** are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the applicant does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term of the **prior patent**, "as the term of said **prior patent** is presently shortened by any terminal disclaimer," in the event that said **prior patent** later:

expires for failure to pay a maintenance fee;
is held unenforceable;
is found invalid by a court of competent jurisdiction;
is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;
has all claims canceled by a reexamination certificate;
is reissued; or
is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

Check either box 1 or 2 below, if appropriate.

1. ☑ The undersigned is the applicant. If the applicant is an assignee, the undersigned is authorized to act on behalf of the assignee.

I hereby acknowledge that any willful false statements made are punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

2. ☐ The undersigned is an attorney or agent of record. Reg. No._____

/Ping-Jung Yang/ — Signature
2023-11-09 — Date

Ping-Jung Yang — Typed or printed name

_____ — Title
+886-913635863 — Telephone Number

☑ Terminal disclaimer fee under 37 CFR 1.20(d) included.

**WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.**

This collection of information is required by 37 CFR 1.321. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

| Electronic Patent Application Fee Transmittal | | | | | |
|---|---|---|---|---|---|
| **Application Number:** | 17985827 | | | | |
| **Filing Date:** | 12-Nov-2022 | | | | |
| **Title of Invention:** | CHIP PACKAGE | | | | |
| **First Named Inventor/Applicant Name:** | Ping-Jung Yang | | | | |
| **Filer:** | Ping-Jung. Yang | | | | |
| **Attorney Docket Number:** | Mars16-001-US-C03 | | | | |
| Filed as Small Entity | | | | | |
| **Filing Fees for Utility under 35 USC 111(a)** | | | | | |
| **Description** | | **Fee Code** | **Quantity** | **Amount** | **Sub-Total in USD($)** |
| **Basic Filing:** | | | | | |
| **Pages:** | | | | | |
| **Claims:** | | | | | |
| CLAIMS IN EXCESS OF 20 | | 2202 | 5 | 40 | 200 |
| **Miscellaneous-Filing:** | | | | | |
| **Petition:** | | | | | |
| **Patent-Appeals-and-Interference:** | | | | | |
| **Post-Allowance-and-Post-Issuance:** | | | | | |

| Description | Fee Code | Quantity | Amount | Sub-Total in USD($) |
|---|---|---|---|---|
| **Extension-of-Time:** | | | | |
| **Miscellaneous:** | | | | |
| STATUTORY OR TERMINAL DISCLAIMER | 2814 | 1 | 170 | 170 |
| | | **Total in USD ($)** | | **370** |

| Electronic Acknowledgement Receipt | |
|---|---|
| **EFS ID:** | 48810037 |
| **Application Number:** | 17985827 |
| **International Application Number:** | |
| **Confirmation Number:** | 1762 |
| **Title of Invention:** | CHIP PACKAGE |
| **First Named Inventor/Applicant Name:** | Ping-Jung Yang |
| **Customer Number:** | 102851 |
| **Filer:** | Ping-Jung. Yang |
| **Filer Authorized By:** | |
| **Attorney Docket Number:** | Mars16-001-US-C03 |
| **Receipt Date:** | 08-NOV-2023 |
| **Filing Date:** | 12-NOV-2022 |
| **Time Stamp:** | 13:08:56 |
| **Application Type:** | Utility under 35 USC 111(a) |

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| Payment was successfully received in RAM | $370 |
| RAM confirmation Number | E2023A8D11315201 |
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## File Listing:

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|---|---|---|---|---|---|
| 1 | | Mars16-001-US-C03-PA-11092023.pdf | 1533019<br>d2744489ecf4fbc85d909af26cbc77bc12e17d4f | yes | 12 |
| | **Multipart Description/PDF files in .zip description** | | | | |
| | **Document Description** | | **Start** | **End** | |
| | Amendment/Request for Reconsideration-After Non-Final Rejection | | 1 | 1 | |
| | Claims | | 2 | 10 | |
| | Applicant Arguments/Remarks Made in an Amendment | | 11 | 12 | |
| **Warnings:** | | | | | |
| **Information:** | | | | | |
| 2 | Terminal Disclaimer Filed | Mars16-001-US-C03-TD.pdf | 163585<br>c7ab30ddfa7bc4bec72db98ed5a21af7d21c7715 | no | 2 |
| **Warnings:** | | | | | |
| **Information:** | | | | | |
| 3 | Fee Worksheet (SB06) | fee-info.pdf | 40123<br>17f9a6eb0127bb097b6aa4ccd454732f6641acda | no | 2 |
| **Warnings:** | | | | | |
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**New Applications Under 35 U.S.C. 111**

**If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.**

**National Stage of an International Application under 35 U.S.C. 371**

**If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.**

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**If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.**

Docket No.: Mars-16-001-US-C03 **PATENT**

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

| | | |
|---|---|---|
| In re Application of | : | Customer Number: 102851 |
| Ping-Jung Yang | : | Confirmation Number: 1762 |
| Application No.: 17985827 | : | Group Art Unit: 2812 |
| Filed: Nov. 12, 2022 | : | Examiner: XIAOMING LIU |

For: CHIP PACKAGE

**Preliminary Amendment**

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Please amend the above-identified application and consider the remarks as follows:

**Remarks/Arguments** begin on page 2 of this paper.



IPR2026-00067
TSMC EX1002 Page 345

## REMARKS/ARGUMENTS

Claims 1-31 are pending in the application, of which claims 1, 11 and 21 are the pending independent claims. Claims 5-6, 13 and 17 are cancelled. No new matter is believed to be added into the application by this paper.

### *Double Patenting*

Claims 1-4, 7-12, 14-16 and18-26 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-4, 7-12, 14-16 and18-26 of U.S. Pat. No. 11538763.

The rejection to the double patenting is believed to be moot as a terminal disclaimer for U.S. Pat. No. 11538763 is submitted herein.

Accordingly, no new matter is believed to be added into the application by this paper.

In view of the Amendments, Applicants submit that the claims are in condition for allowance and respectfully request a notice to this effect.

Respectfully submitted,

Mars Yang

Date: __2023-11-09_____ Ping-Jung Yang



IPR2026-00067
TSMC EX1002 Page 346

| Electronic Acknowledgement Receipt | |
|---|---|
| **EFS ID:** | 48812557 |
| **Application Number:** | 17985827 |
| **International Application Number:** | |
| **Confirmation Number:** | 1762 |
| **Title of Invention:** | CHIP PACKAGE |
| **First Named Inventor/Applicant Name:** | Ping-Jung Yang |
| **Customer Number:** | 102851 |
| **Filer:** | Ping-Jung. Yang |
| **Filer Authorized By:** | |
| **Attorney Docket Number:** | Mars16-001-US-C03 |
| **Receipt Date:** | 08-NOV-2023 |
| **Filing Date:** | 12-NOV-2022 |
| **Time Stamp:** | 20:41:20 |
| **Application Type:** | Utility under 35 USC 111(a) |

## Payment information:

| Submitted with Payment | no |
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## File Listing:

| Document Number | Document Description | File Name | File Size(Bytes)/ Message Digest | Multi Part /.zip | Pages (if appl.) |
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| 1 | | Mars16-001-US-C03-PA-11092023-R2.pdf | 80222<br>bf3e8d5bfef1d3357253ae82139d7f8200f59eec | yes | 2 |

| | Multipart Description/PDF files in .zip description | | |
|---|---|---|---|
| | **Document Description** | **Start** | **End** |
| | Amendment/Request for Reconsideration-After Non-Final Rejection | 1 | 1 |
| | Applicant Arguments/Remarks Made in an Amendment | 2 | 2 |
| **Warnings:** | | | |
| **Information:** | | | |
| | **Total Files Size (in bytes):** | 80222 | |

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**New Applications Under 35 U.S.C. 111**
**If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.**
**National Stage of an International Application under 35 U.S.C. 371**
**If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.**
**New International Application Filed with the USPTO as a Receiving Office**
**If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.**

| *Application Number* | Application/Control No. | Applicant(s)/Patent under Reexamination | |
|---|---|---|---|
| * 17/985,827 * | 17/985,827 | Yang, Ping-Jung | |
| | Examiner | Art Unit | |
| | LIU, XIAOMING | 2812 | |

| Document Code - DISQ | Internal Document - DO NOT MAIL |
|---|---|

| TERMINAL DISCLAIMER | ☑ APPROVED | ☐ DISAPPROVED |
|---|---|---|
| **Date Filed:** **08 November 2023** | **This patent is subject to a Terminal Disclaimer** | |

**Approved/Disapproved by:**

/KIMBERLY R WHITE/

**Technology Center: OPLC**

**Telephone: (571)272-6179**

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| Issue Classification | Application/Control No. | Applicant(s)/Patent Under Reexamination |
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| | 17/985,827 | Yang, Ping-Jung |
| | **Examiner** | **Art Unit** |
| | XIAOMING LIU | 2812 |

| CPC | | | | | | | |
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| **Symbol** | | | | | | **Type** | **Version** |
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| H01L | / | 23 | / | 49811 | | I | 2013-01-01 |
| H01L | / | 23 | / | 49827 | | I | 2013-01-01 |
| H01L | / | 23 | / | 49833 | | I | 2013-01-01 |
| H10K | / | 77 | / | 10 | | I | 2023-02-01 |
| H01L | / | 2224 | / | 1308 | | A | 2013-01-01 |
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| NONE | | **Total Claims Allowed:** | |
|---|---|---|---|
| (Assistant Examiner) | (Date) | 27 | |
| /XIAOMING LIU/<br>Examiner, Art Unit 2812 | 17 November 2023 | O.G. Print Claim(s) | O.G. Print Figure |
| (Primary Examiner) | (Date) | 1 | fig12 |

U.S. Patent and Trademark Office — Part of Paper No.: 20231117



IPR2026-00067
TSMC EX1002 Page 350

| Issue Classification | Application/Control No. | Applicant(s)/Patent Under Reexamination |
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| | 17/985,827 | Yang, Ping-Jung |
| | **Examiner** | **Art Unit** |
| | XIAOMING LIU | 2812 |

| CPC | | | | | | |
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| H01L | / | 23 | / | 49816 | A | 2013-01-01 |
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| H01L | / | 2224 | / | 05624 | A | 2013-01-01 |
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| C09K | / | 2323 | / | 03 | A | 2020-08-01 |

| NONE | | **Total Claims Allowed:** | |
|---|---|---|---|
| (Assistant Examiner) | (Date) | 27 | |
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| (Primary Examiner) | (Date) | 1 | fig12 |

U.S. Patent and Trademark Office — Part of Paper No.: 20231117



IPR2026-00067
TSMC EX1002 Page 351

| Issue Classification | Application/Control No. | Applicant(s)/Patent Under Reexamination |
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| | 17/985,827 | Yang, Ping-Jung |
| | **Examiner** | **Art Unit** |
| | XIAOMING LIU | 2812 |

**CPC Combination Sets**

| Symbol | | | | | Type | Set | Ranking | Version |
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| NONE | | **Total Claims Allowed:** | |
|---|---|---|---|
| (Assistant Examiner) | (Date) | 27 | |
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U.S. Patent and Trademark Office — Part of Paper No.: 20231117



IPR2026-00067
TSMC EX1002 Page 352

| Issue Classification | Application/Control No. | Applicant(s)/Patent Under Reexamination |
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| | 17/985,827 | Yang, Ping-Jung |
| | Examiner | Art Unit |
| | XIAOMING LIU | 2812 |

| CPC Combination Sets | | | | | | | | |
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| NONE | | Total Claims Allowed: | |
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| (Assistant Examiner) | (Date) | 27 | |
| /XIAOMING LIU/<br>Examiner, Art Unit 2812 | 17 November 2023 | O.G. Print Claim(s) | O.G. Print Figure |
| (Primary Examiner) | (Date) | 1 | fig12 |

U.S. Patent and Trademark Office — Part of Paper No.: 20231117



IPR2026-00067
TSMC EX1002 Page 353

| Issue Classification | Application/Control No. | Applicant(s)/Patent Under Reexamination |
|---|---|---|
| | 17/985,827 | Yang, Ping-Jung |
| | Examiner | Art Unit |
| | XIAOMING LIU | 2812 |

| CPC Combination Sets | | | | | | | | |
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| NONE | | Total Claims Allowed: | |
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| (Assistant Examiner) | (Date) | 27 | |
| /XIAOMING LIU/<br>Examiner, Art Unit 2812 | 17 November 2023 | O.G. Print Claim(s) | O.G. Print Figure |
| (Primary Examiner) | (Date) | 1 | fig12 |

U.S. Patent and Trademark Office — Part of Paper No.: 20231117



IPR2026-00067
TSMC EX1002 Page 354

| Issue Classification | Application/Control No. | Applicant(s)/Patent Under Reexamination |
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| | 17/985,827 | Yang, Ping-Jung |
| | **Examiner** | **Art Unit** |
| | XIAOMING LIU | 2812 |

| CPC Combination Sets | | | | | | | | |
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| NONE | | **Total Claims Allowed:** | |
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| (Assistant Examiner) | (Date) | 27 | |
| /XIAOMING LIU/<br>Examiner, Art Unit 2812 | 17 November 2023 | O.G. Print Claim(s) | O.G. Print Figure |
| (Primary Examiner) | (Date) | 1 | fig12 |

U.S. Patent and Trademark Office — Part of Paper No.: 20231117



IPR2026-00067
TSMC EX1002 Page 355

| Issue Classification | Application/Control No. | Applicant(s)/Patent Under Reexamination |
|---|---|---|
| | 17/985,827 | Yang, Ping-Jung |
| | **Examiner** | **Art Unit** |
| | XIAOMING LIU | 2812 |

| INTERNATIONAL CLASSIFICATION | | | | | |
|---|---|---|---|---|---|
| **CLAIMED** | | | | | |
| H01L23/538 | / | 23 | / | 538 | |
| H01L23/15 | / | 23 | / | 15 | |
| H01L23/498 | / | 23 | / | 498 | |

| NON-CLAIMED | | | | |
|---|---|---|---|---|
| | / | | / | |

| US ORIGINAL CLASSIFICATION | |
|---|---|
| **CLASS** | **SUBCLASS** |
| | |

| CROSS REFERENCES(S) | | | | | | |
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| **CLASS** | **SUBCLASS (ONE SUBCLASS PER BLOCK)** | | | | | |
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| NONE | | **Total Claims Allowed:** | |
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| (Assistant Examiner) | (Date) | 27 | |
| /XIAOMING LIU/<br>Examiner, Art Unit 2812 | 17 November 2023 | O.G. Print Claim(s) | O.G. Print Figure |
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U.S. Patent and Trademark Office — Part of Paper No.: 20231117



IPR2026-00067
TSMC EX1002 Page 356

| Issue Classification | Application/Control No. | Applicant(s)/Patent Under Reexamination |
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| | 17/985,827 | Yang, Ping-Jung |
| | **Examiner** | **Art Unit** |
| | XIAOMING LIU | 2812 |

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☑ T.D. ☐ R.1.47

**CLAIMS**

| Final | Original | Final | Original | Final | Original | Final | Original | Final | Original | Final | Original | Final | Original | Final | Original |
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| 4 | 4 | | 13 | 19 | 22 | 9 | 31 | | | | | | | | |
| | 5 | 12 | 14 | 20 | 23 | | | | | | | | | | |
| | 6 | 13 | 15 | 21 | 24 | | | | | | | | | | |
| 5 | 7 | 14 | 16 | 22 | 25 | | | | | | | | | | |
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| 7 | 9 | 15 | 18 | 24 | 27 | | | | | | | | | | |

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| NONE | | **Total Claims Allowed:** | |
| (Assistant Examiner) | (Date) | 27 | |
| /XIAOMING LIU/<br>Examiner, Art Unit 2812 | 17 November 2023 | O.G. Print Claim(s) | O.G. Print Figure |
| (Primary Examiner) | (Date) | 1 | fig12 |

U.S. Patent and Trademark Office — Part of Paper No.: 20231117



IPR2026-00067
TSMC EX1002 Page 357

| Search Notes | Application/Control No. | Applicant(s)/Patent Under Reexamination |
|---|---|---|
| | 17/985,827 | Yang, Ping-Jung |
| | Examiner | Art Unit |
| | XIAOMING LIU | 2812 |

| CPC - Searched* | | |
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| **Symbol** | **Date** | **Examiner** |
| H01L23/49827 \| H01L23/5384 \| H01L2224/08165 \| H01L2224/16165 \| H01L2224/16235 \| H01L2224/32165 \| H01L2224/32235 \| H01L2224/40165 \| H01L2224/40235 \| H01L2224/48165 \| H01L2224/48235 with date and text | 11/03/2023 | XL |

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| | | |

| US Classification - Searched* | | | |
|---|---|---|---|
| **Class** | **Subclass** | **Date** | **Examiner** |
| | | | |

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

| Search Notes | | |
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| **Search Notes** | **Date** | **Examiner** |
| Searched: (USPAT, USPGPUB, USOCR, FPRS, EPO, JPO, DERWENT, IBMTDB) | 11/04/2023 | XL |
| Inventor search Conducted, limited with text | 11/04/2023 | XL |
| Inventor search Conducted, limited with text | 11/04/2023 | XL |
| Google text search conducted | 11/04/2023 | XL |
| Non-Patent Literature searched: science direct, TC2800 | 11/04/2023 | XL |
| updated search | 11/17/2023 | XL |

| /XIAOMING LIU/<br>Examiner, Art Unit 2812 | |
|---|---|



IPR2026-00067
TSMC EX1002 Page 358

| Search Notes | Application/Control No. | Applicant(s)/Patent Under Reexamination |
|---|---|---|
| | 17/985,827 | Yang, Ping-Jung |
| | Examiner | Art Unit |
| | XIAOMING LIU | 2812 |

| Interference Search | | | |
|---|---|---|---|
| **US Class/CPC Symbol** | **US Subclass/CPC Group** | **Date** | **Examiner** |
| H01L23 | 49827 5384 with text | 11/17/2023 | XL |
| H01L2224 | 08165 16165 16235 32165 32235 40165 40235 48165 48235 with text | 11/17/2023 | XL |
| | all CPC group with text | 11/17/2023 | XL |

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| /XIAOMING LIU/<br>Examiner, Art Unit 2812 | |



IPR2026-00067
TSMC EX1002 Page 359

## PE2E SEARCH - Search History (Prior Art)

| Ref # | Hits | Search Query | DBs | Default Operator | Plurals | British Equivalents | Time Stamp |
|---|---|---|---|---|---|---|---|
| L1 | 2 | ("20200161245").PN. | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | OFF | OFF | 2020/09/10 12:31 PM |
| L2 | 2 | L1 and polymer and copper | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | OFF | OFF | 2020/09/10 01:04 PM |
| L3 | 277 | (US-20120282739-$ or US-20120319254-$ or US-20120089180-$ or US-20100244059-$ or US-20090179317-$ or US-20090127638-$ or US-20070135550-$ or US-20110127314-$ or US-20090160053-$ or US-20110204513-$ or US-20100260224-$ or US-20060081877-$ or US-20120174855-$ or US-20100200898-$ or US-20110233754-$ or US-20130280826-$ or US-20130292808-$ or US-20120062439-$ or US-20080308917-$ or US-20040238857-$ or US-20130241077-$ or US-20100059855-$ or US-20110188193-$ or US-20110165734-$ or US-20090230531-$ or US-20090152714-$).did. or (US-20090152692-$ or US-20080211084-$ or US-20070132093-$ or US-20050224937-$ or US-20130105967-$ or US-20070158818-$ or US-20130161784-$ or US-20120199843-$ or US-20120193802-$ or US-20120161163-$ or US-20120132817-$ or US-20120049366-$ or US-20060270079-$ or US-20130193465-$ or US-20130234318-$ or US-20130113091-$ or US-20110260308-$ or US-20040238956-$ or US-20080182398-$ or US-20150214206-$ or US-20150221624-$ or US- | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | OFF | OFF | 2020/09/10 01:39 PM |



IPR2026-00067
TSMC EX1002 Page 360

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|---|---|---|---|---|---|---|---|
| | | 20140035134-$ or US-20100078781-$ or US-20140312497-$ or US-20140160699-$ or US-20110215444-$ or US-20150262931-$).did. or (US-20150108661-$ or US-20100184256-$ or US-20090256670-$ or US-20080150119-$ or US-20050253231-$ or US-20030096089-$ or US-20150342060-$ or US-20120094442-$ or US-20110115083-$ or US-20140217436-$ or US-20140048949-$ or US-20130214386-$ or US-20120086117-$ or US-20120049363-$ or US-20120032282-$ or US-20140264810-$ or US-20120160647-$ or US-20100000775-$ or US-20070243704-$ or US-20050090035-$ or US-20050151272-$ or US-20100019373-$ or US-20140118978-$ or US-20120293977-$ or US-20110227223-$ or US-20090236730-$ or US-20080049392-$).did. or (US-20090096070-$ or US-20130168857-$ or US-20110309526-$ or US-20080211111-$ or US-20080277802-$ or US-20070080469-$ or US-20140246223-$ or US-20150162194-$ or US-20160343592-$ or US-20140054796-$ or US-20130343067-$ or US-20130017652-$ or US-20120306104-$ or US-20120019123-$ or US-20110291541-$ or US-20110222280-$ or US-20100171139-$ or US-20120305977-$ or US-20150021754-$ or US-20110121449-$ or US-20150221614-$ or US-20130200531-$ or US-20130062761-$ or US-20120028411-$ or US- | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | 20130295725-$ or US-20060194370-$ or US-20080212288-$).did. or (US-7589405-$ or US-8906794-$ or US-6614122-$ or US-8558399-$ or US-8432022-$ or US-8228682-$ or US-8982577-$ or US-4706167-$ or US-5531020-$ or US-8252615-$ or US-6331451-$ or US-8946886-$ or US-8415785-$ or US-5804881-$ or US-9786623-$ or US-9040352-$ or US-7855391-$ or US-8507927-$ or US-7619901-$ or US-9768038-$ or US-9627261-$ or US-5250843-$ or US-9735113-$ or US-9431316-$ or US-8617935-$ or US-8518749-$).did. or (US-8482134-$ or US-8258012-$ or US-8105872-$ or US-7955942-$ or US-7846777-$ or US-7727806-$).did. | | | | | |
| L4 | 121 | ("10192796"\|"8648470"\|"8846454"\|"8980691"\|"8987918"\|"9048211"\|"9431331"\|"9704780"\|"9837303"\|"10043768"\|"8742579"\|"8786060"\|"8796137"\|"8883561"\|"8895440"\|"8916421"\|"8952489"\|"8952521"\|"8993377"\|"9082806"\|"9224647"\|"9281292"\|"9324672"\|"9331060"\|"9343442"\|"9362187"\|"9385006"\|"9385009"\|"9397050"\|"9406619"\|"9406658"\|"9508626"\|"9524955"\|"9593009"\|"9679863"\|"9704843"\|"9735113"\|"20020038725"\|"20020145197"\|"20020159243"\|"20050012217"\|"20060006539"\|"20060020371"\|"20070045841"\|"20070268581"\|" | (US-PGPUB; USPAT) | OR | OFF | OFF | 2020/09/10 01:40 PM |



IPR2026-00067
TSMC EX1002 Page 362

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|---|---|---|---|---|---|---|---|
| | | 20080054457"\|"20080080111"\|"20080113505"\|"20080129439"\|"20080149384"\|"20080150623"\|"20080283277"\|"20080284014"\|"20080318361"\|"20090109655"\|"20090174065"\|"20090273073"\|"20100164030"\|"20100200898"\|"20100246152"\|"20100290191"\|"20110026232"\|"20110065250"\|"20110089574"\|"20110147055"\|"20110242050"\|"20130292846"\|"20130307140"\|"20140103488"\|"20140210101"\|"20140252646"\|"20140264839"\|"20140367160"\|"20150166329"\|"20170345761"\|"20170345764"\|"20170373004"\|"4221047"\|"4639543"\|"4975103"\|"5294238"\|"5705855"\|"6156413"\|"6177707"\|"6194762"\|"6265771"\|"6309901"\|"6339197"\|"6434016"\|"6539750"\|"6673698"\|"6691409"\|"6772514"\|"6799438"\|"6839946"\|"6894358"\|"6989604"\|"7038309"\|"7071521"\|"7072018"\|"7091589"\|"7151009"\|"7259080"\|"7279771"\|"7285834"\|"7337540"\|"7362403"\|"7476623"\|"7557440"\|"7749900"\|"7808799"\|"7993510"\|"8207453"\|"8338238"\|"8354297"\|"8822281"\|"8878360"\|"9048233"\|"9147638"\|"9385105"\|"9627365").PN. | | | | | |
| L5 | 19 | ((("YANG") near3 ("Ping-Jung"))).INV. | (US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT) | OR | OFF | OFF | 2020/09/10 01:40 PM |
| L6 | 3569 | (H01L2224/45147).CPC. | (US-PGPUB) | OR | OFF | OFF | 2020/09/10 01:42 PM |
| L7 | 2 | ("20200161245").PN. | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | OFF | OFF | 2020/09/10 01:42 PM |
| L8 | 799 | L6 and polymer and chip | (US-PGPUB) | OR | OFF | OFF | 2020/09/10 01:43 PM |
| L9 | 2 | ("2009/0315171").URPN. | (USPAT) | OR | OFF | OFF | 2020/09/10 01:48 PM |
| L10 | 5 | ("20080277783" \| "20090315171" \| | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2020/09/10 01:49 PM |

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|---|---|---|---|---|---|---|---|
| | | "20110110061" \| "8318537" \| "9064757").PN. OR ("9437534").URPN. | | | | | |
| L11 | 9 | ("2011/0110061").URPN. | (USPAT) | OR | OFF | OFF | 2020/09/10 01:50 PM |
| L12 | 1645 | ((("YUAN") near3 ("Zhongfa")) OR (("LIU") near3 ("Yong")) OR (("LIU") near3 ("Yumin")) OR (("QIAN") near3 ("Qiuxiao"))).INV. | (US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT) | OR | OFF | OFF | 2020/09/10 01:54 PM |
| L13 | 28 | L12 and copper and polymer | (US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT) | OR | OFF | OFF | 2020/09/10 01:55 PM |
| L14 | 18 | ("2009/0184403").URPN. | (USPAT) | OR | OFF | OFF | 2020/09/10 01:58 PM |
| L15 | 4 | ("20090184403").PN. OR ("8614120").URPN. | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2020/09/10 01:58 PM |
| L16 | 20179 | (H01L23/49827 \| H01L23/5384 \| H01L2224/08165 \| H01L2224/16165 \| H01L2224/16235 \| H01L2224/32165 \| H01L2224/32235 \| H01L2224/40165 \| H01L2224/40235 \| H01L2224/48165 \| H01L2224/48235).CPC. | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2020/09/10 02:05 PM |
| L17 | 6787 | L16 and copper and polymer | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2020/09/10 02:05 PM |
| L18 | 2733 | L16 and copper same polymer | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2020/09/10 02:05 PM |
| L19 | 970 | L16 and cpu same gpu | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2020/09/10 02:11 PM |
| L20 | 82 | L16 and cpu same gpu same passive | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2020/09/10 02:15 PM |
| L21 | 121 | ("10192796"\|"8648470"\|"8846454"\|"8980691"\|"8987918"\|"9048211"\|"9431331"\|"9704780"\|"9837303"\|"10043768"\|"8742579"\|"8786060"\|"8796137"\|"8883561"\|"8895440"\|"8916421"\|"8952489"\|"8952521"\|"8993377"\|"9082806"\|"9224647"\|"9281292"\|"9324672"\|"9331060"\|"9343442"\|"9362187"\|"9385006"\|"9385009"\|"9397050"\|"9406619"\|"9406658"\|"9508626"\|"9524955"\|"959300 | (US-PGPUB; USPAT) | OR | OFF | OFF | 2020/09/10 06:30 PM |

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|---|---|---|---|---|---|---|---|
| | | 9"\|"9679863"\|"9704843"\|"9735113"\|"20020038725"\|"20020145197"\|"20020159243"\|"20050012217"\|"20060006539"\|"20060020371"\|"20070045841"\|"20070268581"\|"20080054457"\|"20080080111"\|"20080113505"\|"20080129439"\|"20080149384"\|"20080150623"\|"20080283277"\|"20080284014"\|"20080318361"\|"20090109655"\|"20090174065"\|"20090273073"\|"20100164030"\|"20100200898"\|"20100246152"\|"20100290191"\|"20110026232"\|"20110065250"\|"20110089574"\|"20110147055"\|"20110242050"\|"20130292846"\|"20130307140"\|"20140103488"\|"20140210101"\|"20140252646"\|"20140264839"\|"20140367160"\|"20150166329"\|"20170345761"\|"20170345764"\|"20170373004"\|"4221047"\|"4639543"\|"4975103"\|"5294238"\|"5705855"\|"6156413"\|"6177707"\|"6194762"\|"6265771"\|"6309901"\|"6339197"\|"6434016"\|"6539750"\|"6673698"\|"6691409"\|"6772514"\|"6799438"\|"6839946"\|"6894358"\|"6989604"\|"7038309"\|"7071521"\|"7072018"\|"7091589"\|"7151009"\|"7259080"\|"7279771"\|"7285834"\|"7337540"\|"7362403"\|"7476623"\|"7557440"\|"7749900"\|"7808799"\|"7993510"\|"8207453"\|"8338238"\|"8354297"\|"8822281"\|"8878360"\|"9048233"\|"9147638"\|"9385105"\|"9627365").PN. | | | | | |
| L24 | 2 | "20130242493" | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | OFF | OFF | 2020/09/10 06:34 PM |
| L25 | 32 | ("2013/0242493").URPN. | (USPAT) | OR | OFF | OFF | 2020/09/10 06:36 PM |
| L27 | 21 | "ppm/.degree.C" | (USPAT) | OR | OFF | OFF | 2020/09/10 06:42 PM |
| L28 | 1788 | polymer same | (USPAT) | OR | OFF | OFF | 2020/09/10 |



IPR2026-00067
TSMC EX1002 Page 365

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|---|---|---|---|---|---|---|---|
| | | expansion adj coefficient | | | | | 06:45 PM |
| L29 | 446 | polymer near10 expansion adj coefficient | (USPAT) | OR | OFF | OFF | 2020/09/10 06:45 PM |
| L34 | 3 | "20110257716" | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | OFF | OFF | 2020/09/10 06:55 PM |
| L35 | 46 | (US-20110304008-$ or US-20120313207-$ or US-20120241938-$ or US-20120193785-$ or US-20120052631-$ or US-20110297434-$ or US-20110026232-$ or US-20100290191-$ or US-20100207154-$ or US-20100200898-$ or US-20100102457-$ or US-20100044850-$ or US-20090315171-$ or US-20110110061-$ or US-20100123257-$ or US-20100052119-$ or US-20090184403-$ or US-20120326170-$ or US-20130050228-$ or US-20130049217-$ or US-20120313209-$ or US-20120306096-$ or US-20120228749-$ or US-20140124777-$ or US-20140042637-$ or US-20130328211-$).did. or (US-20130292844-$ or US-20130119562-$ or US-20100258944-$ or US-20100258946-$ or US-20100252937-$ or US-20080149384-$ or US-20130277855-$ or US-20170373004-$ or US-20170345761-$ or US-20130242493-$).did. or (US-9437534-$ or US-8247269-$ or US-8614120-$ or US-7968978-$ or US-9627365-$ or US-9817312-$ or US-9615453-$ or US-9363890-$ or US-9161443-$ or US-9030751-$).did. | (US-PGPUB; USPAT) | OR | OFF | OFF | 2020/09/10 06:58 PM |
| L37 | 30 | L35 and polyimide | (US-PGPUB; USPAT) | OR | ON | ON | 2020/09/10 |

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|---|---|---|---|---|---|---|---|
| | | | | | | | 07:00 PM |
| L38 | 65 | (US-20160181184-$ or US-20170062361-$ or US-20160163666-$ or US-20150206934-$ or US-20140021618-$ or US-20120208129-$ or US-20180062386-$ or US-20160173039-$ or US-20160087588-$ or US-20110241793-$ or US-20110057742-$ or US-20100032818-$ or US-20100001363-$ or US-20130147540-$ or US-20190259758-$ or US-20190252306-$ or US-20150179591-$ or US-20140346663-$ or US-20140312362-$ or US-20140077362-$ or US-20130200528-$ or US-20130026658-$ or US-20100165585-$ or US-20160071820-$).did. or (US-6659663-$ or US-10153553-$ or US-6829152-$ or US-10580726-$ or US-10090266-$ or US-9972555-$ or US-8168470-$ or US-9954028-$ or US-10177115-$).did. | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | OFF | OFF | 2020/09/10 10:50 PM |
| L39 | 1659 | ((("STATS") near3 ("CHIPPAC") near3 ("LTD"))).AS,AANM. | (USPAT) | OR | OFF | OFF | 2020/09/10 10:51 PM |
| L40 | 3 | "20090230517" | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | OFF | OFF | 2020/09/10 10:57 PM |
| L41 | 3 | "20090155959" | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | OFF | OFF | 2020/09/10 11:20 PM |
| L42 | 3 | "20130049217" | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | OFF | OFF | 2020/09/11 10:28 AM |
| L44 | 3 | "20090155959" | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | OFF | OFF | 2020/09/11 10:34 AM |
| L45 | 2 | "20090155959" and passive | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | OFF | OFF | 2020/09/11 10:35 AM |
| L46 | 3 | "20090230517" | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | OFF | OFF | 2020/09/11 10:57 AM |
| L47 | 20179 | (H01L23/49827 \| H01L23/5384 \| | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2020/09/11 11:06 AM |

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|---|---|---|---|---|---|---|---|
| | | H01L2224/08165 \| H01L2224/16165 \| H01L2224/16235 \| H01L2224/32165 \| H01L2224/32235 \| H01L2224/40165 \| H01L2224/40235 \| H01L2224/48165 \| H01L2224/48235).CPC. | | | | | |
| L48 | 537 | L47 and cpu same gpu same DRAM | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2020/09/11 11:06 AM |
| L49 | 127 | L47 and cpu same gpu same DRAM and integration | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2020/09/11 11:06 AM |
| L50 | 20179 | (H01L23/49827 \| H01L23/5384 \| H01L2224/08165 \| H01L2224/16165 \| H01L2224/16235 \| H01L2224/32165 \| H01L2224/32235 \| H01L2224/40165 \| H01L2224/40235 \| H01L2224/48165 \| H01L2224/48235).CPC. | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2020/09/11 01:47 PM |
| L51 | 146 | L50 and tsv same layout | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2020/09/11 01:47 PM |
| L52 | 6 | "20130049217" "20090155959" "20090230517" "20130277801" "20110257716" "20100252934" | (US-PGPUB) | OR | OFF | OFF | 2020/09/17 04:44 PM |
| L53 | 71 | (US-20110304008-$ or US-20120313207-$ or US-20120241938-$ or US-20120193785-$ or US-20120052631-$ or US-20110297434-$ or US-20110026232-$ or US-20100290191-$ or US-20100207154-$ or US-20100200898-$ or US-20100102457-$ or US-20100044850-$ or US-20090315171-$ or US-20110110061-$ or US-20100123257-$ or US-20100052119-$ or US-20090184403-$ or US-20120326170-$ or US-20130050228-$ or US-20130049217-$ or US-20120313209-$ or US-20120306096-$ or US-20120228749-$ or | (US-PGPUB; USPAT) | OR | ON | ON | 2021/04/22 11:47 AM |

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|---|---|---|---|---|---|---|---|
| | | US-20140124777-$ or US-20140042637-$ or US-20130328211-$).did. or (US-20130292844-$ or US-20130119562-$ or US-20100258944-$ or US-20100258946-$ or US-20100252937-$ or US-20080149384-$ or US-20130277855-$ or US-20170373004-$ or US-20170345761-$ or US-20130242493-$ or US-20100252934-$).did. or (US-9437534-$ or US-8247269-$ or US-8614120-$ or US-7968978-$ or US-9627365-$ or US-9817312-$ or US-9615453-$ or US-9363890-$ or US-9161443-$ or US-9030751-$ or US-8354304-$ or US-8273602-$ or US-8270176-$ or US-8263434-$ or US-8217514-$ or US-8193036-$ or US-8133762-$ or US-8110440-$ or US-8110908-$ or US-8105915-$ or US-8080445-$ or US-8067308-$ or US-8067828-$ or US-8067275-$ or US-8063477-$ or US-8034661-$).did. or (US-8008121-$ or US-7977802-$ or US-7935570-$ or US-7880293-$ or US-7858441-$ or US-7842542-$ or US-7838337-$ or US-7790503-$).did. | | | | | |
| L54 | 21477 | (H01L23/49827 \| H01L23/5384 \| H01L2224/08165 \| H01L2224/16165 \| H01L2224/16235 \| H01L2224/32165 \| H01L2224/32235 \| H01L2224/40165 \| H01L2224/40235 \| | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2021/04/22 11:47 AM |



IPR2026-00067
TSMC EX1002 Page 369

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|---|---|---|---|---|---|---|---|
| | | H01L2224/48165 \| H01L2224/48235).CPC. | | | | | |
| L55 | 166 | L54 and tsv same layout | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2021/04/22 11:47 AM |
| L56 | 2 | ("20200161245").PN. | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | ON | ON | 2021/04/22 11:48 AM |
| L57 | 2 | ("20140085842").PN. | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | ON | ON | 2021/04/22 12:22 PM |
| L58 | 3 | "20110147055" | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | ON | ON | 2021/04/22 12:24 PM |
| L63 | 31 | (US-20040238945-$ \| US-20050098891-$ \| US-20060292851-$ \| US-20110278736-$ \| US-20110285005-$ \| US-20120193785-$ \| US-10490521-$ \| US-6002592-$ \| US-6423570-$ \| US-7019406-$ \| US-7569422-$ \| US-8193555-$ \| US-8431977-$ \| US-8445323-$ \| US-8456856-$ \| US-8837872-$).DID. | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | OFF | OFF | 2021/06/03 01:46 AM |
| L64 | 2 | ("20200161245").PN. | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | ON | ON | 2021/06/03 01:52 AM |
| L67 | 7 | L63 and cpu same gpu | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | OFF | OFF | 2021/06/03 02:18 AM |
| L68 | 10 | ("20060193691" \| "20090014826" \| "20090042338" \| "20090057868" \| "6777767" \| "7582556" \| "8193555").PN. OR ("8431977").URPN. | (US-PGPUB; USPAT; USOCR) | OR | ON | ON | 2021/06/03 02:48 AM |
| L69 | 3 | "20110304008" | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2021/06/04 02:18 PM |
| L70 | 13 | ("2011/0304008").URPN. | (USPAT) | OR | ON | ON | 2021/06/04 02:21 PM |
| L71 | 130 | ("2012/0193785").URPN. | (USPAT) | OR | ON | ON | 2021/06/04 05:27 PM |
| L73 | 3 | "20120170887" | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | OFF | OFF | 2021/06/05 05:28 PM |
| L75 | 3 | "20110304008" | (US-PGPUB; USPAT; USOCR; DERWENT) | OR | OFF | OFF | 2021/06/05 05:58 PM |
| L76 | 33 | ("20040238941" \| "20040262735" \| "20050130368" \| "20070096292" \| | (US-PGPUB; USPAT; USOCR) | OR | ON | ON | 2021/06/05 07:41 PM |

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| | | "20080001285" \| "20080099911" \| "20080136004" \| "20090170242" \| "20090294899" \| "20090302435" \| "20100006994" \| "20100059876" \| "5250843" \| "5353498" \| "5841193" \| "6495912" \| "6828670" \| "6905912" \| "7214565" \| "7619901" \| "7772081" \| "7790503" \| "7858441" \| "8193604").PN. OR ("8445323").URPN. | | | | | |
| L77 | 5 | "20100140779" | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2021/06/05 07:45 PM |
| L78 | 3 | "20110304008" "20100140779" "20120170887" | (US-PGPUB) | OR | OFF | OFF | 2021/06/05 11:31 PM |
| L79 | 1 | "10622310".pn. | (US-PGPUB; USPAT) | OR | OFF | OFF | 2021/06/05 11:41 PM |
| L80 | 2 | ("2013/0328211").urpn. AND (PGPB \| USPT \| USOC).dbnm. | (US-PGPUB; USPAT; USOCR) | OR | ON | ON | 2021/11/02 03:42 PM |
| L81 | 2 | "20210335714" | (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, CA, CH, CN, DD, DE, EA, EP, ES, FR, GB, JP, KR, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2022/09/15 02:02 PM |
| L82 | 22 | ((("YANG") near3 ("Ping-Jung"))).INV. | (US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT) | OR | OFF | OFF | 2022/09/15 02:03 PM |
| L83 | 31 | (Artificial Intelligence) More like doc: US-20210335714-A1 Text: (US-11107768-B2 OR US-20200161245-A1 OR US-10622310-B2 OR US-20170047313-A1 OR US-9615453-B2 OR US-20170207188-A1 OR US-20190027459-A1 OR US-10096565-B2 OR US-10453819-B2 OR US-20140085842-A1 OR CN-107046018-B | (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2022/09/15 02:34 PM |

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|---|---|---|---|---|---|---|---|
| | | OR TW-201712812-A OR TW-I675440-B OR CN-107046018-A OR CN-111968959-A OR US-20140117534-A1 OR CN-109411482-A OR US-20190057938-A1 OR US-9673125-B2 OR US-10692815-B2).did. | | | | | |
| L84 | 34 | (Artificial Intelligence) More like doc: US-20140085842-A1 Text: (US-20170207188-A1 OR US-10453819-B2 OR US-9615453-B2 OR US-20190027459-A1 OR US-10096565-B2 OR US-10622310-B2 OR US-20170047313-A1 OR US-20200161245-A1 OR US-20210335714-A1 OR US-11107768-B2 OR US-20160284637-A1 OR US-8207453-B2 OR DE-112010004890-B4 OR US-20120192413-A1 OR TW-201714500-A OR US-10070524-B2 OR US-20140085846-A1 OR CN-107926110-B OR WO-2017034958-A1 OR EP-3338520-A1).did. | (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2022/09/15 02:36 PM |
| L85 | 71 | ((US-20100102457-A1 OR US-20120241938-A1 OR US-20120193785-A1 OR US-20120052631-A1 OR US-20110297434-A1 OR US-20110026232-A1 OR US-20100290191-A1 OR US-20100207154-A1 OR US-20090184403-A1 OR US-20120313207-A1 OR US-20100044850-A1 OR US-20090315171-A1 OR US-20110110061-A1 OR US-20100123257-A1 OR US-20100052119-A1 OR | (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | OFF | OFF | 2022/09/15 02:45 PM |

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|---|---|---|---|---|---|---|---|
| | | US-20100200898-A1 OR US-20140124777-A1 OR US-20120326170-A1 OR US-20130050228-A1 OR US-20130049217-A1 OR US-20120313209-A1 OR US-20120306096-A1 OR US-20110304008-A1 OR US-20140042637-A1 OR US-20130328211-A1 OR US-20130292844-A1 OR US-20130119562-A1 OR US-20100258944-A1 OR US-20100258946-A1 OR US-20100252937-A1 OR US-20120228749-A1 OR US-20130277855-A1 OR US-20170373004-A1 OR US-20170345761-A1 OR US-20130242493-A1 OR US-20080149384-A1 OR US-20100252934-A1).did. AND PGPB.dbnm.) OR ((US-9437534-B2 OR US-8247269-B1 OR US-8614120-B2 OR US-7968978-B2 OR US-8110908-B2 OR US-8110440-B2 OR US-9627365-B1 OR US-9817312-B2 OR US-9615453-B2 OR US-9363890-B2 OR US-8008121-B2 OR US-9030751-B2 OR US-8354304-B2 OR US-8273602-B2 OR US-8270176-B2 OR US-8263434-B2 OR US-8217514-B2 OR US-8193036-B2 OR US-8133762-B2 OR US-7977802-B2 OR US-8105915-B2 OR US-8080445-B1 OR US-8067308-B2 OR US-8067828-B2 OR US-8067275-B2 OR US-8063477-B2 OR US-8034661-B2 OR US- | | | | | |

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|---|---|---|---|---|---|---|---|
| | | 9161443-B2 OR US-7935570-B2 OR US-7880293-B2 OR US-7858441-B2 OR US-7842542-B2 OR US-7838337-B2 OR US-7790503-B2).did. AND USPT.dbnm.) | | | | | |
| L86 | 2 | ("2013/0328211").urpn. AND (PGPB \| USPT \| USOC).dbnm. | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2022/09/15 02:53 PM |
| L87 | 33 | (Artificial Intelligence) More like doc: US-20120228749-A1 Text: (US-8268677-B1 OR US-9685403-B2 OR US-20140319661-A1 OR US-20120299165-A1 OR US-8810011-B2 OR US-9391046-B2 OR US-10643952-B2 OR US-20120292745-A1 OR US-20100276792-A1 OR US-20110298101-A1 OR US-9484279-B2 OR US-20170018507-A1 OR US-20140291820-A1 OR US-9437482-B2 OR US-8791015-B2 OR US-20120273926-A1 OR US-20110298109-A1 OR US-20120112327-A1 OR US-20130001762-A1 OR US-8581370-B2).did. | (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | OFF | OFF | 2022/09/15 02:53 PM |
| L88 | 34 | (Artificial Intelligence) More like doc: US-20120193785-A1 Text: (WO-2012106183-A1 OR US-8503186-B2 OR US-8804360-B2 OR US-20130292849-A1 OR TW-I416693-B OR US-9099540-B2 OR US-8487444-B2 OR US-20100225002-A1 OR TW-201034157-A OR JP-2010219526-A OR US-20110248396-A1 OR US-20130230985-A1 OR CN-101840912-B OR CN-101840912-A OR | (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | OFF | OFF | 2022/09/15 02:54 PM |



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TSMC EX1002 Page 374

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | KR-20170018813-A OR KR-20100100629-A OR JP-2017518634-A OR CN-109801897-B OR CN-106463467-A OR TW-202002188-A).did. | | | | | |
| L89 | 30 | ("2008/0149384").urpn. AND (PGPB \| USPT \| USOC).dbnm. | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2022/09/15 02:55 PM |
| L90 | 56 | ("4221047" \| "4639543" \| "4975103" \| "5294238" \| "5705855" \| "6156413" \| "6177707" \| "6194762" \| "6309901" \| "6339197" \| "6539750" \| "6673698" \| "6691409" \| "6772514" \| "6799438" \| "6839946" \| "6894358" \| "6989604" \| "7038309" \| "7071521" \| "7072018" \| "7091589" \| "7259080" \| "7279771" \| "7285834" \| "7337540" \| "7362403" \| "7476623" \| "7749900" \| "7993510" \| "20020038725" \| "20020145197" \| "20020159243" \| "20050012217" \| "20080149384" \| "20080283277" \| "20090174065" \| "20090273073" \| "20100164030").pn. OR ("8207453").urpn. AND (PGPB \| USPT \| USOC).dbnm. | (US-PGPUB; USPAT; USOCR) | OR | OFF | OFF | 2022/09/15 02:55 PM |
| L91 | 34 | (Artificial Intelligence) More like doc: US-8207453-B2<br>Text: (KR-20140041933-A OR WO-2011084235-A2 OR TW-I467716-B OR US-20120192413-A1 OR TW-201138032-A OR US-10070524-B2 OR US-20110147055-A1 OR KR-101389626-B1 OR US-20160284637-A1 OR US-9686861-B2 OR KR-101531482-B1 OR KR-20120095426-A OR DE-112010004890-B4 OR DE-112010004890-T5 OR CN-102668068-A OR CN-102668068-B | (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | OFF | OFF | 2022/09/15 02:56 PM |



IPR2026-00067
TSMC EX1002 Page 375

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|---|---|---|---|---|---|---|---|
| | | OR US-20110147059-A1 OR KR-101466582-B1 OR WO-2011084216-A2 OR US-20160322290-A1).did. | | | | | |
| L92 | 32 | (Artificial Intelligence) Similar to: 17/372,459 with 0 CPC Selections and 0 Text Selections<br>Text: (SE-8202170-L OR ES-8304363-A1 OR ES-8503920-A1 OR IE-853216-L OR JP-S61168940-A OR JP-S568855-A OR IE-57063-B1 OR JP-S60244053-A OR EP-0380914-B1 OR JP-S56120147-A OR US-4871583-A OR JP-S61287131-A OR JP-S5979594-A OR JP-S6292353-A OR CA-1189196-A OR WO-9917361-A3 OR US-6054652-A OR JP-S62222661-A OR JP-S62242346-A OR JP-S62195162-A OR JP-S6035543-A OR JP-S59182548-A OR JP-S62173742-A OR EP-0004556-A1 OR EP-0188838-B1 OR US-4161817-A OR JP-S60165746-A OR JP-H0247892-A OR JP-H0466105-B2 OR GB-2324415-A OR JP-S60241238-A OR US-11164818-B2 OR CN-2652088-Y OR US-4882657-A OR TW-I765532-B OR JP-S62123743-A OR JP-S59117142-A OR CN-1496212-A OR CN-100352319-C OR JP-S61242047-A OR JP-S59103360-A OR JP-S59188949-A OR JP-2505739-B2 OR EP-0004556-B1 OR DE-19747609-A1 OR DE- | (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, CA, CH, CN, DD, DE, EA, EP, ES, FR, GB, JP, KR, OA, RU, SU, WO)) | OR | ON | ON | 2022/10/21 08:02 PM |

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| | | 19747609-B4 OR JP-S62242348-A OR CA-2147396-A1 OR JP-S57201054-A OR JP-S59161843-A).did. | | | | | |
| L93 | 1 | ("20230073104").pn. | (US-PGPUB; USPAT) | OR | ON | ON | 2023/11/01 08:08 PM |
| L94 | 143 | (US-20020038725-$ \| US-20020145197-$ \| US-20020159243-$ \| US-20040238945-$ \| US-20040251045-$ \| US-20050012217-$ \| US-20050098891-$ \| US-20060006539-$ \| US-20060020371-$ \| US-20060292851-$ \| US-20070045841-$ \| US-20070263364-$ \| US-20070268581-$ \| US-20080054457-$ \| US-20080080111-$ \| US-20080113505-$ \| US-20080129439-$ \| US-20080149384-$ \| US-20080150623-$ \| US-20080283277-$ \| US-20080284014-$ \| US-20080318361-$ \| US-20090109655-$ \| US-20090174065-$ \| US-20090273073-$ \| US-20100164030-$ \| US-20100200898-$ \| US-20100246152-$ \| US-20100290191-$ \| US-20110026232-$ \| US-20110065250-$ \| US-20110089574-$ \| US-20110147055-$ \| US-20110242050-$ \| US-20110278736-$ \| US-20110285005-$ \| US-20120068271-$ \| US-20120193785-$ \| US-20130292846-$ \| US-20130303777-$ \| US-20130307140-$ \| US-20140103488-$ \| US-20140210101-$ \| US-20140252646-$ \| US-20140264839-$ \| US-20140367160-$ \| US-20150166329-$ \| US-20170345761-$ \| US-20170345764-$ \| US-20170373004-$ \| | (US-PGPUB; USPAT) | OR | ON | ON | 2023/11/04 09:46 PM |

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|---|---|---|---|---|---|---|---|
| | | US-0068271-$ \| US-<br>10043768-$ \| US-<br>10192796-$ \| US-<br>1026744-$ \| US-<br>10490521-$ \| US-<br>4221047-$ \| US-<br>4639543-$ \| US-<br>4975103-$ \| US-<br>5294238-$ \| US-<br>5705855-$ \| US-<br>6002592-$ \| US-<br>6156413-$ \| US-<br>6177707-$ \| US-<br>6194762-$ \| US-<br>6265771-$ \| US-<br>6309901-$ \| US-<br>6339197-$ \| US-<br>6423570-$ \| US-<br>6434016-$ \| US-<br>6539750-$ \| US-<br>6673698-$ \| US-<br>6691409-$ \| US-<br>6772514-$ \| US-<br>6799438-$ \| US-<br>6839946-$ \| US-<br>6894358-$ \| US-<br>6989604-$ \| US-<br>7019406-$ \| US-<br>7038309-$ \| US-<br>7071521-$ \| US-<br>7072018-$ \| US-<br>7091589-$ \| US-<br>7151009-$ \| US-<br>7259080-$ \| US-<br>7279771-$ \| US-<br>7285834-$ \| US-<br>7337540-$ \| US-<br>7362403-$ \| US-<br>7476623-$ \| US-<br>7557440-$ \| US-<br>7569422-$ \| US-<br>7749900-$ \| US-<br>7808799-$ \| US-<br>7993510-$ \| US-<br>8193555-$ \| US-<br>8207453-$ \| US-<br>8338238-$ \| US-<br>8354297-$ \| US-<br>8431977-$ \| US-<br>8445323-$ \| US-<br>8456856-$ \| US-<br>8648470-$ \| US-<br>8742579-$ \| US-<br>8786060-$ \| US-<br>8796137-$ \| US-<br>8822281-$ \| US-<br>8837872-$ \| US-<br>8846454-$ \| US- | | | | | |

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|---|---|---|---|---|---|---|---|
| | | 8878360-$ \| US-<br>8883561-$ \| US-<br>8895440-$ \| US-<br>8916421-$ \| US-<br>8952489-$ \| US-<br>8952521-$ \| US-<br>8980691-$ \| US-<br>8987918-$ \| US-<br>8993377-$ \| US-<br>9048211-$ \| US-<br>9048233-$ \| US-<br>9082806-$ \| US-<br>9147638-$ \| US-<br>9224647-$ \| US-<br>9281292-$ \| US-<br>9324672-$ \| US-<br>9331060-$ \| US-<br>9343442-$ \| US-<br>9362187-$ \| US-<br>9385006-$ \| US-<br>9385009-$ \| US-<br>9385105-$ \| US-<br>9397050-$ \| US-<br>9406619-$ \| US-<br>9406658-$ \| US-<br>9431331-$ \| US-<br>9508626-$ \| US-<br>9524955-$ \| US-<br>9593009-$ \| US-<br>9627365-$ \| US-<br>9679863-$ \| US-<br>9704780-$ \| US-<br>9704843-$ \| US-<br>9735113-$ \| US-<br>9837303-$).DID. | | | | | |
| L95 | 1 | "11538763".pn. | (US-PGPUB; USPAT) | OR | ON | ON | 2023/11/04 09:49 PM |

## PE2E SEARCH - Search History (Interference)

| Ref # | Hits | Search Query | DBs | Default Operator | Plurals | British Equivalents | Time Stamp |
|---|---|---|---|---|---|---|---|
| N83 | 10204 | (H01L23/49827 \| H01L23/5384 \| H01L2224/08165 \| H01L2224/16165 \| H01L2224/16235 \| H01L2224/32165 \| H01L2224/32235 \| H01L2224/40165 \| H01L2224/40235 \| H01L2224/48165 \| H01L2224/48235).CPC. | (USPAT) | OR | OFF | OFF | 2021/07/02 04:25 PM |
| N84 | 22 | N83 and (pitch and (coeffcient or expansion) and thickness).clm. | (USPAT) | OR | OFF | OFF | 2021/07/02 04:25 PM |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| N85 | 244 | (pitch and (coeffcient or expansion) and thickness).clm. | (USPAT) | OR | OFF | OFF | 2021/07/02 04:25 PM |
| N86 | 11 | N59 AND (copper AND pitch AND polymer AND thickness).clm. | (USPAT) | OR | OFF | OFF | 2022/09/15 02:42 PM |
| N87 | 85 | (copper AND pitch AND polymer AND thickness).clm. | (USPAT) | OR | OFF | OFF | 2022/09/15 02:42 PM |
| N88 | 85 | (copper AND pitch AND polymer AND thickness).clm. | (USPAT) | OR | OFF | OFF | 2022/10/21 08:03 PM |
| N89 | 12408 | (H01L23/49827 \| H01L23/5384 \| H01L2224/08165 \| H01L2224/16165 \| H01L2224/16235 \| H01L2224/32165 \| H01L2224/32235 \| H01L2224/40165 \| H01L2224/40235 \| H01L2224/48165 \| H01L2224/48235).CPC. | (USPAT) | OR | OFF | OFF | 2023/11/17 06:17 PM |
| N91 | 2 | N89 AND (thickness AND silicon AND oxygen AND copper AND pitch ).clm. | (US-PGPUB; USPAT) | OR | ON | ON | 2023/11/17 06:23 PM |

## Bibliographic Data

Application No: 17/985,827

Foreign Priority claimed: ○ Yes ◉ No

35 USC 119 (a-d) conditions met: ☐ Yes ☑ No ☐ Met After Allowance

Verified and Acknowledged: /XIAOMING LIU/ (Examiner's Signature) | (Initials)

Title: CHIP PACKAGE

| FILING or 371(c) DATE | CLASS | GROUP ART UNIT | ATTORNEY DOCKET NO. |
|---|---|---|---|
| 11/12/2022 | 257 | 2812 | Mars16-001-US-C03 |
| RULE | | | |

**APPLICANTS**

Ping-Jung Yang, Hsin-Chu City, TAIWAN

**INVENTORS**

Ping-Jung Yang, Hsinchu City, TAIWAN

**CONTINUING DATA**

This application is a CON of 17372459 07/11/2021 PAT 11538763

17372459 is a CON of 16752650 01/26/2020 PAT 11107768

16752650 is a CON of 15261956 09/11/2016 PAT 10622310

15261956 has PRO of 62219249 09/16/2015

15261956 is a CIP of 14036256 09/25/2013 PAT 9615453

14036256 has PRO of 61705649 09/26/2012

**FOREIGN APPLICATIONS**

**IF REQUIRED, FOREIGN LICENSE GRANTED****

11/28/2022

**** SMALL ENTITY ****

**STATE OR COUNTRY**

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102851 7590 11/24/2023

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HSINCHU CITY, 30091
TAIWAN

| EXAMINER | |
|---|---|
| LIU, XIAOMING | |
| ART UNIT | PAPER NUMBER |
| 2812 | |

DATE MAILED: 11/24/2023

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 17/985,827 | 11/12/2022 | Ping-Jung Yang | Mars16-001-US-C03 | 1762 |

TITLE OF INVENTION: CHIP PACKAGE

| APPLN. TYPE | ENTITY STATUS | ISSUE FEE DUE | PUBLICATION FEE DUE | PREV. PAID ISSUE FEE | TOTAL FEE(S) DUE | DATE DUE |
|---|---|---|---|---|---|---|
| nonprovisional | SMALL | $480 | $0.00 | $0.00 | $480 | 02/26/2024 |

**THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.**

**THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.**

**HOW TO REPLY TO THIS NOTICE:**

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 40% the amount of undiscounted fees, and micro entity fees are 20% the amount of undiscounted fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

**IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.**



PTOL-85 (Rev. 11/23)

IPR2026-00067
TSMC EX1002 Page 382

## PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via the USPTO patent electronic filing system.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications. **Because electronic patent issuance may occur shortly after issue fee payment, any desired continuing application should preferably be filed prior to payment of this issue fee in order not to jeopardize copendency.**

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

102851 7590 11/24/2023
PING-JUNG YANG
NO 2, NIOUPU SOUTH RD., SIANGSHAN DISTRICT
HSINCHU CITY, 30091
TAIWAN

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

**Certificate of Mailing or Transmission**

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via the USPTO patent electronic filing system or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 17/985,827 | 11/12/2022 | Ping-Jung Yang | Mars16-001-US-C03 | 1762 |

TITLE OF INVENTION: CHIP PACKAGE

| APPLN. TYPE | ENTITY STATUS | ISSUE FEE DUE | PUBLICATION FEE DUE | PREV. PAID ISSUE FEE | TOTAL FEE(S) DUE | DATE DUE |
|---|---|---|---|---|---|---|
| nonprovisional | SMALL | $480 | $0.00 | $0.00 | $480 | 02/26/2024 |

| EXAMINER | ART UNIT | CLASS-SUBCLASS |
|---|---|---|
| LIU, XIAOMING | 2812 | 257-091000 |

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/AIA/122 or PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑Issue Fee ❑Publication Fee (if required)

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via the USPTO patent electronic filing system ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

❑ Applicant asserting small entity status. See 37 CFR 1.27

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

❑ Applicant changing to regular undiscounted fee status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____



IPR2026-00067
TSMC EX1002 Page 383

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 17/985,827 | 11/12/2022 | Ping-Jung Yang | Mars16-001-US-C03 | 1762 |

102851 7590 11/24/2023

PING-JUNG YANG
NO 2, NIOUPU SOUTH RD., SIANGSHAN DISTRICT
HSINCHU CITY, 30091
TAIWAN

| EXAMINER | |
|---|---|
| LIU, XIAOMING | |
| **ART UNIT** | **PAPER NUMBER** |
| 2812 | |

DATE MAILED: 11/24/2023

**Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)**
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.



PTOL-85 (Rev. 11/23)

IPR2026-00067
TSMC EX1002 Page 384

## OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

## Privacy Act Statement

**The Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

| Notice of Allowability | Application No. 17/985,827 | Applicant(s) Yang, Ping-Jung | |
|---|---|---|---|
| | Examiner XIAOMING LIU | Art Unit 2812 | AIA (FITF) Status No |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--*

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to 11/8/2023.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are See Continuation Sheet . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   **Certified copies:**

   a) ☐ All b) ☐ Some* c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
**THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.**

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   **Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).**

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

**Attachment(s)**

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☐ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/XIAOMING LIU/
Examiner, Art Unit 2812



IPR2026-00067
TSMC EX1002 Page 386

Continuation of 3. The allowed claim(s) is/are: 1-4,7-12,14-16 and 18-31

**DETAILED ACTION**

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

***Terminal Disclaimer***

The terminal disclaimer filed on 11/8/2023 disclaiming the terminal portion of any patent granted on this application which would extend beyond the expiration date of U.S. Patent No.11538763 has been reviewed and is accepted. The terminal disclaimer has been recorded. As result, a double patenting rejection (non-statutory obvious type double patenting) may be obviated and will not be further detailed below.

***Allowable Subject Matter***

Claims 1-4,7-12,14-16 and 18-31 are allowed.

The following is an examiner's statement of reasons for allowance: currently independent claims 1, 11 and 21 are allowable because the closest prior art does not appear to disclose, alone or in combination, the limitations of material and structure of the chip package in combination with the other required elements of claim 1, 11 or 21.

Specifically, the limitations are material to the inventive concept of the application in hand to forming a polymer interconnect with sufficient coefficient of expansion to enable holes and other features formed inside with improved chemical durability, strength and optical properties.

Dependent claims 2-4, 7-10, 12, 14-16, 18-20 and 22-31 are respectively dependent on currently amended allowable independent claims 1 or 21. Therefore, claims 2-4, 7-10, 12, 14-16, 18-20 and 22-31 incorporate the allowable limitations of claims 1, 11 or 21. Consequently, claims 2-4, 7-10, 12, 14-16, 18-20 and 22-31 are allowable.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to XIAOMING LIU whose telephone number is (571)270-0384. The examiner can normally be reached Monday-Friday, 9am-8pm, EST.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Charles Garber can be reached on (571)272-2194. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit: https://patentcenter.uspto.gov. Visit https://www.uspto.gov/patents/apply/patent-center for more information about Patent Center and https://www.uspto.gov/patents/docx for information about filing in DOCX format. For additional questions, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/XIAOMING LIU/
Examiner, Art Unit 2812

UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

# ELECTRONIC ACKNOWLEDGEMENT RECEIPT

| APPLICATION # | RECEIPT DATE / TIME | ATTORNEY DOCKET # |
|---|---|---|
| **17/985,827** | **11/27/2023 11:13:00 AM Z ET** | **Mars16-001-US-C03** |

## Title of Invention

CHIP PACKAGE

## Application Information

| | | | |
|---|---|---|---|
| APPLICATION TYPE | Utility - Nonprovisional Application under 35 USC 111(a) | PATENT # | - |
| CONFIRMATION # | 1762 | FILED BY | Ping-Jung Yang |
| PATENT CENTER # | 63378053 | FILING DATE | 11/12/2022 |
| CUSTOMER # | 102851 | FIRST NAMED INVENTOR | Ping-Jung Yang |
| CORRESPONDENCE ADDRESS | - | AUTHORIZED BY | - |

## Documents

**TOTAL DOCUMENTS: 1**

| DOCUMENT | PAGES | DESCRIPTION | SIZE (KB) |
|---|---|---|---|
| Mars16-001-US-C03-AANOA-11272023.pdf | 14 | Amendment after Notice of Allowance (Rule 312) | 133 KB |

## Digest

| DOCUMENT | MESSAGE DIGEST(SHA-512) |
|---|---|
| Mars16-001-US-C03-AANOA-11272023.pdf | 80272DB6312AFF7E517E828159489A2AEB2B0EE710F218FF07DB6ACC7D794ADE361601993AE2557A503D9A4A7A334302349FF045508FEDAB842211952D222F70 |

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized

by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

**New Applications Under 35 U.S.C. 111**

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

**National Stage of an International Application under 35 U.S.C. 371**

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

**New International Application Filed with the USPTO as a Receiving Office**

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Docket No.: Mars-16-001-US-C03 **PATENT**

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

| | | |
|---|---|---|
| In re Application of | : | Customer Number: 102851 |
| Ping-Jung Yang | : | Confirmation Number: 1762 |
| Application No.: 17985827 | : | Group Art Unit: 2812 |
| Filed: Nov. 12, 2022 | : | Examiner: XIAOMING LIU |

For: CHIP PACKAGE

**AMENDMENT AFTER ALLOWANCE UNDER 37 CFR §1.312**

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

Pursuant to amendments after allowance under 37 CFR §1.312, Applicants hereby respectfully submit this paper and request to amend claim 1 of the above-identified application in the manner presented hereafter. The amendments embody merely the correction of formal matters in the claims without changing the scopes thereof.

**Amendments to the Claims** are reflected in the listing of claims which begins on page 2 of this paper.

**Remarks/Arguments** are beginning on page 11 of this paper.



IPR2026-00067
TSMC EX1002 Page 392

**Amendments to the Claims:**

This listing of claims will replace all prior versions, and listings, of claims in the application.

**Listing of Claims:**

What is claimed is:

1. (Currently amended) A chip package comprising:

a solid layer having a first surface and a second surface opposite to said first surface, wherein said solid layer comprises a compound of silicon and oxygen, wherein said solid layer has a thickness between 50 and 150 micrometers, wherein said solid layer comprises a first region and a second region between said first region and a first edge of said solid layer;

a plurality of metal posts in a plurality of through holes in said second region respectively, wherein one of said plurality of metal posts comprises a first copper layer contacting a sidewall of one of said plurality of through holes, wherein said first region has a width in a direction greater than a shortest distance between said sidewall of one of said plurality of through holes and said first edge in said direction and greater than a pitch between two neighboring metal posts of said plurality of metal posts;

a first interconnection scheme over said first surface, wherein said first interconnection scheme comprises a first metal interconnect over said second surface and a ~~first~~ polymer layer over said first metal interconnect, wherein said first metal interconnect is connected to a first metal post of said plurality of metal posts, wherein said first metal interconnect comprises a first metal layer and a second copper layer over said first metal layer;



IPR2026-00067
TSMC EX1002 Page 393

a first metal bump over said first interconnection scheme, wherein said first metal bump comprises a second metal layer and a first tin-containing layer over said second metal layer; and

a first semiconductor chip under said second surface, wherein said first interconnection scheme comprise a second metal interconnect across over a sidewall of the first semiconductor chip, wherein said first semiconductor chip comprises a third metal interconnect on a first metal pad of said first semiconductor chip, wherein said third metal interconnect comprises a third metal layer on said first metal pad and a third copper layer over said third metal layer, wherein said third copper layer has a thickness between 5 and 30 micrometers, wherein said first semiconductor chip is connected to a second metal post of said plurality of metal posts through said third metal interconnect.

2. (Previously presented) The chip package of claim 1, wherein said first semiconductor chip comprises a central-processing-unit (CPU) circuit block and a graphics-processing-unit (GPU) circuit block.

3. (Currently amended) The chip package of claim 1, wherein said first interconnection scheme further comprises a fourth metal interconnect over said first metal interconnect and said ~~first~~ polymer layer, wherein said ~~first~~ polymer layer is between said first and fourth metal interconnects, wherein said fourth metal interconnect comprises a fourth metal layer and a fourth copper layer over said fourth metal layer.

4. (Previously presented) The chip package of claim 1, wherein said first metal pad is an aluminum pad.



IPR2026-00067
TSMC EX1002 Page 394

Claims 5-6 are cancelled

7. (Previously presented) The chip package of claim 1, wherein said compound comprises a $SiO_2$ compound.

8. (Currently amended) The chip package of claim 1, further comprising a second semiconductor chip over said first semiconductor chip, wherein said second semiconductor chip comprises a second metal bump on a second metal pad of said second semiconductor chip, wherein said second metal bump comprises a second tin-containing layer.

9. (Previously presented) The chip package of claim 1, wherein said solid layer further comprises a third region opposite to said second region, wherein said third region is between said first region and a second edge of said solid layer, wherein said plurality of metal posts in said plurality of through holes in said third region respectively.

10. (Previously presented) The chip package of claim 1, wherein said second region is a rectangle region and surrounding said first region.

11. (Currently amended) A chip package comprising:

a solid layer having a first surface and a second surface opposite to said first surface, wherein said solid layer comprises a compound of silicon and oxygen, wherein said solid layer has a thickness between 100 and 300 micrometers, wherein said solid layer comprises a first region and a second region between said first region and a first edge of said solid layer;



IPR2026-00067
TSMC EX1002 Page 395

a plurality of copper posts in a plurality of through holes in said second region respectively, wherein said first region has a width in a direction greater than a shortest distance between a sidewall of one of said plurality of through holes and said first edge in said direction and greater than a pitch between two neighboring copper posts of said plurality of copper posts;

a first interconnection scheme over said first surface, wherein said first interconnection scheme comprises a first metal interconnect over said first surface, and a ~~first~~ polymer layer over said first metal interconnect, wherein said first metal interconnect is connected to one of said plurality of copper posts, wherein said first metal interconnect comprises a first metal layer and a first copper layer over said first metal layer;

a first metal ~~bumps~~ bump over said first interconnection scheme, wherein said first metal ~~bumps~~ bump comprises a first tin-containing layer;

a second metal ~~bumps~~ bump over said first interconnection scheme;

a first semiconductor chip over said first interconnection scheme and between said first and second metal bumps, wherein said first semiconductor chip has a height between a backside surface of said first semiconductor chip and a top surface of said ~~first~~ polymer layer is smaller than a thickness of said first metal bump, wherein said first semiconductor chip comprises a third metal bump on a first metal pad of said first semiconductor chip, wherein said third metal bump comprises a second tin-containing layer; and

a second semiconductor chip over said first interconnection scheme, wherein said second semiconductor chip comprises a fourth metal bump on a second metal pad of said second semiconductor chip, wherein said fourth metal bump comprises a third tin-containing layer.

12. (Previously presented) The chip package of claim 11, wherein said compound comprises a $SiO_2$ compound.



IPR2026-00067
TSMC EX1002 Page 396

Claim 13 is cancelled

14. (Previously presented) The chip package of claim 11, wherein no any copper post in said first region.

15. (Previously presented) The chip package of claim 11, further comprising a third semiconductor chip under said first interconnection scheme, wherein said third semiconductor chip comprises a second metal interconnect on a third metal pad of said third semiconductor chip, wherein said second metal interconnect comprises a second metal layer on said third metal pad and a second copper layer over said second metal layer, wherein said second copper layer has a thickness between 5 and 30 micrometers.

16. (Previously presented) The chip package of claim 11, further comprising a third semiconductor chip under said first interconnection scheme, wherein said third semiconductor chip comprises a second metal interconnect on a third metal pad of said third semiconductor chip, wherein said second metal interconnect comprises a second metal layer on said third metal pad and a second copper layer over said second metal layer, wherein said third semiconductor chip comprises a central-processing-unit (CPU) circuit block and a graphics-processing-unit (GPU) circuit block.

Claim 17 is cancelled

18. (Previously presented) The chip package of claim 11, wherein said solid layer further comprises a third region opposite to said second region, wherein said third region is between said first region



IPR2026-00067
TSMC EX1002 Page 397

and a second edge of said solid layer, wherein said plurality of copper posts in said plurality of through holes in said third region respectively.

19. (Previously presented) The chip package of claim 11, wherein said second region is a rectangle region and surrounding said first region.

20. (Previously presented) The chip package of claim 11, further comprising an electrical device under said second surface, wherein said electrical device comprise a third semiconductor chip and a metal wire connected to a third metal pad of said third semiconductor chip, wherein said third semiconductor chip is a DRAM chip.

21. (Previously presented) A chip package comprising:

a solid layer having a first surface and a second surface opposite to said first surface, wherein said solid layer comprises a compound of silicon and oxygen, wherein said solid layer has a thickness between 50 and 150 micrometers, wherein said solid layer comprises a first region and a second region between said first region and a first edge of said solid layer;

a plurality of copper posts in a plurality of through holes in said second region respectively;

a first interconnection scheme over said first surface, wherein said first interconnection scheme comprises first and second metal interconnects over said first surface, and a ~~first~~ polymer layer over said first and second metal interconnects, wherein said first metal interconnect is connected to a first copper post of said plurality of copper posts, wherein said first metal interconnect comprises a first metal layer and a first copper layer over said first metal layer;

a first semiconductor chip over said first interconnection scheme, wherein said first semiconductor chip comprises a third metal interconnect under a first metal pad of said first



IPR2026-00067
TSMC EX1002 Page 398

semiconductor chip, wherein said third metal interconnect comprises a second metal layer under said first metal pad and a second copper layer under said second metal layer, wherein said second copper layer has a thickness between 5 and 30 micrometers, wherein said first semiconductor chip is coupled to a second copper post of said plurality of copper posts through said third metal interconnect;

a second semiconductor chip over said first interconnection scheme, wherein said second semiconductor chip comprises a second metal pad coupled to said second metal interconnect;

a third semiconductor chip under said first interconnection scheme; and

a plurality of metal bumps under said second surface, wherein one of said plurality of metal bumps comprises a tin-containing layer.

22. (Previously presented) The chip package of claim 21, wherein said compound comprises a $SiO_2$ compound.

23. (Previously presented) The chip package of claim 21, wherein said solid layer further comprises a third region opposite to said second region, wherein said third region is between said first region and a second edge of said solid layer, wherein said plurality of copper posts in said plurality of through holes in said third region respectively.

24. (Previously presented) The chip package of claim 21, further comprising a fourth semiconductor chip over said first semiconductor chip, wherein said fourth semiconductor chip comprises a third metal pad at a bottom surface of said fourth semiconductor chip, wherein said first semiconductor chip further comprising a plurality of through-silicon-via metal layers and a fourth metal pad at a top surface of said first semiconductor chip, wherein said first metal pad is at a bottom surface of said



IPR2026-00067
TSMC EX1002 Page 399

first semiconductor chip, wherein said first metal pad is coupled to said fourth metal pad through one of said plurality of through-silicon-via metal layers, wherein said third metal pad is coupled to said fourth metal pad through a solder layer.

25. (Previously presented) The chip package of claim 21, wherein said first semiconductor chip is a graphics-processing-unit (GPU) chip.

26. (Currently amended) The chip package of claim 21, wherein said second semiconductor chip is a logic chip.

27. (Previously presented) The chip package of claim 21, wherein said first semiconductor chip is a logic chip.

28. (Previously presented) The chip package of claim 21, wherein said third semiconductor chip has a thickness between a backside surface of said third semiconductor chip and a top surface of said third semiconductor chip is smaller than a thickness of one of said plurality of metal bumps.

29. (Previously presented) The chip package of claim 21, further comprising another said first semiconductor chip over said first interconnection scheme.

30. (Previously presented) The chip package of claim 21, further comprising a fourth semiconductor chip under said first interconnection scheme, wherein said fourth semiconductor chip has a thickness between a backside surface of said fourth semiconductor chip and a top surface of said fourth semiconductor chip is smaller than a thickness of one of said plurality of metal bumps..



IPR2026-00067
TSMC EX1002 Page 400

31. (Previously presented) The chip package of claim 1, further comprising another said first semiconductor chip under said second surface.



IPR2026-00067
TSMC EX1002 Page 401

## REMARKS

The Examiner is thanked for the thorough examination of the present application and Notice of Allowance issued on Nov. 24, 2023. Upon entry of this amendment, Claims 1-31 are pending in the application, of which claims 1, 11 and 21 are the pending independent claims. Claims 5-6, 13 and 17 are cancelled. Claims 1, 3, 8, 11 and 21 have been amended under 37 CFR §1.312, complying with the provisions of 37 CFR §1.121, embodying merely the correction of formal matters in the claims without changing the scope thereof. Claims 1-4, 7-12, 14-16, 18-31 are now allowed in the present application. Applicants respectfully request entrance of the amendments under 37 CFR § 1.312 for at least the following reasons. No new matter has been introduced into the disclosure by the amendments.

**Amendments to the Claims**

In this paper, Claims 1, 3, 8, 11 and 21 have been amended to correct informalities and for disclosure consistency, complying with the provisions of 37 CFR §1.121(e), to correct inaccuracies of description and definition, and to secure substantial correspondence between the claims, the remainder of the specification, and the drawings.

In claims 1, 3 and 21, "a first polymer layer" was corrected and replaced with "a polymer layer "A) The amendment is needed to correct informalities in grammar. As the amendment corrects informalities, B) the amended claims require no additional search or examination and C) the amendment does not change the patentability of claim 11. D) The amendment was not presented earlier as it was only found following review after receiving the Notice of Allowance.



IPR2026-00067
TSMC EX1002 Page 402

In claim 3, “a first polymer is between” was corrected and replaced with “a polymer layer is between “A) The amendment is needed to correct informalities in grammar. As the amendment corrects informalities, B) the amended claims require no additional search or examination and C) the amendment does not change the patentability of claim 11. D) The amendment was not presented earlier as it was only found following review after receiving the Notice of Allowance.

In claims 1 and 8, added the words “first” and “second” to "tin-containing layer" A) The amendment is needed to correct informalities in grammar. As the amendment corrects informalities, B) the amended claims require no additional search or examination and C) the amendment does not change the patentability of claim 8. D) The amendment was not presented earlier as it was only found following review after receiving the Notice of Allowance.

In claim 11, “a first polymer layer” was corrected and replaced with “a polymer layer “, “a first metal bumps” was corrected and replaced with “a first metal bump“, “a second metal bumps” was corrected and replaced with “a second metal bump“ and added the words “first”, “second” and “third” to "tin-containing layer". A) The amendments are needed to correct informalities in grammar. As the amendment corrects informalities, B) the amended claims require no additional search or examination and C) the amendment does not change the patentability of claim 11. D) The amendment was not presented earlier as it was only found following review after receiving the Notice of Allowance.

In light of the above, Applicants respectfully request entrance of the amendments under 37 CFR §1.312 to Claims 1, 3, 8, 11 and 21.

In this paper, Claims 1, 3, 8, 11 and 21 are amended to correct informalities and for disclosure consistency, complying with the provisions of 37 CFR §1.121(e), to correct inaccuracies



IPR2026-00067
TSMC EX1002 Page 403

of description and definition, and to secure substantial correspondence between the claims, the remainder of the specification, and the drawings.

Thus, upon entry of these amendments, no claim has been canceled, no new claim has been added, and Claims 1, 3, 8, 11 and 21 have been amended under 37 CFR §1.312, complying with the provisions of 37 CFR §1.121, embodying merely the correction of formal matters in the claims without changing the scope thereof.

With respect to the claim amendments, Applicants would like to note that they have not dedicated to the public or abandoned any unclaimed subject matter and have not acquiesced to any rejections or objections by the Patent office. Applicants also expressly reserve the right to pursue prosecution on any presently excluded subject matter in one or more future continuation and/or divisional application(s).

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**CONCLUSION**

In view of the amendments herein, Applicants submit that the claims remain in condition for allowance and respectfully request amendment of the application in the manner identified above.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact the undersigned by phone (886-913-635-863) or email (semars3898@gmail.com).



IPR2026-00067
TSMC EX1002 Page 404

Respectfully submitted,



Date: __2023-11-26_____ Ping-Jung Yang

Email: semars3898@gmail.com



IPR2026-00067
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|---|---|
| Ping-Jung Yang | (Typed or printed name) |
| | (Signature) |
| Ping-Jung Yang | (Date) |

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 17/985,827 | 11/12/2022 | Ping-Jung Yang | Mars16-001-US-C03 | 1762 |

TITLE OF INVENTION: CHIP PACKAGE

| APPLN. TYPE | ENTITY STATUS | ISSUE FEE DUE | PUBLICATION FEE DUE | PREV. PAID ISSUE FEE | TOTAL FEE(S) DUE | DATE DUE |
|---|---|---|---|---|---|---|
| nonprovisional | SMALL | $480 | $0.00 | $0.00 | $480 | 02/26/2024 |

| EXAMINER | ART UNIT | CLASS-SUBCLASS |
|---|---|---|
| LIU, XIAOMING | 2812 | 257-091000 |

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(B) RESIDENCE: (CITY and STATE OR COUNTRY): HSINCHU CITY, TAIWAN

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Authorized Signature Ping-Jung Yang Date 2023-07-28

Typed or printed name Ping-Jung Yang Registration No. _____



PTOL-85 Part B (11/23) Approved for use through 03/31/2026 OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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| APPLICATION # | RECEIPT DATE / TIME | ATTORNEY DOCKET # |
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| **17/985,827** | **11/30/2023 11:00:51 AM Z ET** | **Mars16-001-US-C03** |

## Title of Invention

CHIP PACKAGE

## Application Information

| | | | |
|---|---|---|---|
| APPLICATION TYPE | Utility - Nonprovisional Application under 35 USC 111(a) | PATENT # | - |
| CONFIRMATION # | 1762 | FILED BY | Ping-Jung Yang |
| PATENT CENTER # | 63434128 | FILING DATE | 11/12/2022 |
| CUSTOMER # | 102851 | FIRST NAMED INVENTOR | Ping-Jung Yang |
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| DOCUMENT | PAGES | DESCRIPTION | SIZE (KB) |
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| Mars16-001-C03-issuefee-11282023.pdf | 1 | Issue Fee Payment (PTO-85B) | 114 KB |

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## Title of Invention

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## Application Information

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|---|---|---|---|
| APPLICATION TYPE | Utility - Nonprovisional Application under 35 USC 111(a) | PATENT # | - |
| CONFIRMATION # | 1762 | FILED BY | Ping-Jung Yang |
| PATENT CENTER # | 63449768 | AUTHORIZED BY | - |
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|---|---|---|---|
| APPLICATION TYPE | Utility - Nonprovisional Application under 35 USC 111(a) | PATENT # | - |
| CONFIRMATION # | 1762 | FILED BY | Ping-Jung Yang |
| PATENT CENTER # | 63449768 | FILING DATE | 11/12/2022 |
| CUSTOMER # | 102851 | FIRST NAMED INVENTOR | Ping-Jung Yang |
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CHIP PACKAGE

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| APPLICATION TYPE | Utility - Nonprovisional Application under 35 USC 111(a) | PATENT # | - |
| CONFIRMATION # | 1762 | FILED BY | Ping-Jung Yang |
| PATENT CENTER # | 63449804 | FILING DATE | 11/12/2022 |
| CUSTOMER # | 102851 | FIRST NAMED INVENTOR | Ping-Jung Yang |
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I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via the USPTO patent electronic filing system or by facsimile to (571) 273-2885, on the date below.

| | |
|---|---|
| Ping-Jung Yang | (Typed or printed name) |
| | (Signature) |
| Ping-Jung Yang | (Date) |

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 17/985,827 | 11/12/2022 | Ping-Jung Yang | Mars16-001-US-C03 | 1762 |

TITLE OF INVENTION: CHIP PACKAGE

| APPLN. TYPE | ENTITY STATUS | ISSUE FEE DUE | PUBLICATION FEE DUE | PREV. PAID ISSUE FEE | TOTAL FEE(S) DUE | DATE DUE |
|---|---|---|---|---|---|---|
| nonprovisional | SMALL | $480 | $0.00 | $0.00 | $480 | 02/26/2024 |

| EXAMINER | ART UNIT | CLASS-SUBCLASS |
|---|---|---|
| LIU, XIAOMING | 2812 | 257-091000 |

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/AIA/122 or PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Ping-Jung Yang

(B) RESIDENCE: (CITY and STATE OR COUNTRY): HSINCHU CITY, TAIWAN

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☒ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ☒ Issue Fee ❑ Publication Fee (if required)

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

☒ Electronic Payment via the USPTO patent electronic filing system ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

❑ Applicant asserting small entity status. See 37 CFR 1.27

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

❑ Applicant changing to regular undiscounted fee status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature Ping-Jung Yang Date 2023-07-28

Typed or printed name Ping-Jung Yang Registration No. _____



PTOL-85 Part B (11/23) Approved for use through 03/31/2026 OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

IPR2026-00067
TSMC EX1002 Page 415

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United States Patent and Trademark Office
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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 17/985,827 | 11/12/2022 | Ping-Jung Yang | Mars16-001-US-C03 | 1762 |

102851 7590 12/22/2023

PING-JUNG YANG
NO 2, NIOUPU SOUTH RD., SIANGSHAN DISTRICT
HSINCHU CITY, 30091
TAIWAN

| EXAMINER | |
|---|---|
| LIU, XIAOMING | |

| ART UNIT | PAPER NUMBER |
|---|---|
| 2812 | |

| MAIL DATE | DELIVERY MODE |
|---|---|
| 12/22/2023 | PAPER |

**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

| Response to Rule 312 Communication | Application No. | Applicant(s) | |
|---|---|---|---|
| | 17/985,827 | Yang, Ping-Jung | |
| | Examiner | Art Unit | AIA (FITF) Status |
| | XIAOMING LIU | 2812 | No |

***-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --***

1. ☑ The amendment filed on 27 November 2023 under 37 CFR 1.312 has been considered, and has been:
   a) ☑ entered.
   b) ☐ entered as directed to matters of form not affecting the scope of the invention.
   c) ☐ disapproved because the amendment was filed after the payment of the issue fee.
      Any amendment filed after the date the issue fee is paid must be accompanied by a petition under 37 CFR 1.313(c)(1) and the required fee to withdraw the application from issue.
   d) ☐ disapproved. See explanation below.
   e) ☐ entered in part. See explanation below.
   f) ☐ not entered because the supplemental or corrected Application Data sheet (ADS)
      ☐ was not accompanied by a petition to accept an unintentionally delayed claim under 37 CFR 1.55 or 27 CFR 1.78;
      ☐ did not identify the information being changed in accordance with 37 CFR 1.76(c)(2);
      ☐ was not properly signed in accordance with 37 CFR 1.76(e) (or 37 CFR 1.33(b) for applications filed prior to September 16, 2012).

/XIAOMING LIU/
Examiner, Art Unit 2812

OK TO ENTER: /X.L/

Docket No.: Mars-16-001-US-C03 **PATENT**

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

| | | |
|---|---|---|
| In re Application of | : | Customer Number: 102851 |
| Ping-Jung Yang | : | Confirmation Number: 1762 |
| Application No.: 17985827 | : | Group Art Unit: 2812 |
| Filed: Nov. 12, 2022 | : | Examiner: XIAOMING LIU |

For: CHIP PACKAGE

**AMENDMENT AFTER ALLOWANCE UNDER 37 CFR §1.312**

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

Pursuant to amendments after allowance under 37 CFR §1.312, Applicants hereby respectfully submit this paper and request to amend claim 1 of the above-identified application in the manner presented hereafter. The amendments embody merely the correction of formal matters in the claims without changing the scopes thereof.

**Amendments to the Claims** are reflected in the listing of claims which begins on page 2 of this paper.

**Remarks/Arguments** are beginning on page 11 of this paper.



IPR2026-00067
TSMC EX1002 Page 418

| INFORMATION DISCLOSURE STATEMENT BY APPLICANT ( Not for submission under 37 CFR 1.99) | | |
|---|---|---|
| | Application Number | |
| | Filing Date | |
| | First Named Inventor | Ping-Jung Yang |
| | Art Unit | |
| | Examiner Name | |
| | Attorney Docket Number | Mars16-001-US-C03 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 42 | 9147638 | | 2015-09-29 | Liu; Yueli et al. | |
| | 43 | 9385105 | | 2016-07-05 | Meyer; Thorsten et al. | |
| | 44 | 9627365 | | 2017-04-18 | Yu; Chen-Hua et al. | |
| Change(s) applied to document. /P.H./ 12/6/2023 | 45 | 8338238 | | 03/2012 ~~1212-12-25~~ | Hajime TOKUNAGA , Atsugi et al. | |
| | 46 | 9362187 | | 2016-06-07 | Ossimitz; Peter | |
| | 47 | 9593009 | | 2017-03-14 | Fuergut; Edward et al. | |
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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /X.L/

| INFORMATION DISCLOSURE STATEMENT BY APPLICANT ( Not for submission under 37 CFR 1.99) | | |
|---|---|---|
| | Application Number | |
| | Filing Date | |
| | First Named Inventor | Ping-Jung Yang |
| | Art Unit | |
| | Examiner Name | |
| | Attorney Docket Number | Mars16-001-US-C03 |

| | | | | | | |
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| | 47 | 20120193785 | | 2012-08-02 | Mou-Shiung Lin et al. | |
| | 48 | 20070263364 | | 2010-10-05 | Tadahiko Kawabe et al. | |
| | 49 | 20130303777 | | 2013-11-14 | Ken Okamoto et al. | |
| | 50 | 20120068271 | | 2012-12-25 | Hajime Tokunaga | |
| | 51 | 20110242050 | | 2011-10-06 | San-ho BYUN et al. | |
| | 52 | 20070045841 | | 2007-03-01 | Won ChoHo Kang | |
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Change(s) applied to document. /P.J.Y./ 12/6/2023

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

**FOREIGN PATENT DOCUMENTS** Remove

| Examiner Initial* | Cite No | Foreign Document Number[3] | Country Code[2] | Kind Code[4] | Publication Date | Name of Patentee or Applicant of cited Document | Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear | T[5] |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2012/0068271 | wo | | 2012-03-22 | Semiconductor Energy Laboratory Co., Ltd. | | |
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| INFORMATION DISCLOSURE STATEMENT BY APPLICANT ( Not for submission under 37 CFR 1.99) | | |
|---|---|---|
| | Application Number | |
| | Filing Date | |
| | First Named Inventor | Ping-Jung Yang |
| | Art Unit | |
| | Examiner Name | |
| | Attorney Docket Number | Mars16-001-US-C03 |

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| Change(s) applied to documen /P.H./ 12/6/2023 | 26 | 20110065250 | | 2011-03-17 | ~~Semiconductor Energy Laboratory Co., Ltd.~~ Tokunaga | |
| | 27 | 20130292846 | | 2013-11-07 | Lee; Seok-hyun et al. | |
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| INFORMATION DISCLOSURE STATEMENT BY APPLICANT ( Not for submission under 37 CFR 1.99) | | |
|---|---|---|
| | Application Number | |
| | Filing Date | |
| | First Named Inventor | Ping-Jung Yang |
| | Art Unit | |
| | Examiner Name | |
| | Attorney Docket Number | Mars16-001-US-C03 |

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If you wish to add additional U.S. Patent citation information please click the Add button. Add

**U.S.PATENT APPLICATION PUBLICATIONS** Remove

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|---|---|---|---|---|---|---|
| | 1 | 20020038725 | | 2002-04-04 | Suzuki et al. | |
| | 2 | 20020145197 | | 2002-10-10 | Ohta et al. | |



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| INFORMATION DISCLOSURE STATEMENT BY APPLICANT ( Not for submission under 37 CFR 1.99) | | |
|---|---|---|
| | Application Number | |
| | Filing Date | |
| | First Named Inventor | Ping-Jung Yang |
| | Art Unit | |
| | Examiner Name | |
| | Attorney Docket Number | Mars16-001-US-C03 |

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| APPLICATION NO. | ISSUE DATE | PATENT NO. | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 17/985,827 | 02/06/2024 | 11894306 | Mars16-001-US-C03 | 1762 |

102851 7590 01/17/2024

PING-JUNG YANG
NO 2, NIOUPU SOUTH RD., SIANGSHAN DISTRICT
HSINCHU CITY, 30091
TAIWAN

# ISSUE NOTIFICATION

The projected patent number and issue date are specified above. The patent will issue electronically. The electronically issued patent is the official patent grant pursuant to 35 U.S.C. § 153. The patent may be accessed on or after the issue date through Patent Center at https://patentcenter.uspto.gov/. The patent will be available in both the public and the private sides of Patent Center. Further assistance in electronically accessing the patent, or about Patent Center, is available by calling the Patent Electronic Business Center at 1-888-217-9197.

The USPTO is implementing electronic patent issuance with a transition period, during which period the USPTO will mail a ceremonial paper copy of the electronic patent grant to the correspondence address of record. Additional copies of the patent (i.e., certified and presentation copies) may be ordered for a fee from the USPTO's Certified Copy Center at https://certifiedcopycenter.uspto.gov/index.html. The Certified Copy Center may be reached at (800)972-6382.

**Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)**
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Center (https://patentcenter.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Patents Stakeholder Experience (OPSE), Stakeholder Support Division (SSD) at (571)-272-4200.

INVENTOR(s) (Please see PATENT CENTER site https://patentcenter.uspto.gov for additional inventors):

Ping-Jung Yang, Hsinchu City, TAIWAN;

APPLICANT(s) (Please see PATENT CENTER site https://patentcenter.uspto.gov for additional applicants):

Ping-Jung Yang, Hsin-Chu City, TAIWAN

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|---|---|---|---|---|
| 17/985,827 | 11/12/2022 | Ping-Jung Yang | Mars16-001-US-C03 | 1762 |

102851 7590 02/07/2024

PING-JUNG YANG
NO 2, NIOUPU SOUTH RD., SIANGSHAN DISTRICT
HSINCHU CITY, 30091
TAIWAN

| EXAMINER | |
|---|---|
| LIU, XIAOMING | |

| ART UNIT | PAPER NUMBER |
|---|---|
| 2812 | |

| MAIL DATE | DELIVERY MODE |
|---|---|
| 02/07/2024 | PAPER |

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The time period for reply, if any, is set in the attached communication.

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| APPLICATION NO. | ISSUE DATE | PATENT NO. |
|---|---|---|
| 17/985,827 | 06-Feb-2024 | 11894306 |

PING-JUNG YANG
NO 2, NIOUPU SOUTH RD., SIANGSHAN DISTRICT
HSINCHU CITY, 30091
TAIWAN

# EGRANT NOTIFICATION

Your electronic patent grant (eGrant) is now available, which can be accessed via Patent Center at https://patentcenter.uspto.gov

The electronic patent grant is the official patent grant under 35 U.S.C. 153. For more information, please visit https://www.uspto.gov/electronicgrants



IPR2026-00067
TSMC EX1002 Page 427

# PATENT ASSIGNMENT COVER SHEET

Electronic Version v1.1
Stylesheet Version v1.2

Assignment ID: PATI718284

| | |
|---|---|
| **SUBMISSION TYPE:** | NEW ASSIGNMENT |
| **NATURE OF CONVEYANCE:** | ASSIGNMENT |
| **SEQUENCE:** | 1 |

**CONVEYING PARTY DATA**

| Name | Execution Date |
|---|---|
| Mr. Ping-Jung Yang | 12/26/2024 |

**RECEIVING PARTY DATA**

| | |
|---|---|
| **Company Name:** | MYW SEMITECH, LLC |
| **Street Address:** | 8 The Green, #21147 |
| **City:** | Dover |
| **State/Country:** | DELAWARE |
| **Postal Code:** | 19901 |

**PROPERTY NUMBERS Total: 12**

| Property Type | Number |
|---|---|
| **Application Number:** | 61705649 |
| **Application Number:** | 62219249 |
| **Application Number:** | 14036256 |
| **Application Number:** | 15261956 |
| **Application Number:** | 15476999 |
| **Application Number:** | 16139040 |
| **Application Number:** | 16752650 |
| **Application Number:** | 17372459 |
| **Application Number:** | 17985827 |
| **Application Number:** | 18524118 |
| **Application Number:** | 18778983 |
| **Application Number:** | 19001689 |

**CORRESPONDENCE DATA**

**Fax Number:**

***Correspondence will be sent to the e-mail address first; if that is unsuccessful, it will be sent using a fax number, if provided; if that is unsuccessful, it will be sent via US Mail.***

**Phone:** 0913635863
**Email:** semars3898@gmail.com
**Correspondent Name:** Mr. Ping-Jung Yang
**Address Line 1:** No.52, Ln. 97, Shengjun Rd.

| | |
|---|---|
| **Address Line 4:** | Hsinchu City, TAIWAN 300 |
| **ATTORNEY DOCKET NUMBER:** | Mars Patents assignment |
| **NAME OF SUBMITTER:** | Ping-Jung Yang |
| **SIGNATURE:** | Ping-Jung Yang |
| **DATE SIGNED:** | 12/27/2024 |
| | This document serves as an Oath/Declaration (37 CFR 1.63). |

**Total Attachments: 4**
source=Assignment-MYW SEMITECH LLC-signed-12262024#page1.tiff
source=Assignment-MYW SEMITECH LLC-signed-12262024#page2.tiff
source=Assignment-MYW SEMITECH LLC-signed-12262024#page3.tiff
source=Assignment-MYW SEMITECH LLC-signed-12262024#page4.tiff

**ASSIGNMENT OF PATENT RIGHTS**

For good and valuable consideration, the receipt of which is hereby acknowledged, **PING-JUNG YANG**, a citizen of Taiwan, residing in No. 52, Ln. 97, Shengjun Rd., North Dist., Hsinchu City, Taiwan (***"Assignor"***), does hereby assign, transfer, and convey unto **MYW SEMITECH, LLC.**, a Delaware corporation with an address at 8 The Green, #21147, Dover, DE 19901 USA (***"Assignee"***), or its designees all right, title, and interest that exist today and may exist in the future in and to all of the following (collectively, the ***"Patent Rights"***):

(a) the provisional patent applications, patent applications and patents listed in the table below (the "***Patents***");

(b) all patents and patent applications (i) to which any of the Patents directly or indirectly claims priority, (ii) for which any of the Patents directly or indirectly forms a basis for priority, and/or (iii) that were co-owned applications that directly or indirectly incorporate by reference the Patents;

(c) all reissues, reexaminations, extensions, continuations, continuations in part, continuing prosecution applications, requests for continuing examinations, divisions, registrations of any item in any of the foregoing categories (a) and (b);

(d) all foreign patents, patent applications, and counterparts relating to any item in any of the foregoing categories (a) through (c), including, without limitation, certificates of invention, utility models, industrial design protection, design patent protection, and other governmental grants or issuances;

(e) all items in any of the foregoing in categories (b) through (d), whether or not expressly listed as Patents below and whether or not claims in any of the foregoing have been rejected, withdrawn, cancelled, or the like;

(f) all inventions, invention disclosures, and discoveries described in any item in any of the foregoing categories (a) through (e) that (i) are included in any claim in the Patents and/or any item in the foregoing categories (b) through (e), (ii) are subject matter capable of being reduced to a patent claim in a reissue or reexamination proceedings brought on any of the Patents and/or any item in the foregoing categories (b) through (e), and/or (iii) could have been included as a claim in any of the Patents and/or any item in the foregoing categories (b) through (e);

(g) all rights to apply in any or all countries of the world for patents, certificates of invention, utility models, industrial design protections, design patent protections, or other governmental grants or issuances of any type related to any item in any of the foregoing categories (a) through (f), including, without limitation, under the Paris Convention for the

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(h) all causes of action (whether known or unknown or whether currently pending, filed, or otherwise) and other enforcement rights under, or on account of, any of the Patents and/or any item in any of the foregoing categories (b) through (g), including, without limitation, all causes of action and other enforcement rights for

(i) damages,
(ii) injunctive relief, and
(iii) any other remedies of any kind

for past, current, and future infringement; and

(i) all rights to collect royalties and other payments under or on account of any of the Patents and/or any item in any of the foregoing categories (b) through (h).

| No. | Appl. No. | Filing Date | No. | Appl. No. | Filing Date |
|---|---|---|---|---|---|
| 1 | 61/705649 | 09-26-2012 | 7 | 16/752650 | 01-26-2020 |
| 2 | 62/219249 | 09-16-2015 | 8 | 17/372459 | 07-11-2021 |
| 3 | 14/036256 | 09-25-2013 | 9 | 17/985827 | 11-12-2022 |
| 4 | 15/261956 | 09-11-2016 | 10 | 18/524118 | 11-30-2023 |
| 5 | 15/476999 | 04-01-2017 | 11 | 18/778983 | 07-21-2024 |
| 6 | 16/139040 | 09-23-2018 | 12 | 19/001689 | 12-26-2024 |

Assignor represents, warrants and covenants that:

(1) Assignor has the full power and authority, and has obtained all third party consents, approvals and/or other authorizations required to enter into this Agreement and to carry out its obligations hereunder, including the assignment of the Patent Rights to Assignee; and

(2) Assignor owns, and by this document assigns to Assignee, all right, title, and interest to the Patent Rights, including, without limitation, all right, title, and interest to sue for infringement of the Patent Rights. Assignor has obtained and properly recorded previously executed assignments for the Patent Rights as necessary to fully perfect its rights and title

therein in accordance with governing law and regulations in each respective jurisdiction. The Patent Rights are free and clear of all liens, claims, mortgages, security interests or other encumbrances, and restrictions. There are no actions, suits, investigations, claims or proceedings threatened, pending or in progress relating in any way to the Patent Rights. There are no existing contracts, agreements, options, commitments, proposals, bids, offers, or rights with, to, or in any person to acquire any of the Patent Rights.

Assignor hereby authorizes the respective patent office or governmental agency in each jurisdiction to issue any and all patents, certificates of invention, utility models or other governmental grants or issuances that may be granted upon any of the Patent Rights in the name of Assignee, as the assignee to the entire interest therein.

Assignor will do all things necessary, proper, or advisable, including without limitation, the execution, acknowledgment, and recordation of specific assignments, oaths, declarations, and other documents on a country-by-country basis, to assist Assignee in obtaining, perfecting, sustaining, and/or enforcing the Patent Rights. Such assistance will include providing, and obtaining from the respective inventors, prompt production of pertinent facts and documents, giving of testimony, execution of petitions, oaths, powers of attorney, specifications, declarations or other papers, and other assistance reasonably necessary for filing patent applications, complying with any duty of disclosure, and conducting prosecution, reexamination, reissue, interference or other priority proceedings, opposition proceedings, cancellation proceedings, public use proceedings, infringement or other court actions and the like with respect to the Patent Rights.

The terms and conditions of this Assignment of Patent Rights will inure to the benefit of Assignee, its successors, assigns, and other legal representatives and will be binding upon Assignor, its successors, assigns, and other legal representatives.

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IN WITNESS WHEREOF this Assignment of Patent Rights is executed at _____ on _____.

**ASSIGNOR**

By: Ping-Jung Yang Dec. 26. 2024

Name: PING-JUNG YANG

Title: Inventor