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(54) Title: SUBSTRATE HOLDER TO REDUCE SUBSTRATE EDGE STRESS DURING CHEMICAL MECHANICAL POLISHING

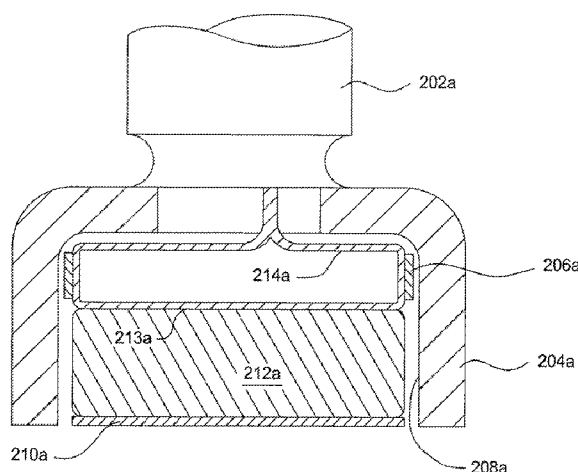


FIG. 2A

(57) Abstract: Embodiments of the present invention generally relate to methods for chemical mechanical polishing a substrate. The methods generally include coupling a first substrate to be polished to a dummy substrate, and removing a portion of the backside of the first substrate to reduce the thickness of the first substrate. The first substrate and the dummy substrate are positioned in a carrier head assembly comprising an inflatable membrane and a support ring. The first substrate is placed in contact with a polishing pad to reduce the surface roughness of the backside of the first substrate. The support ring restricts lateral movement of the inflatable membrane to prevent the first substrate from contacting an interior surface of the carrier head assembly. The support ring is sized to allow vertical movement of the inflatable membrane within the carrier head assembly.



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SUBSTRATE HOLDER TO REDUCE SUBSTRATE EDGE STRESS DURING CHEMICAL MECHANICAL POLISHING

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] Embodiments of the present invention generally relate to a method for chemical mechanical polishing (CMP) of a substrate and an apparatus for practicing the method.

Description of the Related Art

[0002] Vias have been used in semiconductor fabrication to provide electrical coupling between one or more layers of conductive material within a semiconductor device. More recently, through-silicon vias (TSV) have arisen as an alternative method to conventional wire bonding. Through-silicon vias allow for shorter interconnects by forming an interconnect in the z-axis. The interconnect is created through a substrate by forming a via extending from a front surface to a back surface of the substrate. After creating the interconnects in the z-axis, multiple substrates can then be stacked on top of one another, and electrically coupled through the vertically extending interconnect. TSV substrates may provide a means for reducing the footprint of substrates in semiconductor applications.

[0003] Therefore, there is a need in the art for methods and apparatus for processing substrates useful in TSV applications.

SUMMARY OF THE INVENTION

[0004] Embodiments of the present invention generally relate to methods for chemical mechanical polishing a substrate. The methods generally include coupling a first substrate to be polished to a dummy substrate, and removing a portion of the backside of the first substrate to reduce the thickness of the first substrate. The first substrate and the dummy substrate are positioned in a carrier head assembly comprising an inflatable membrane and a support ring. The first substrate is placed

in contact with a polishing pad to reduce the surface roughness of the backside of the first substrate. The support ring restricts lateral movement of the inflatable membrane to prevent the first substrate from contacting an interior surface of the carrier head assembly. The support ring is sized to allow vertical movement of the inflatable membrane within the carrier head assembly.

[0005] In one embodiment, a method includes coupling a first substrate to a second substrate. The first substrate has a first surface in contact with the second substrate, and the first surface is opposite a second surface. The second substrate and the first substrate are positioned in a carrier head assembly. The carrier head assembly comprises an inflatable membrane in contact with the second substrate, and a support ring disposed circumferentially around the inflatable membrane. The second surface of the first substrate is contacted with a polishing pad to reduce the surface roughness of the second surface of the first substrate.

[0006] In another embodiment, a method includes coupling a first surface of a first substrate to a second substrate. The second substrate and the first substrate are positioned in a carrier head assembly. The carrier head assembly comprises an inflatable membrane in contact with the second substrate, and a support ring disposed circumferentially around the inflatable membrane and the second substrate. The inflatable membrane comprises a textured surface. The support ring is positioned to reduce lateral movement of the inflatable membrane and the second substrate such that the first substrate does not contact an interior surface of the carrier head assembly during polishing. A second surface of the first substrate is contacted with a polishing pad to reduce the surface roughness of the second surface of the first substrate.

[0007] In another embodiment, a method includes coupling a first surface of a first substrate to a second substrate using an epoxy. The first surface of the first substrate is opposite a second surface, and the first surface has a device feature formed thereon. The second substrate and the first substrate are positioned in a carrier head assembly. The carrier head assembly comprises an inflatable membrane in contact with the second substrate, and a support ring disposed circumferentially around the inflatable membrane and the second substrate. The

support ring is sized to restrict substantially all lateral movement of the inflatable membrane, but allow the inflatable membrane to travel in a vertical direction. The first substrate is contacted with a polishing pad to reduce a surface roughness of the second surface of the first substrate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] So that the manner in which the above recited features of the present invention can be understood in detail, a more particular description of the invention, briefly summarized above, may be had by reference to embodiments, some of which are illustrated in the appended drawings. It is to be noted, however, that the appended drawings illustrate only typical embodiments of this invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

[0009] Figure 1 is a schematic sectional view of one embodiment of a polishing station that includes a carrier head.

[0010] Figures 2A and 2B are schematic sectional views of carrier head assemblies for use in substrate processing.

[0011] Figure 3A is a schematic perspective view of one embodiment of a membrane support structure for use in a polishing head membrane.

[0012] Figures 3B and 3C are schematic views of textured surfaces of membranes for use in a polishing head.

[0013] Figures 4A and 4B are schematic sectional views of carrier head assemblies.

[0014] To facilitate understanding, identical reference numerals have been used, where possible, to designate identical elements that are common to the figures. It is contemplated that elements disclosed in one embodiment may be beneficially utilized on other embodiments without specific recitation.

DETAILED DESCRIPTION

[0015] Embodiments of the present invention generally relate to methods for chemical mechanical polishing a substrate. The methods generally include coupling a first substrate to be polished to a dummy substrate, and removing a portion of the backside of the first substrate to reduce the thickness of the first substrate. The first substrate and the dummy substrate are positioned in a carrier head assembly comprising an inflatable membrane and a support ring. The first substrate is placed in contact with a polishing pad to reduce the surface roughness of the backside of the first substrate. The support ring restricts lateral movement of the inflatable membrane to prevent the first substrate from contacting an interior surface of the carrier head assembly. The support ring is sized to allow vertical movement of the inflatable membrane within the carrier head assembly.

[0016] Embodiments of the present invention are beneficial for processing substrates useful for through-silicon via applications. Suitable apparatus for performing chemical mechanical polishing on substrates are the REFLEXION LK™ and the REFLEXION GT CMP systems available from Applied Materials, Inc. of Santa Clara, California. It is contemplated that other commercially available chemical mechanical polishing systems can advantageously utilize embodiments disclosed herein.

[0017] Figure 1 is a partial sectional view of one embodiment of a polishing station 100 that includes a carrier head body 104. The polishing station 100 includes the carrier head assembly 102 and a platen assembly 120. A first substrate 110 and a second substrate 112 are disposed in the carrier head assembly 102 during polishing. The carrier head assembly 102 generally retains a first substrate 110 against a polishing pad assembly 130 disposed on the platen assembly 120. At least one of a carrier head assembly 102 or platen assembly 120 is rotated or otherwise moved to provide relative motion between the first substrate 110 and the polishing pad assembly 130. In the embodiment depicted in Figure 1, the carrier head assembly 102 is coupled to an actuator or motor 150 that provides at least rotational motion to the substrate 110 about axis 118. The motor 150 may also

oscillate the carrier head assembly 102, such that the substrate 110 is moved laterally back and forth across the surface 132 of the polishing pad assembly 130.

[0018] The polishing pad assembly 130 may comprise a conventional material such as a foamed polymer disposed on the platen assembly 120 as a pad. In one embodiment, the conventional polishing material is foamed polyurethane. In one embodiment, the pad is an IC1010 polyurethane pad, available from Rodel Inc., of Newark, Delaware. IC1010 polyurethane pads typically have a thickness of about 2.05 mm and a compressibility of about 2%. Other pads that can be used include IC1000 pads with and without an additional compressible bottom layer underneath the IC1000 pad, IC1010 pads with an additional compressible bottom layer underneath the IC1010 pad, and polishing pads available from other manufacturers. The compositions described herein are placed on the pad to contribute to the chemical mechanical polishing of a substrate.

[0019] In one embodiment, the carrier head assembly 102 includes a carrier head body 104 defining a substrate receiving pocket. The substrate receiving pocket allows a first substrate 110 and a second substrate 112 to be disposed therein. A membrane 114 is disposed in the substrate receiving pocket and may be evacuated to chuck a second substrate 112 to the carrier head assembly 102, and pressurized to control the downward force of a first substrate 110 when pressed against the polishing pad assembly 130. The membrane 114 is circumferentially encompassed by support ring 106. In one embodiment, the carrier head may be a multi-zone carrier head. One suitable carrier head assembly 102 is a TITAN HEAD™ carrier head available from Applied Materials, Inc., located in Santa Clara, California.

[0020] The platen assembly 120 is supported on a base 154 by bearings 156 that facilitate rotation of the platen assembly 120 about axis 117. A motor 158 is coupled to the platen assembly 120 and rotates the platen assembly 120 such that the polishing pad assembly 130 is moved relative to the carrier head assembly 102.

[0021] The combined slurry/rinse arm assembly or fluid delivery arm assembly 140 is utilized to deliver slurry from a slurry supply 161 through tube 163 to a surface

132 of the polishing pad assembly 130. In an alternative embodiment, the rinse fluid and the processing fluid may be provided to the polishing pad assembly 130 through separate delivery arm assemblies. In the embodiment depicted in Figure 1, the fluid delivery arm assembly 140 includes an arm 142 extending from a stanchion 144. A motor 146 is provided to control the rotation of the arm 142 about a center line of the stanchion 144. An adjustment mechanism 147 may be provided to control the elevation of a distal end 148 of the arm 142 relative to the working surface of the polishing pad assembly 130. The adjustment mechanism 147 may be an actuator coupled to at least one of the arm 142 or the stanchion 144 for controlling the elevation of the distal end 148 of the arm 142 relative to the platen assembly 120.

[0022] The fluid delivery arm assembly 140 may include a plurality of rinse outlet ports 160 arranged to uniformly deliver a spray and/or stream of rinsing fluid to the surface of the polishing pad assembly 130. The ports 160 are coupled by a tube 162 routed through the fluid delivery arm assembly 140 to a rinsing fluid supply 164. In one embodiment, the fluid delivery arm may have between 12 and 15 ports. The rinsing fluid supply 164 provides a rinsing fluid to the polishing pad assembly 130 before, during, and/or after polishing the phase change alloy containing substrate and/or after the substrate 110 is removed to clean the polishing pad assembly 130. The polishing pad assembly 130 may also be cleaned using fluid from the ports 160 after conditioning the pad using a conditioning element, such as a diamond disk or brush (not shown). The polishing station 100 can also include a pad conditioner apparatus (not shown) to maintain the condition of the polishing pad assembly 130 so that it will effectively polish the first substrate 110. The pad conditioner may be coupled to arm 142, or may be coupled to a separate arm (not shown).

[0023] The nozzle assembly 166 is disposed at the distal end of the arm 142. The nozzle assembly 166 is coupled to the slurry supply 161 by a tube 168 routed through the fluid delivery arm assembly 140. Slurry supply 161 may generally supply any processing fluid. The processing fluid supply may be a polishing slurry or polishing abrasive. The nozzle assembly 166 includes a nozzle 170 that may be selectively adjusted relative to the arm, such that the fluid exiting the nozzle 170 may be selectively directed to a specific area of the polishing pad assembly 130.

[0024] In one embodiment, the nozzle 170 is configured to generate a spray of slurry. In another embodiment, the nozzle 170 is adapted to provide a stream of slurry. In another embodiment, the nozzle 170 is configured to provide a stream and/or spray of slurry at a rate between about 200 to about 500 ml/second to the polishing surface.

[0025] In the embodiment depicted in Figure 1, a first substrate 110 may be a substrate used in through-silicon via applications. The first substrate 110 typically has a thickness of about 100 microns or less. Because the substrate is thin and flexible, the first substrate 110 is coupled to a second substrate 112 for support. The second substrate may have a thickness of about two inches. If a device feature is formed on a surface of the first substrate 110, then first substrate 110 and second substrate 112 are coupled together such that the device feature is positioned between the two substrates, e.g., the surface of the first substrate 110 having the device feature formed thereon is oriented towards the second substrate 112. Orienting the substrate in this manner protects the device feature formed on the first substrate 110 during subsequent processes.

[0026] When coupling the first substrate 110 and the second substrate 112, the two substrates may be fixedly coupled by epoxy, or any other suitable material that does not have an adverse effect on the substrates. The second substrate 112 is generally a glass dummy substrate or a sacrificial substrate. After coupling the first substrate 110 and the second substrate 112, but prior to chemical mechanical polishing the first substrate 110, a portion of the first substrate 110 may be removed. The thickness of the first substrate 110 may be reduced using mechanical grinding, or etching. The reduced thickness of the first substrate 110 allows for use in TSV and stacked chip applications. Generally, the first substrate has an initial thickness approximately equal to the second substrate prior to the reduction in thickness. The process used for reducing the thickness of the first substrate 110 typically leaves a rough surface on the backside of the first substrate. To reduce the surface roughness on the backside of the first substrate 110, chemical mechanical polishing may be used. The reduced thickness of the first substrate 110 leaves the substrate flexible and fragile. Therefore, the first substrate 110 is coupled to a second

substrate 112 as an additional means of support during grinding and polishing of the first substrate 110.

[0027] Figure 2A is a schematic sectional view of a polishing head assembly for use in substrate processing. The polishing head assembly has a carrier head body 204a defining a substrate receiving pocket. The substrate receiving pocket is adapted to contain a first substrate 210a and second substrate 212a during a chemical mechanical polishing process.

[0028] A membrane 214a is disposed within the substrate receiving pocket. The membrane 214a may be a flexible elastic membrane. In one embodiment, the membrane 214a may be high strength silicone rubber. A surface 213a of membrane 214a generally is textured to increase the friction between the membrane 214a and a second substrate 212a. The friction provided by the textured surface 213a prevents the second substrate 212a, or the first substrate 210a coupled thereto, from moving or sliding with respect to the membrane 214a when placed in the substrate receiving pocket of the carrier head body 204a. If the second substrate 212a moves or slides with respect to membrane 214a, the first substrate 210a may come into contact with the carrier head body 204a. As previously mentioned, the first substrate 210a is thin and flexible, and can break easily. If the first substrate 210a comes into contact with the carrier head body 204a, the outer edge of the first substrate 210a is subjected to increased stress which may cause the substrate to chip, crack, fracture or break.

[0029] A support ring 206a is disposed circumferentially around the membrane 214a. The purpose of the support ring is to allow for vertical movement of the membrane 214a, while restricting horizontal movement of the membrane 214a within the carrier head assembly 202a. Additionally, the support ring 206a provides lateral support and stiffness to the membrane 214a, allowing the membrane 214a to retain its shape and not over-flex in the horizontal direction. The membrane 214a is formed of a flexible material, and may permit the first substrate 210a to come into contact with the inner sidewall 208a of the carrier head body 204a during polishing if sufficient support is not provided. For example, the first substrate 210a may come

into contact with the carrier head body 204a as a result of a rocking motion applied to the carrier head assembly 202a.

[0030] The support ring 206a may be formed of an elastic material and clamped to the membrane 214a. The distance between support ring 206a and the inner sidewall 208a of the carrier head body 204a is preferably just enough to allow the membrane 214a to float in a vertical direction, but have substantially no vertical movement. For example, the distance between the support ring 206a and the carrier head body 204a may be about ten-thousandths of an inch when the membrane is centered in the carrier head assembly 202a. In another embodiment, the support ring internal diameter is reduced, and a membrane clamp is not used to secure the support ring 206a to the membrane 214a. Therefore, when pressure is applied on the membrane, the membrane expands and further reduces the gap between the membrane 214a and the sidewall 208a. Furthermore, this expansion also increases the rigidity or stiffness of the membrane, allowing the first substrate 210a and the second substrate 212a to stay substantially centered in the carrier head body 204a.

[0031] By having the support ring 206a substantially the same outer diameter as the inner diameter of the carrier head body, the movement of the membrane is restricted in the horizontal direction. This restriction in the horizontal direction is useful for protecting the first substrate 210a in instances where the first substrate is adhered to the second substrate 212a off-center. For example, if the first substrate 210a is coupled to the second substrate 212a such that a portion of the first substrate 210a extends past or protrudes beyond the outer diameter of the second substrate 212a, it would be possible in some instances that the first substrate 210a would contact the carrier head body 204a. However, if the support ring 206a prohibits substantially all of the horizontal movement of the membrane and the first and second substrates frictionally held thereby, then there is less likelihood that the first substrate 210a will contact the carrier head body 204a. A support ring of increased thickness, *e.g.*, one having an outside diameter substantially the same or slightly less than the interior diameter of the carrier head body 204a, assists in protecting the edges of the first substrate 210a. The combination of increased

support ring thickness to restrict lateral movement of the membrane 214a, and the increased friction of surface 213a to maintain the second substrate in the appropriate position reduces the edge-stress applied to the first substrate 210a.

[0032] Additionally, the inner sidewall 208a of carrier head body 204a is substantially planar. For example, the inner sidewall 208a of the carrier head body 204a may consist essentially of a substantially planar surface. It is preferable to not have any grooves to facilitate fluid flow, or any other deformations in the sidewall 208a. When grooves are present, it may be possible that the first substrate 210a or the second substrate 212a may contact this groove. This may cause an unevenly worn spot to form where the first or second substrate occasionally contacts the groove. Additionally, if the first substrate 210a contacts the groove, it may cause the first substrate to chip or crack. Since the membrane 214a is permitted to move in a vertical direction, it is possible that the first substrate 210a could rub on the sidewall 208a until the groove is contacted, damaging the first substrate 210a.

[0033] Figure 2B is a schematic sectional view of carrier head assembly for use in substrate processing. In the embodiment of Figure 2B, a carrier head assembly 202b has a carrier head body 204b defining a substrate receiving pocket. A membrane 214b is disposed in the substrate receiving pocket. The membrane has a textured surface 213b with a relatively high coefficient of friction. The textured surface 214b is placed in contact with a second substrate 212b, which is coupled to a first substrate 210b. The textured surface 213b of membrane 214b prevents the second substrate 212b from moving relative to the membrane 214b once placed in contact with the membrane 214b.

[0034] A support ring 206b is placed circumferentially around and in contact with the membrane 214b and the second substrate 212b. Although the support ring 206b in Figure 2B is shown as extending along most of the sidewall of the second substrate 212b, it is not necessary for the support ring to be in contact with substantially all of the sidewall of the second substrate 212b. For example, the support ring 206b may be in contact with at least about 25 percent, at least about 50 percent, or at least about 75 percent of the sidewall of the second substrate 212b.

[0035] The support ring 206b may be clamped to the membrane 214b, and allow for the second substrate to be inserted therein for polishing. The extended support ring as shown in Figure 2B is additionally used to hold the second substrate in the appropriate position with respect to the membrane 214b. For example, the support ring 206b may hold the second substrate 212b in the center of membrane 214b. Both the textured surface 213b and the support ring 206b may be used to prevent the first substrate 210b from contacting the inner sidewall 208b of the carrier head body 204b.

[0036] Figure 3A is a schematic perspective view of one embodiment of a membrane support structure for use in a polishing head membrane. The membrane support structure comprises a plurality of concentric circles 315a-d. A membrane (not shown) adapted to be inflated, for example a bladder, may surround the concentric circles. The concentric circles 315a-d provide additional rigidity to reduce lateral movement of the membrane during chemical mechanical polishing. The concentric circles 315a-d are typically formed from the same material as the membrane, and may be coupled to an interior surface of the membrane to reduce movement within the membrane. Additionally, the concentric circles 315a-d may have holes therethrough (not shown) for allowing spaces between the concentric circles 315a-d to be pressurized to inflate and hold a substrate against a polishing pad, or vacuum evacuated to chuck a substrate to a carrier head. The concentric circles 315a-d aid in preventing the membrane from deforming or skewing due to the rocking motion applied during chemical mechanical polishing. If the membrane skews, any substrates being polished may come into contact with the sidewall of a polishing head, thereby damaging the substrate.

[0037] Figures 3B and 3C are schematic views of textured surfaces of membranes for use in a polishing head. In Figure 3B, the texture is provided by a set of grooves 316a-c that extend radially from near the center of the surface of the membrane 314b. The grooves can be radially symmetric, or they could form a cross-hatch pattern, or they could be random. In the embodiment of Figure 3B, three grooves are shown. However, the number, size, and location of the grooves may vary depending on the particular application. In the embodiment of Figure 3C,

the texture is provided by bumps 319c that project from a surface of membrane 314c. The bumps can form a pattern, or be randomly formed on the surface of the membrane 314c. For example, the bumps 319c may form concentric circles, a spiral, or may be formed into regions. In the embodiment of Figure 3C, the bumps radiate from the center of the surface of membrane 314c in straight lines. However, other variations are possible as long as bumps provide sufficient texture. Additionally, the bumps 319c can have a uniform concentration across the surface of membrane 314c, or the bumps 319c can have regions of different concentration. The bumps 319c can have a uniform height, or the bumps can have different heights.

[0038] Figure 4A is a schematic sectional view of carrier head assembly 400a. The membrane 414a disposed in carrier head body 404a lacks both sufficient rigidity and interior concentric circles for support. Therefore, the membrane 414a adopts a skewed shape in the carrier head body 404a when the first substrate 410a is subjected to a chemical mechanical polishing process. Because the membrane 414a skews, the first substrate 410a is permitted to come into contact with the sidewall 408a of carrier head body 404a. This contact increases the stress on the edge of the first substrate 410a leading to cracking, chipping, or breaking. It should be noted that an appropriately sized support ring 406a could be used to increase rigidity and reduce flexing of the membrane 414a.

[0039] Additionally, substrate 410a is permitted to come into contact with the inner sidewall 408a of carrier head body 404a because the second substrate 412a is permitted to move in relation to membrane 414a. The second substrate 412a can slide or move in relation to the membrane 414a when there is not sufficient friction between the second substrate 412a or the membrane surface 415a. Also, the membrane 414a has a wide range of lateral movement due to the relatively small size of the support ring 406a, which allows for a large gap between support ring 406a and the inner sidewall 408a of the carrier head body 404a. The wide range of horizontal movement allows the first substrate 410a to contact the inner sidewall 408a. This can be especially problematic in instances where the first substrate 410a

is off-centered from the second substrate 410b, and/or where the second substrate 412a is off-centered from the membrane 414a.

[0040] Figure 4B is a schematic sectional view of carrier head assembly 400b. The membrane 414b has sufficient rigidity such that membrane 414b does not skew or horizontally flex during a chemical mechanical polishing process. However, membrane 414b is still permitted to move in a vertical direction, which may be influenced or controlled by the amount of pressure in the membrane 414b. The support ring 406b has sufficient thickness such that the first substrate 410b and the second substrate 412b cannot contact the inner sidewall 408b of the carrier head body 404b. Additionally, the membrane surface 415b has sufficient texturing and a sufficiently high coefficient of friction such that the second substrate 412b does not move with respect to the membrane 414b during polishing. The texturing of membrane surface 415b in combination with the rigidity of membrane 414b and the support ring 406b prevent the first substrate from contacting the carrier head body 404b.

[0041] Embodiments described herein provide methods and apparatus for chemical mechanical polishing of thin, flexible, or fragile substrates. By restricting the movement of the inflatable membrane within the carrier head, fragile substrates are not permitted to contact the carrier head, and are therefore not subjected to increased edge stress which may break the substrates. Also, a properly sized support ring assists in preventing the first substrate from contacting the carrier head when the first substrate is adhered to the second substrate off-center. Additionally, the textured surface of the inflatable membrane assists in preventing the second substrate in contact therewith from sliding off center and contacting the carrier head. By reducing the contact between the first substrate and the carrier head, the amount of damage or stress subjected upon the first substrate can be reduced. This results in a higher overall yield and higher quality substrates by minimizing damage thereto.

[0042] While the foregoing is directed to embodiments of the present invention, other and further embodiments of the invention may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.

Claims:

1. A method, comprising:
 - coupling a first substrate to a second substrate, the first substrate having a first surface in contact with the second substrate and a second surface opposite the first surface;
 - positioning the second substrate and the first substrate in a carrier head assembly, the carrier head assembly comprising:
 - an inflatable membrane in contact with the second substrate; and
 - a support ring disposed circumferentially around the inflatable membrane; and
 - contacting the second surface of the first substrate to a polishing pad to reduce the surface roughness of the second surface of the first substrate.
2. The method of claim 1, wherein the support ring is sized to restrict substantially all lateral movement of the inflatable membrane, but allow the inflatable membrane to travel in a vertical direction.
3. The method of claim 1, wherein the average distance between the support ring and an interior surface of the carrier head assembly is less than about ten-thousandths of an inch.
4. The method of claim 3, wherein the interior surface of the carrier head assembly consists essentially of a planar surface.
5. The method of claim 4, wherein the first substrate is coupled to the second substrate using an epoxy.
6. The method of claim 5, wherein the first substrate comprises a through-silicon via, and a device feature formed on the first surface.

7. The method of claim 6, further comprising removing a portion of the second surface of the first substrate to decrease the thickness of the first substrate prior to the contacting the second surface of the first substrate to a polishing pad.
8. A method, comprising:
coupling a first surface of a first substrate to a second substrate;
positioning the second substrate and the first substrate in a carrier head assembly, the carrier head assembly comprising:
an inflatable membrane in contact with the second substrate, the inflatable membrane comprising a textured surface; and
a support ring disposed circumferentially around the inflatable membrane and the second substrate, the support ring positioned to reduce lateral movement of the inflatable membrane and the second substrate such that the first substrate does not contact an interior surface of the carrier head assembly during polishing; and
contacting a second surface of the first substrate to a polishing pad to reduce the surface roughness of the second surface of the first substrate.
9. The method of claim 8, wherein there is substantially no lateral movement of the inflatable membrane in the carrier head.
10. The method of claim 9, wherein the average distance between the support ring and an interior surface of the carrier head assembly is less than about ten-thousandths of an inch, and wherein the interior surface of the carrier head assembly consists essentially of a planar surface.
11. The method of claim 10, further comprising removing a portion of the second surface of the first substrate to decrease the thickness of the first substrate prior to the contacting a second surface of the first substrate to a polishing pad.

12. The method of claim 11, wherein first substrate is coupled to the second substrate using an epoxy, and wherein the support ring contacts at least about 25 percent of the sidewall of the second substrate.

13. The method of claim 12, wherein the support ring contacts at least about 50 percent of the sidewall of the second substrate.

14. A method, comprising:

- coupling a first surface of a first substrate to a second substrate using an epoxy, the first surface of the first substrate opposite a second surface, the first surface having a device feature formed thereon;

- positioning the second substrate and the first substrate in a carrier head assembly, the carrier head assembly comprising:

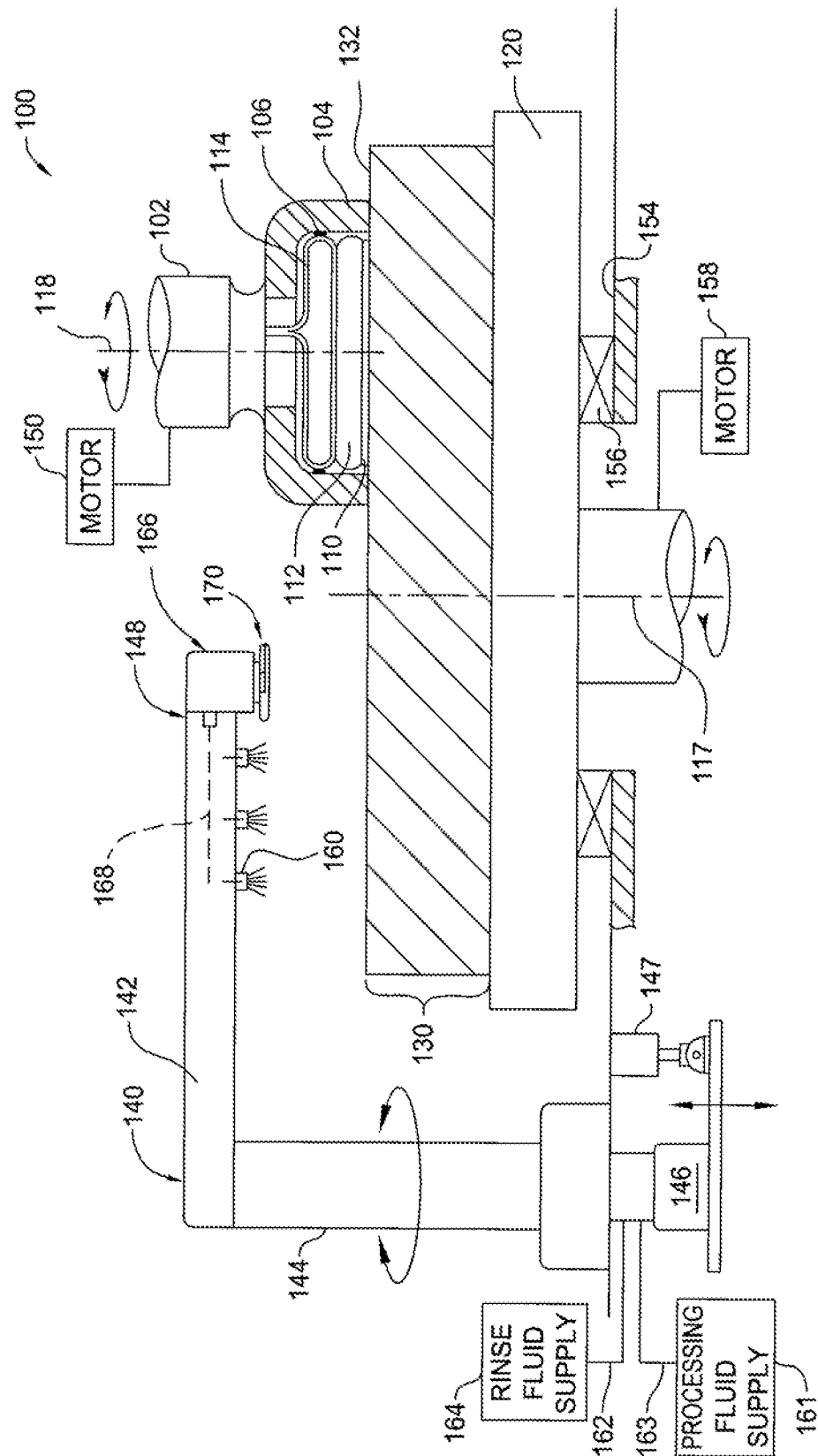
- an inflatable membrane in contact with the second substrate; and

- a support ring disposed circumferentially around the inflatable membrane and the second substrate, the support ring sized to restrict substantially all lateral movement of the inflatable membrane, but allow the inflatable membrane to travel in a vertical direction; and

- contacting the first substrate to a polishing pad to reduce a surface roughness of the second surface of the first substrate.

15. The method of claim 14, wherein the support ring contacts at least about 25 percent of the sidewall of the second substrate, and wherein the inflatable membrane comprises a textured surface in contact with the second substrate.

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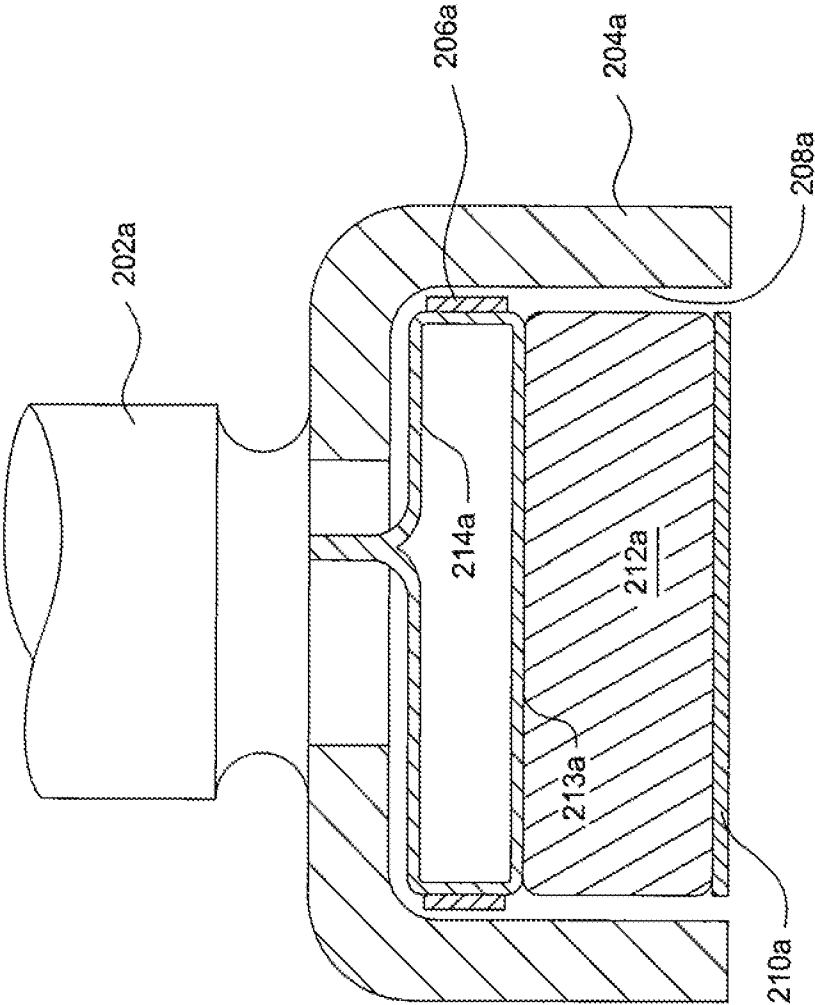


FIG. 2A

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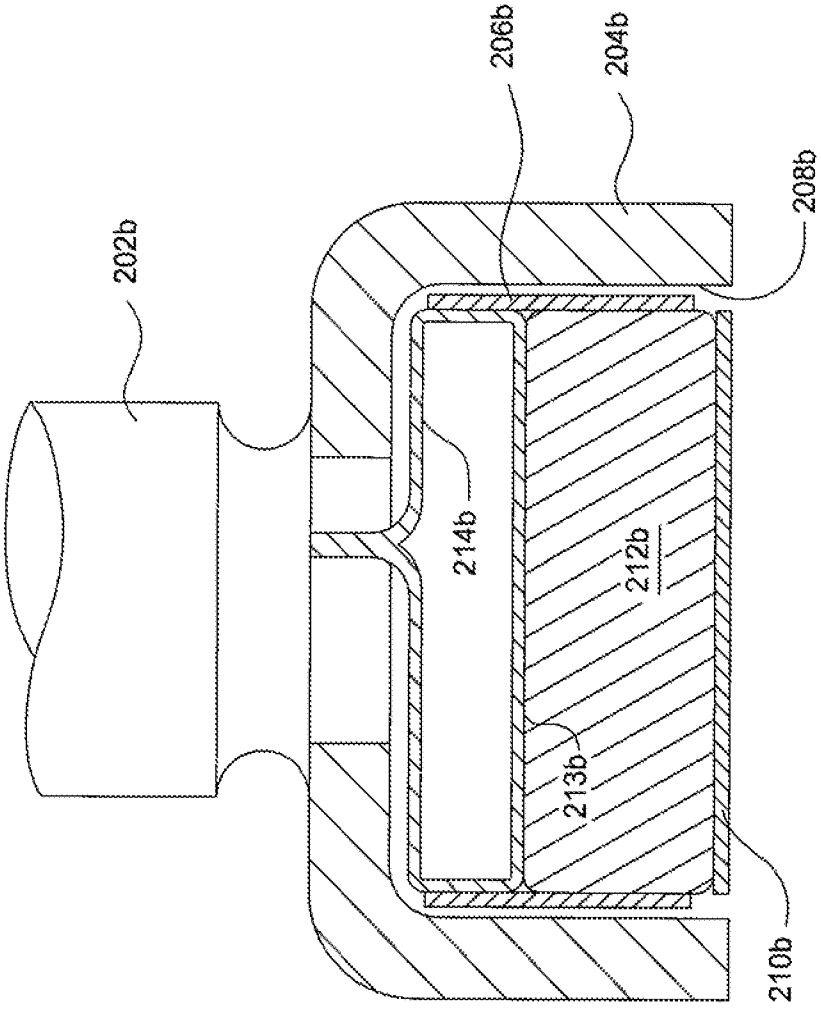


FIG. 2B

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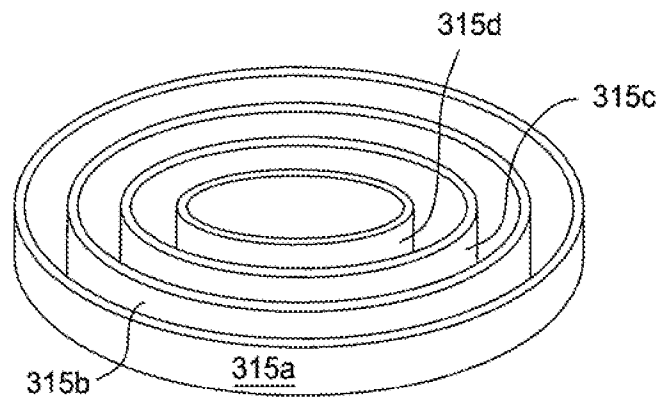


FIG. 3A

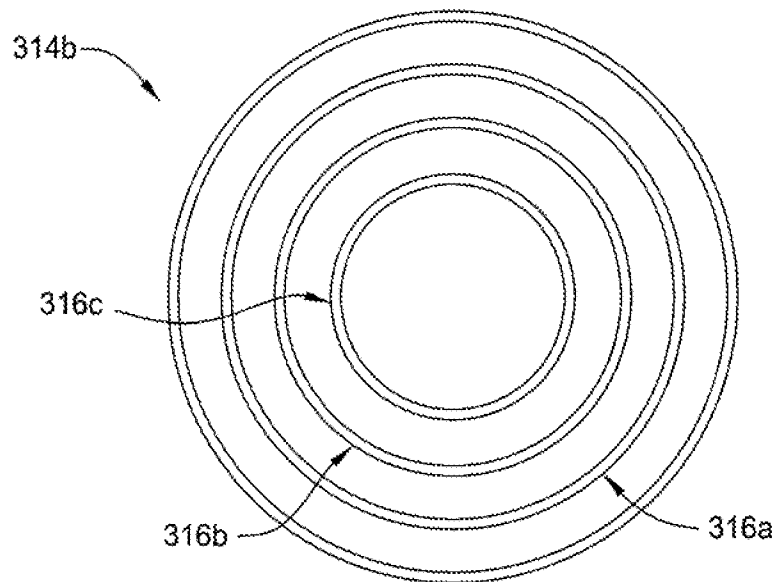


FIG. 3B

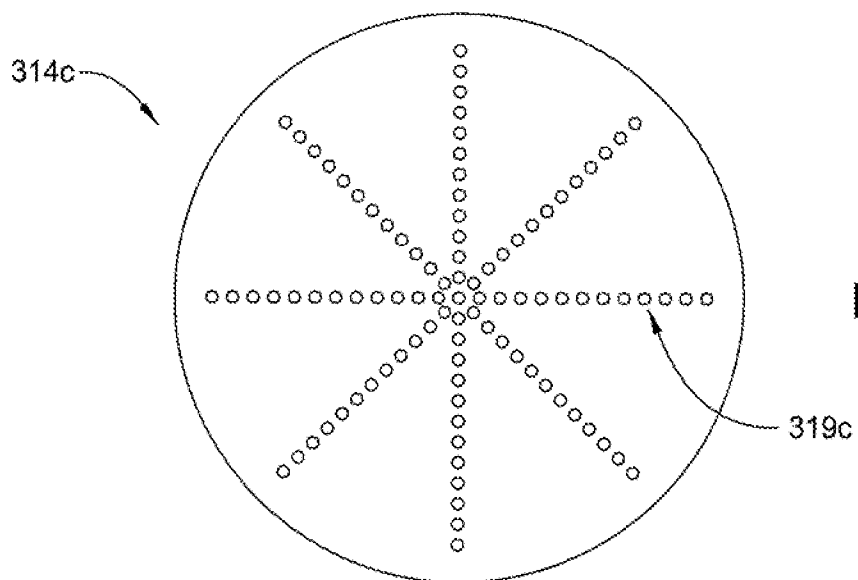


FIG. 3C

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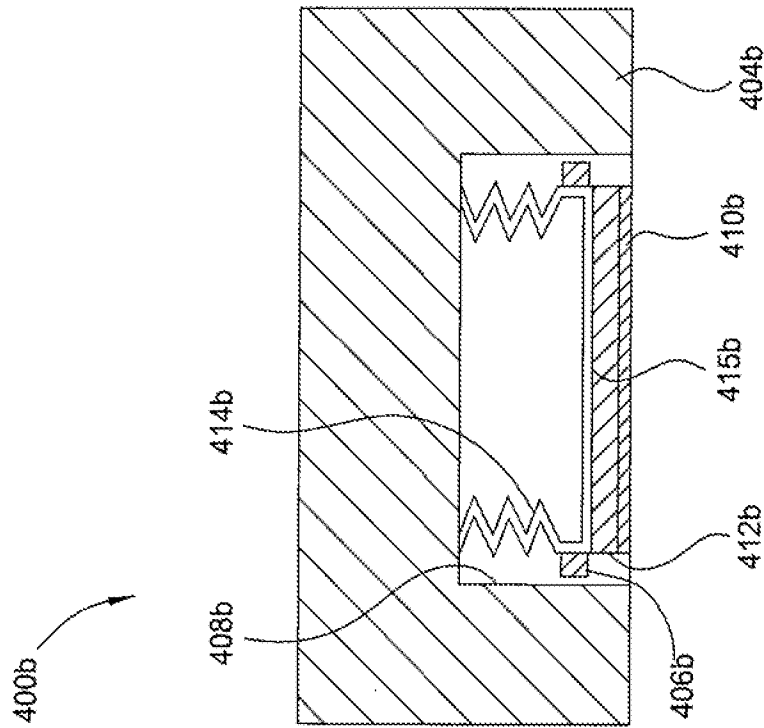


FIG. 4B

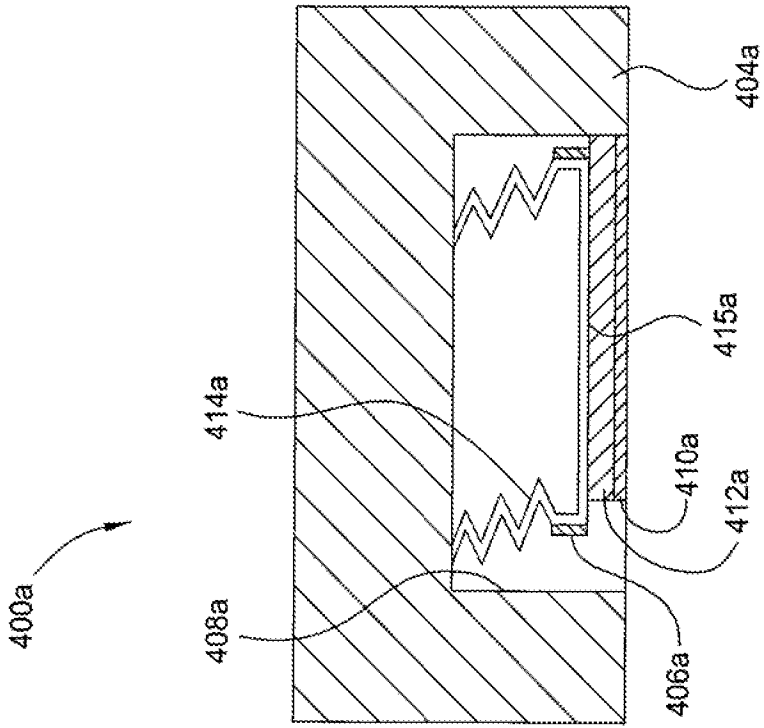


FIG. 4A