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(54) WAFER BACKSIDE ELECTRICAL CONTACT FOR ELECTROCHEMICAL DEPOSITION AND ELECTROCHEMICAL MECHANICAL POLISHING

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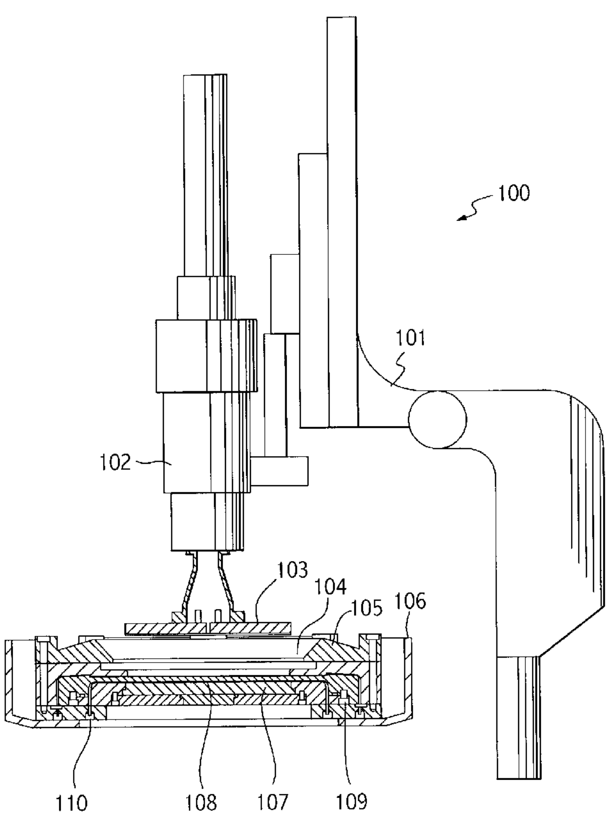
(57) **ABSTRACT**

A method and apparatus for electrochemically plating on a production surface of a substrate are provided. The apparatus generally includes a plating cell having a plating solution reservoir configured to contain a volume of an electrochemical plating solution, and a substrate support member positioned above the plating solution reservoir, the substrate support member being configured to electrically engage a non-production side of a substrate secured thereto. The substrate support member generally includes a substrate support surface having at least one vacuum channel formed therein, a plurality of electrical contact pins extending from the substrate support surface and being positioned to engage a perimeter of the non-production side of the substrate secured thereto, and at least one annular seal positioned on the substrate support surface radially outward of the plurality of electrical contact pins, the at least one annular seal being configured to prevent flow of the electrochemical plating solution to the plurality of electrical contact pins. The plating cell further includes a power supply in electrical communication with an anode positioned in the electrochemical plating solution and the plurality of electrical contact pins.



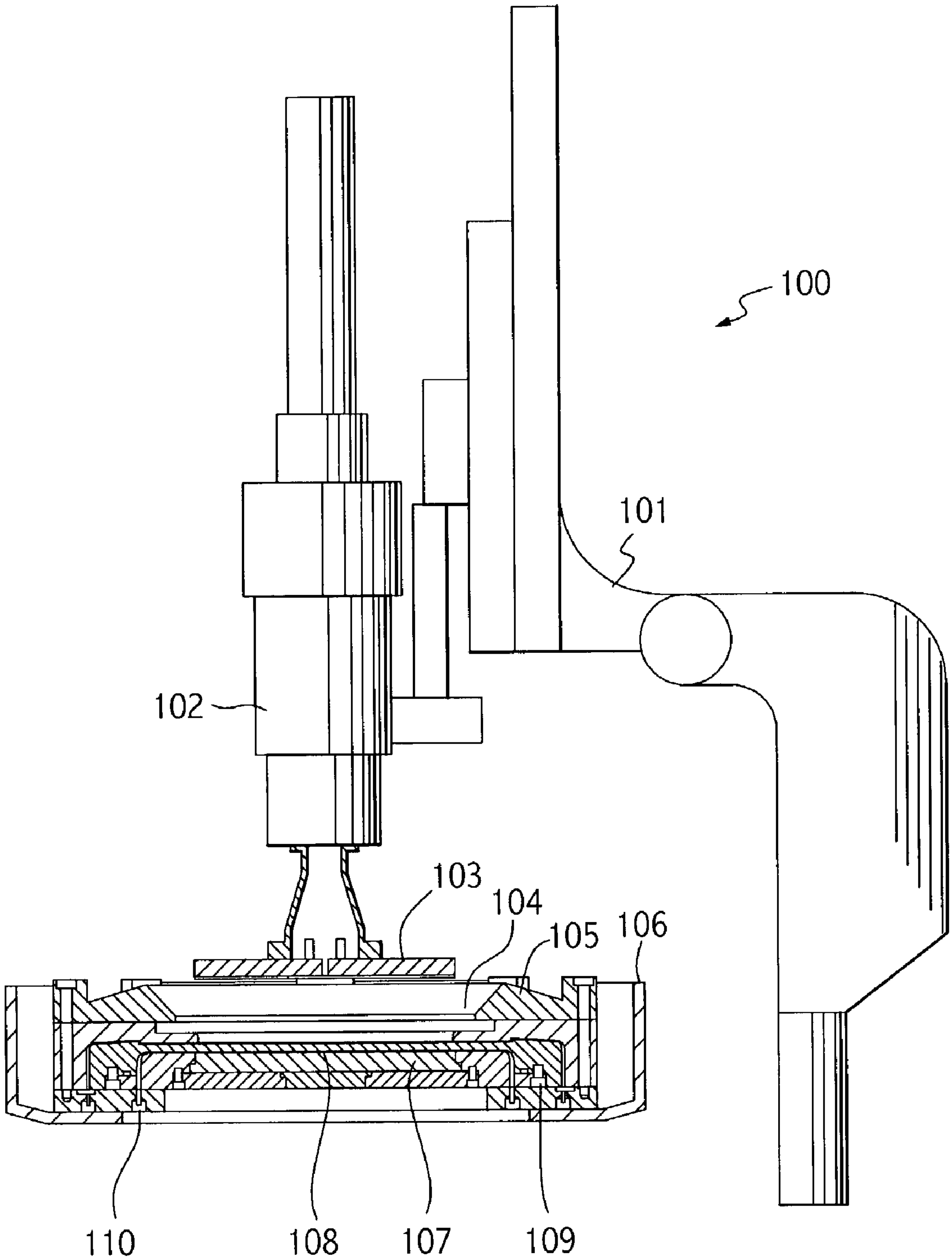


FIG. 1

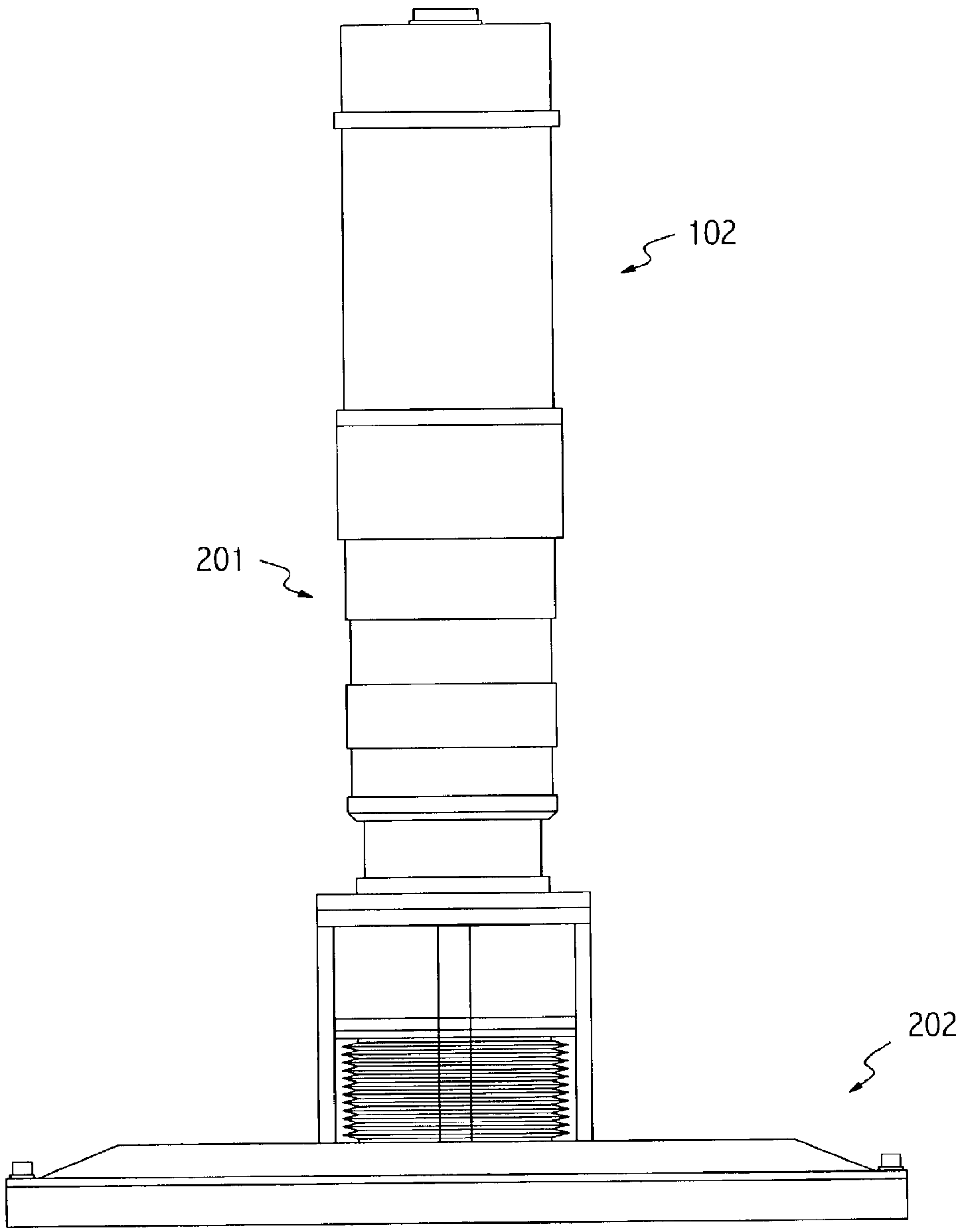


FIG. 2

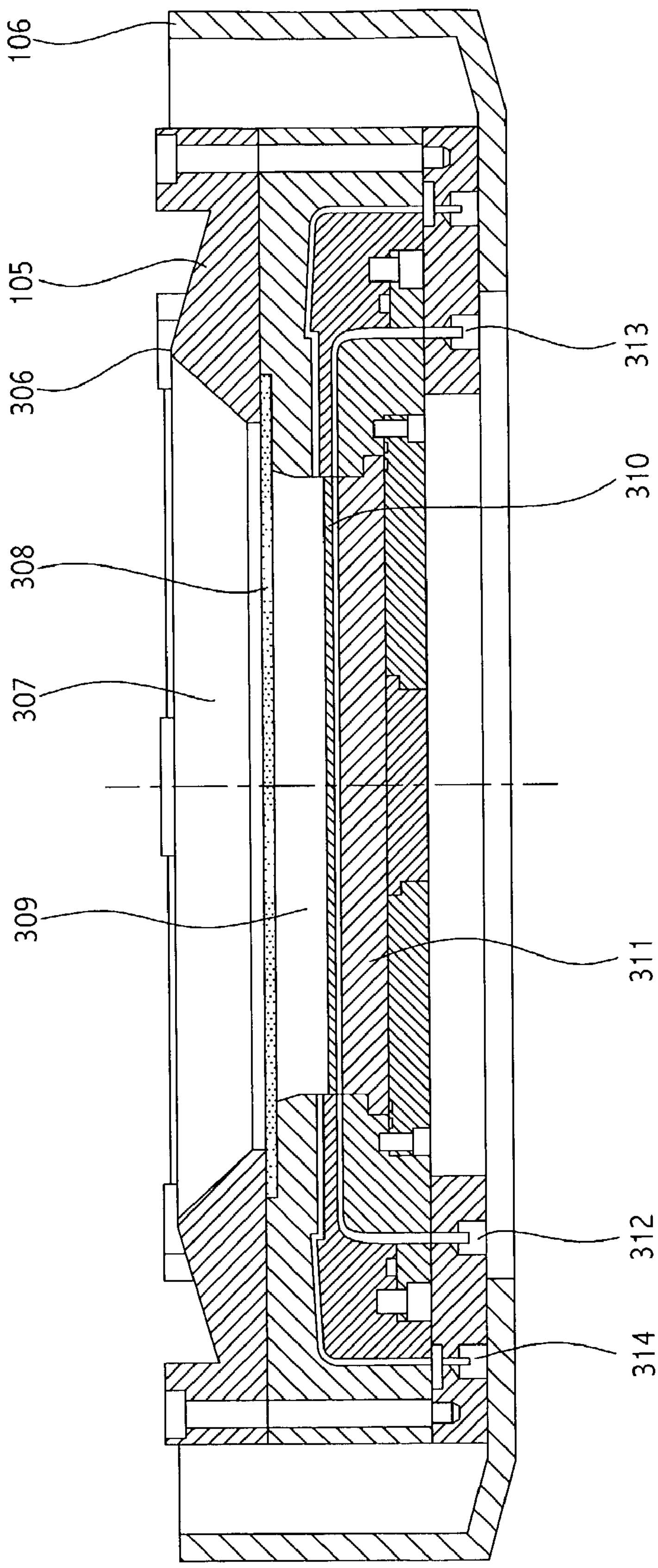


FIG. 3

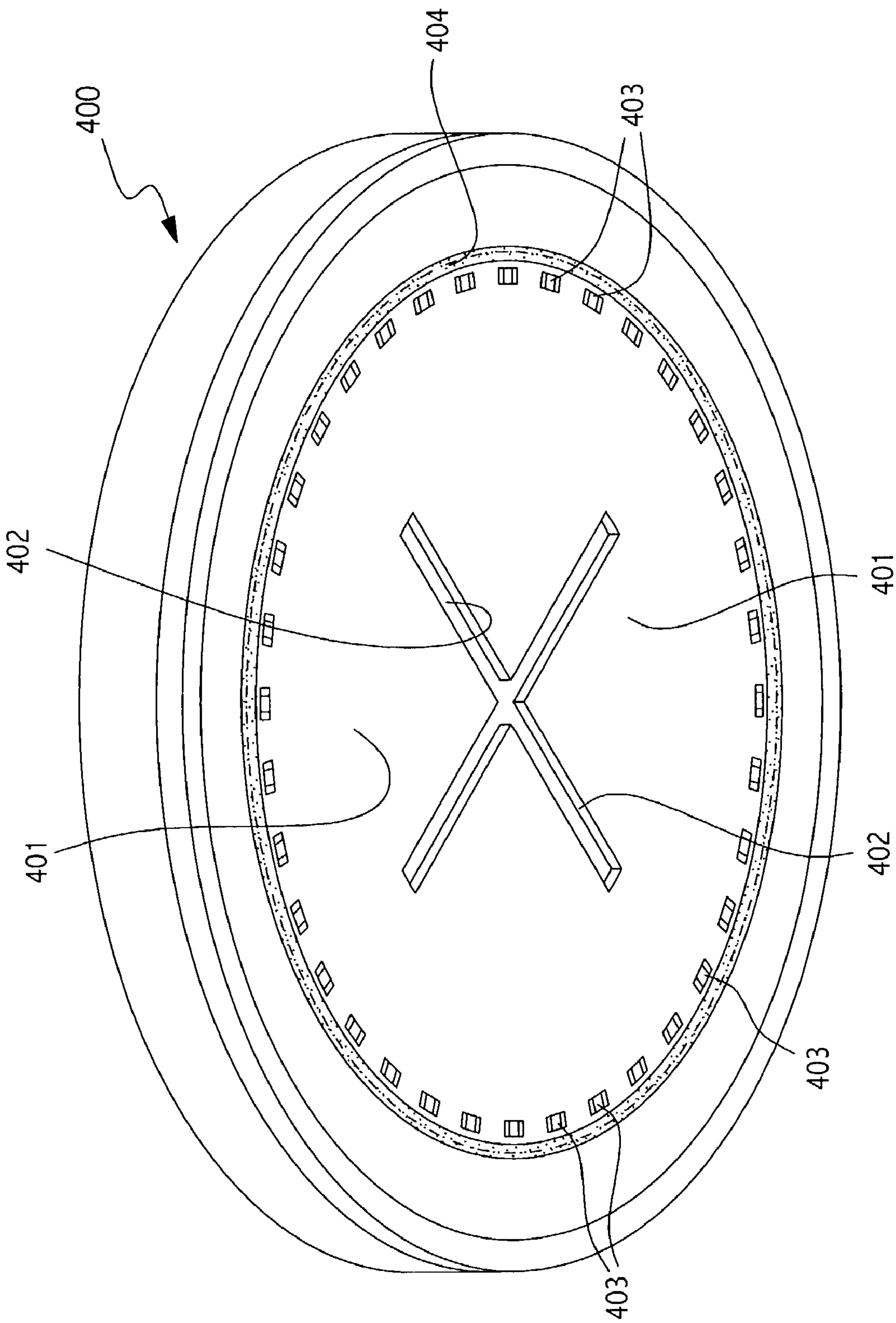


FIG. 4

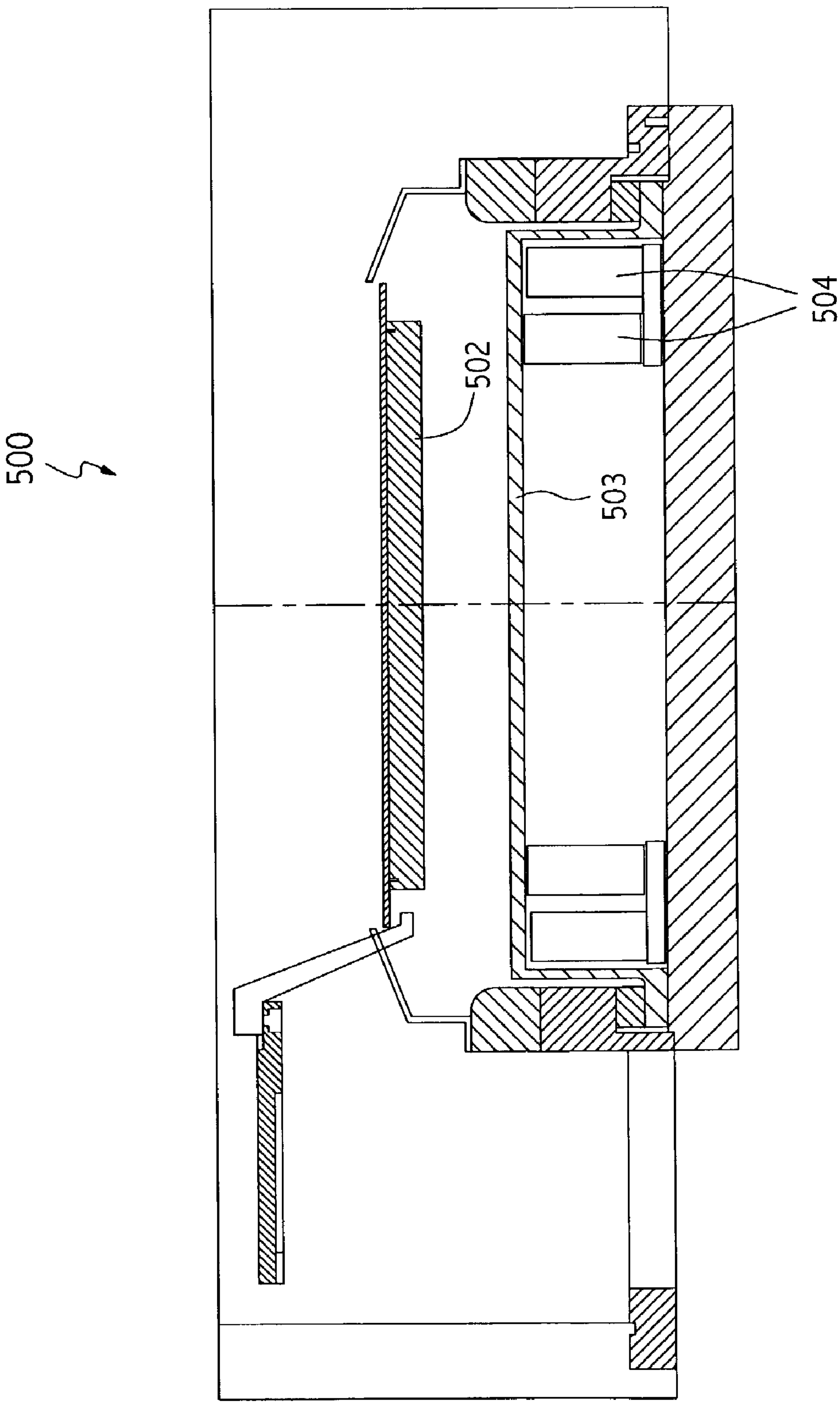


FIG. 5

WAFER BACKSIDE ELECTRICAL CONTACT FOR ELECTROCHEMICAL DEPOSITION AND ELECTROCHEMICAL MECHANICAL POLISHING

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] Embodiments of the invention generally relate to an electrochemical plating system configured to electrically contact a back side surface of a substrate being plated on a front side.

[0003] 2. Description of the Related Art

[0004] Metallization of sub-quarter micron sized features is a foundational technology for present and future generations of integrated circuit manufacturing processes. More particularly, in devices such as ultra large scale integration-type devices, i.e., devices having integrated circuits with more than a million logic gates, the multilevel interconnects that lie at the heart of these devices are generally formed by filling high aspect ratio (greater than about 4:1, for example) interconnect features with a conductive material, such as copper or aluminum, for example. Conventionally, deposition techniques such as chemical vapor deposition (CVD) and physical vapor deposition (PVD) have been used to fill these interconnect features. However, as the interconnect sizes decrease and aspect ratios increase, void-free interconnect feature fill via conventional metallization techniques becomes increasingly difficult. As a result thereof, plating techniques, such as electrochemical plating (ECP) and electroless plating, for example, have emerged as promising processes for void free filling of sub-quarter micron sized high aspect ratio interconnect features in integrated circuit manufacturing processes.

[0005] In an ECP process, for example, sub-quarter micron sized high aspect ratio features formed into the surface of a substrate (or a layer deposited thereon) may be efficiently filled with a conductive material, such as copper, for example. ECP plating processes are generally two stage processes, wherein a seed layer is first formed over the surface features of the substrate, and then the surface features of the substrate are exposed to an electrolyte solution, while an electrical bias is simultaneously applied between the substrate and a copper anode positioned within the electrolyte solution. The electrolyte solution is generally rich in ions to be plated onto the surface of the substrate, and therefore, the application of the electrical bias causes these ions to be urged out of the electrolyte solution and to be plated onto the seed layer.

[0006] Conventional ECP systems generally utilize a cathode contact ring to electrically contact the production surface (the surface being plated or the front side of the substrate) during plating operations. However, one challenge associated with front or production side contact-type plating systems is that the combination of the electrical contacts and the associated seals utilized in these configurations generally takes up several millimeters, generally between about 3 and about 7 millimeters, of the perimeter surface area of the production surface of the substrate. Since this surface area is used to make electrical and seal contacts, the area cannot be used to support device formation. Further, several modern semiconductor processing techniques rely upon low k materials, which are easily damaged, i.e., cracked, via physical contact. As such, when these low k layers are deposited on a substrate and plated over, the electrical contact with the surface has been shown to crack and/or otherwise damage the low k material layer.

[0007] Therefore, there is a need for an apparatus for electrochemically plating substrates, wherein the apparatus minimizes or eliminates contact with the production surfaces of the substrates being plated.

SUMMARY OF THE INVENTION

[0008] Embodiments of the invention generally provide an electrochemical plating cell configured to electrically contact the backside of a substrate being plated. The plating cell generally includes a plating solution reservoir configured to contain a volume of an electrochemical plating solution, and a substrate support member positioned above the plating solution reservoir, the substrate support member being configured to electrically engage a non-production side of a substrate secured thereto. The substrate support member generally includes a substrate support surface having at least one vacuum channel formed therein, a plurality of electrical contact pins extending from the substrate support surface and being positioned to engage a perimeter of the non-production side of the substrate secured thereto, and at least one annular seal positioned on the substrate support surface radially outward of the plurality of electrical contact pins, the at least one annular seal being configured to prevent flow of the electrochemical plating solution to the plurality of electrical contact pins. The plating cell further includes a power supply in electrical communication with an anode positioned in the electrochemical plating solution and the plurality of electrical contact pins.

[0009] Embodiments of the invention further provide an apparatus for electrochemically plating metal onto a substrate, wherein the apparatus includes a substrate support member having a substrate support surface formed thereon, the substrate support member being configured vacuum chuck a non-production side of the substrate to the substrate support surface and electrically engage non-production side of the substrate. The apparatus further includes a plating bath positioned below the substrate support member, the plating bath being configured to contain an electrochemical plating solution and an anode therein. Further, the apparatus includes a head assembly in mechanical communication with the substrate support member, the head assembly being configured actuate the substrate support member in at least one of horizontally, vertically, pivotally, and rotationally.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] So that the manner in which the above recited features of the present invention are attained and can be understood in detail, a more particular description of the invention, briefly summarized above, may be had by reference to the embodiments thereof 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.

[0011] **FIG. 1** illustrates a general partial perspective and sectional view of an exemplary plating cell of the invention.

[0012] FIG. 2 illustrates a perspective view of an exemplary head assembly of the invention.

[0013] FIG. 3 illustrates a detailed sectional view of an exemplary plating cell of the invention.

[0014] FIG. 4 is a perspective view of an exemplary substrate support member of the invention.

[0015] FIG. 5 is a general sectional view of an exemplary deposition chamber configured to deposit the backside conductive layer of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0016] Embodiments of the invention generally provide an electrochemical plating cell configured to electrically contact a back side surface of a substrate being plated. The electrochemical plating cell of the invention generally utilizes a vacuum chuck-type substrate holder configured to secure a substrate thereto with the back side of the substrate (the non-production side of the substrate) being in contact with the vacuum chuck and the production side (the side of the substrate being plated) being exposed to an electrolyte solution. In this configuration, the production surface of the substrate is free of physical contact from the plating cell hardware, i.e., electrical contacts, seals, or other contact devices that may be used to secure the substrate to the substrate support member. The lower surface of the vacuum chuck-type substrate support member is configured to electrically contact the backside of the substrate being chucked thereto via a plurality of electrical contact pins extending outwardly from the lower surface of the vacuum chuck. The plurality of pins are generally configured to physically contact the backside of the substrate secured to the substrate support member. Therefore, since at least a backside of the substrate generally includes a conductive layer deposited thereon that is in electrical communication with the production surface of the substrate, the plurality of backside electrical contact pins may be used to supply an electrical plating bias to the production surface of the substrate without actually contacting the production surface. Additionally, one or more seals may be positioned on the lower surface of the vacuum chuck to prevent to electrolyte used in plating operations from traveling to the backside of the substrate, and more particularly, to prevent the electrolyte from reaching the electrical contact pins and causing plating thereon.

[0017] FIG. 1 illustrates a general partial perspective and sectional view of an exemplary plating cell and head assembly 100 of the invention. Cell and head assembly 100 generally includes a support arm 101 configured to support a head assembly 102 at a position above a plating bath 104 in a manner that allows the head assembly 102 to position a substrate in a plating bath for processing. The head assembly 102 is generally attached to a substrate support member 103 at a lower portion thereof, and is configured to provide vertical, rotational, and angular movement thereto. The substrate support member 103, which will be described in further detail herein, is generally configured to support a substrate on a lower surface thereof, i.e., wherein the lower surface is defined as the surface of the substrate support member positioned adjacent the plating bath 104. Additionally, the lower surface is configured to electrically contact the backside of the substrate supported thereon to facilitate electrochemical plating on the production surface of the substrate, and therefore, the electrical current supplied to the substrate is generally conducted around the bevel edge of the substrate to the plating/production surface by a conductive layer deposited on the front side, the bevel edge, and a portion of the backside of the substrate, as will be described herein.

[0018] The plating bath 104 is generally contained within an inner basin 105, which is separated into two distinct regions: first, an anode region; and second, a cathode region, both of which will be further described herein. The inner basin 105 generally resides within a larger diameter outer basin 106, which operates to collect and drain fluids received from the inner basin 105 via a fluid drain. An anode assembly 107, which may be a consumable or non-consumable-type anode, for example, is generally positioned within a lower portion (anode region) of the inner basin 105. A membrane 108 is generally positioned across the diameter of inner basin at a position above the anode assembly 107, and as such, membrane 108 generally operates to separate the cathode region from the anode region. The membrane may be, for example, a cation membrane, an anion membrane, an uncharged-type membrane, or a multilayer diffusion differentiated permeable membrane, as described in commonly assigned U.S. patent application Ser. No. 10/194,160 filed on Jul. 11, 2002, which is hereby incorporated by reference in its entirety. The upper portion of the inner basin 105 (the cathode region) generally includes an electrolyte solution fluid inlet 109 configured to supply a plating electrolyte solution to the cathode region, while a separate fluid inlet 110 generally operates to supply a fluid solution exclusively to the anode region. Both of the respective fluid inlets will be further described herein.

[0019] FIG. 2 illustrates a perspective view of an exemplary head assembly 102 of the invention. Head assembly 102 generally includes an upper actuation portion 201 and a lower substrate support portion 202. The upper actuation portion 201, which is in mechanical communication with the lower substrate support portion 202, generally operates to control the position of substrate support portion 202. For example, upper actuation portion 201 generally operates to rotate substrate support portion 202, raise and lower substrate support portion 202 in a direction perpendicular to the substrate support surface, i.e., along the vertical axis of the upper actuation portion 201, and vary the angular position of the substrate support surface, such as during an angular immersion process. The substrate support portion 202 generally includes a disk shaped substrate support member 400, which is shown in perspective in FIG. 4. The disk shaped substrate support member 400 includes a substrate lower support surface 401 configured to receive and secure a substrate thereto during and electoral plating process. The substrate support surface generally includes a plurality of vacuum channels 402 formed therein. The vacuum channels are generally in fluid communication with a vacuum source (not shown), and are therefore, configured to vacuum chuck a substrate to the substrate support surface 401 for processing when a vacuum is applied to the vacuum channels 402. The substrate support surface 401 further includes a plurality of electrical contact pins 403 extending therefrom. The plurality of electrical contact pins, which may be positioned in a circular pattern, for example, are generally configured to electrically contact the backside of the substrate being plated when the substrate is vacuum chucked to the substrate support surface **401**. Power is supplied to the plurality of pins via a power supply (not shown). The power supply may supply electrical power to all of the pins **403** cooperatively, banks or groups of pins individually, or to the individual pins **403**. In embodiments where current is supplied to groups or individual pins, a current control system may be employed to control the current applied to each group or pin. The substrate support surface **401** further includes one or more seals **404** positioned proximate the plurality of electrical contact pins **403**. The seals **404** are generally positioned radially outward of the contact pins **403**, so that a dry contact configuration is created. Generally, the seals are configured to prevent electrolyte solution from traveling through the seals and contacting the electrical contact pins **403**, as contact between electoral contact pins **403** and electrolyte solution generally causes plating on the pins, which alters the pin resistance and has a negative effect on the substrate plating uniformity. Both the electrical contact pins **403** and the seals **404** are configured to engage the backside of the substrate being plated, and therefore, the frontside contact configurations of conventional plating cells is eliminated.

[**0020**] **FIG. 3** illustrates a detailed sectional view of an exemplary plating cell **104** of the invention. As briefly described with respect to **FIG. 1**, the exemplary plating cell **104** generally includes an inner basin **105** positioned radially inward from an outer basin **106**. The inner basin **105** generally operates to contain a plating solution therein in a manner that allows the substrate support member **103** to position a substrate within the plating solution during plating operations. The inner basin **105** generally includes sloped sides that terminate at a common upper point **306**, and therefore, the electrolyte solution supplied to the area within inner basin **105** may flow over the common upper point in order to create a substantially planar upper fluid surface and maintain a constant volume of electrolyte solution in the inner basin **105**. The electrolyte solution flowing over the common upper point **306** is received in the outer basin **106** and drained therefrom. The central portion of inner basin **105** generally includes an open volume or bath **307** where the electrolyte solution used for plating operations is contained. The lower portion of volume **307** is generally bounded by a diffusion plate **308**, which generally consists of a disk shaped plate having a plurality of pores or holes formed therein to facilitate fluid flow therethrough. Additionally, diffusion plate **308** may be configured to provide some degree of control over plating parameters, such as deposition uniformity for example, through material selection, positioning of the diffusion plate, and the pore size selection for the diffusion plate. The pores in the diffusion plate **308**, for example, may be between about 1 micron in diameter and about 10 microns in diameter, and the materials used to manufacture the diffusion plate may be insulators, such as, ceramics, plastics, and other materials known in the electroplating art to be insulators and non-reactive with electroplating solutions.

[**0021**] Immediately below diffusion plate **308** is a second open volume **309**, where the electrolyte solution used for plating operations is introduced into prior to traveling through diffusion plate **308** to contact the substrate for plating operations. Fluid for plating operations, i.e., the electrolyte plating solution, is generally supplied to open area **309** via an electrolyte solution inlet **314**, which is generally in fluid communication with an electrolyte supply source (not shown).

[**0022**] An anode assembly is generally positioned below open space **309** and is configured to supply metal ions to the plating solution for plating operations. The anode assembly may be separated from the open volume **309** via a membrane **310**. The anode assembly generally includes a disk shaped metal member **311**, which may be copper or copper phosphate, for example, in a copper electoral plating system. The positioning of membrane **310** generally operates to provide an open volume between the lower surface of membrane **310** and an upper surface of anode **311**. This space between membrane **310** and the upper surface of anode **311** is generally in fluid communication with a second fluid inlet **312** configured to supply a fluid solution to the volume immediately above the anode **311** and below the membrane **310**. Additionally, the area below membrane **310** and above anode **311** may also be in fluid communication with a fluid drain **313** configured to remove fluid from the area. As such, cooperative operation of fluid supply inlet **312** and fluid drain **313** allows for the fluid introduced into the region immediately above anode **311** to be removed therefrom by fluid drain **313**, without the fluid transferring through the membrane **310** into open area **309**. This configuration allows for isolation of the anode assembly from the cathode region of the plating cell, and more particularly, allows for isolation of contaminants generated at the surface of the anode, i.e., organic additive breakdown, copper balls, etc., from traveling from the anode surface and depositing on the production surface of the substrate and generating a defect.

[**0023**] The positioning of membrane **310** generally operates to isolate the anode **311** from the substrate being plated, which is essentially the cathode. As such, the volume proximate the substrate being plated may generally be characterized as a cathode chamber, while the volume proximate the anode, i.e., the volume below membrane **310** and above the upper surface of anode **311**, may generally be characterized as an anode chamber. As noted above, the isolation of anode **311** from the substrate being plated generally operates to prevent additives in the plating solution that degrade upon contact with the anode from traveling to the substrate being plated and causing plating defects. The positioning of the membrane **310** between the anode and the substrate allows for the capture or prevention of these degraded solution additives from traveling from the anode to the substrate surface. Furthermore, the implementation of fluid inlet **312** in conjunction with fluid drain **313**, both of which are exclusively in fluid communication with the anode compartment, i.e., the volume immediately above the anode surface and immediately below the lower surface of membrane **310**, further facilitates prevention of degraded solution additives from traveling from the anode to the substrate being plated. More particularly, inasmuch as the fluid provided to the anode compartment is circulated out of the anode compartment without traveling into the cathode compartment, degraded solution additives are removed from the plating cell altogether before they have a chance to circulate through the membrane **310** into the cathode compartment and cause defects on the plating surface. Further still, the plating solution provided to the anode compartment may be a solution that does not include the plating additives, i.e., the solution may be a copper sulfate solution without additives, and therefore, the solution that contacts the anode may not even have the additives that react with the anode therein.

[0024] Additionally, plating cell **104** is generally configured as a low-volume plating cell. More particularly, the volume of electrolyte solution contained within inner basin **105**, i.e., the volume of electrolyte solution within basin **105** is used for plating operations, is generally less than about one liter for a basin having a diameter of about 300 mm, which is substantially smaller than convention cells that generally hold about 6 liters. Therefore, given the diameter of inner basin **105** of about 300 mm, the depth of the electrolyte solution with in inner basin **105** having about 1 liter of electrolyte solution therein will generally be less than about one inch. More particularly, the depth of the electrolyte solution within inner basin **105** may be between about 1 mm and about 10 mm, for example. As such, when head assembly **102** operates to position a substrate for plating operations within the electrolyte solution contained by inner basin **105**, the surface of the substrate being plated will generally be positioned between about 1 mm and about 10 mm away from the upper surface of diffusion plate **308**. The low-volume plating cell **104** provides several advantages, namely, reduced electrolyte solution required for plating. Additionally, the low-volume, which requires low clearance between the substrate being plated and the diffusion plate **308**, operates to eliminate head recalibration processes when an anode is replaced or changed out.

[0025] In operation, the plating cell of the invention is generally configured to electrochemically plate a metal onto a production surface of a substrate, while making electrical and seal contacts with the substrate on a nonproduction surface of the substrate. Therefore, inasmuch as conventional electrochemical plating systems generally make electrical contact with a conductive seed layer formed on the production surface of the substrate during plating operations, embodiments of the invention include extending the conductive seed layer formed on the production surface to a portion of the non production surface. For example, the conductive seed layer may be extended around the bevel edge of the substrate to an outer perimeter annular region of the non-production surface of the substrate. More particularly, embodiments of the present invention are generally configured to electrically contact the nonproduction surface of the substrate near the perimeter of the substrate, i.e., in a circular pattern near the bevel edge of the substrate on the backside thereof. Therefore, in order to extend the conductive seed layer around the bevel edge of the substrate being plated to the back side thereof, embodiments of the invention contemplate utilizing a deposition chamber configured to deposit an annular region, band, or ring shaped conductive layer onto a portion of the backside of the substrate. Since the backside electrical contact pins of the invention are generally positioned near the outer perimeter of the backside of the substrate, the annular band deposited on the backside of the substrate is generally deposited near the perimeter of the substrate so that the conductive band will align with the plurality of electrical contact pins extending from the substrate support member. For example, **FIG. 5** illustrates an exemplary PVD chamber configured to deposit a narrow band of conductive material onto the backside and bevel edge of the substrate near the perimeter. This narrow band of conductive material, which is generally referred to as a seed layer extension, may then be used by the electrical contact pins of the invention to electrically contact the backside of the substrate being plated via electrical engagement between the backside electrical contact pins and the conductive seed layer extension on the backside of the substrate. The electrical bias applied to the seed layer extension layer on the backside may then be conducted to the production surface via the conductive seed layer extension layer.

[0026] The exemplary PVD chamber **500** illustrated in the **FIG. 5** generally operates to deposit the seed layer extension layer across the bevel edge and onto the backside of the substrate to be plated. The seed layer extension deposition process generally includes positioning a substrate **501** above a disk shaped ring member **502**, wherein the ring is configured to support the substrate **501** with the outer perimeter of the substrate extending beyond the outer perimeter of the ring **502**. The substrate is generally positioned in a face up manner, i.e., the production surface of the substrate is facing away from a deposition target positioned below the ring member **502**, and therefore, the backside of the substrate is facing towards the deposition target. The ring member **502** is positioned above the deposition target **503**, and therefore, when a PVD deposition process is conducted, the outer perimeter portion of the substrate extending beyond the outer perimeter portion of the ring member **502** will be plated with the target material. Additionally, one or more magnetic field generation devices may be positioned near the chamber **500** and may be used to control the directionality of the deposition process to facilitate the seed layer extension deposition. The deposition process used to form a conductive seed layer on the production surface of the substrate and to form the seed layer extension on the non-production surface of the substrate may include using one or more deposition chambers. For example, the seed layer may be deposited on the production surface in a first PVD or CVD chamber, and then the substrate may be transferred to a second deposition chamber (PVD or CVD) where the seed layer extension (the bevel edge and non-production surface layer) may be deposited. Alternatively, a single deposition chamber, i.e., a PVD or a CVD chamber, may be configured to deposit both the production surface seed layer and the non-production surface/bevel edge seed layer extension layer.

[0027] Once the seed layer extension is deposited on the substrate, the substrate may then be transported to a backside contact-type plating cell of the invention. The backside contact plating cell, such as plating cell **100** illustrated in **FIG. 1**, for example, will generally receive with the substrate in a face down position, i.e., the backside of the substrate to be plated is received and secured to a substrate support member in a manner such that the production surface is exposed and the backside is engaged with the substrate support member. If the substrate to be processed in the backside contact electrochemical plating cell of the invention is not in the proper orientation, then the substrate may be flipped over by a flipper robot, for example. The process of securing the substrate to be plated to the substrate support member further includes both electrically contacting the seed layer extension on the backside of the substrate, as well as mechanically engaging the backside of the substrate with one or more seals to prevent electrolyte solution from traveling to the area on the backside of the substrate where the electrical contact pins engage the seed layer extension. Embodiments of the invention generally utilize a vacuum chuck type operation to secure the substrate to be plated to the substrate support member. For example, prior to plating operations, a substrate to be plated is brought to a position proximate the substrate support surface. Thereafter, the substrate support surface may be lowered to a position nearly in contact with the backside of the substrate. A vacuum source in fluid communication with a plurality of grooves formed into the substrate support surface may then be activated such that the backside of the surface is drawn into engagement with the substrate support surface as a result of a negative pressure region generated between the substrate and the substrate support surface. The end result is that the backside of the substrate is vacuum chucked to the substrate support surface. However, inasmuch as the substrate support surface may include a plurality of electrical contact pins extending therefrom, when the backside of the substrate is vacuum chucked to the substrate support surface, the electrical contact pins inherently contact/engage the backside of the substrate. As such, the electrical contact pins are generally positioned around or proximate the perimeter of the substrate support surface, i.e., in an area adjacent the seed layer extension layer deposited on the backside of the substrate. Therefore, since the seed layer extension is in electrical communication with the seed layer deposited on the production surface of the substrate, when the electrical contact pins are caused to engage the seed layer extension, the electrical contact pins become in electrical communication with the seed layer on the production surface of the substrate. Therefore, the electrical contact pins may be used to provide an electrical plating bias to the production surface of the substrate sufficient to facilitate electrochemical plating operations, even though the electrical contacts are in electrical communication with the backside or nonproduction side of the substrate being plated.

[**0028**] Further, since it is known in electrical chemical plating systems that contact between the contact pins and the electrolyte plating solution results in metal being plated directly on the electrical contact pins, it is desirable to isolate the electrical contact pins from the electrolyte solution during plating operations. More particularly, for example, the electrical contact pins may be positioned radially around the perimeter of the substrate support surface in a circular pattern configured to mirror the annular seed layer extension deposited on the backside of the substrate being plated. In this configuration, an annular seal may be positioned radially outward of the electrical contact pins near the perimeter of the substrate support surface. In this configuration, when a substrate to be plated is vacuum chucked to the substrate support surface, the electrical contact pins will engage the seed layer extension layer, while the annular seal will simultaneously engage the perimeter of the backside of the substrate just outside of the electrical contact pins. Inasmuch as the annular seal is positioned radially outward from the electrical contact pins, the electrolyte solution used for plating operations must first pass through the annular seal in order to reach the contact pins. As such, the annular seal generally operates to generate a dry contact configuration via preventing the electrolyte from passing through or around the seal, which minimizes or eliminates plating on the electrical contact pins, and therefore, reduces plating uniformity problems associated therewith.

[**0029**] Once the substrate to be plated is chucked to the substrate support surface and electrically contacted by the electrical contact pins, the substrate support surface is generally lowered into the plating cell containing an electrolyte solution configured to facilitate electrochemical plating operations. For example, as illustrated in **FIG. 1**, head assembly **102** may lower the substrate support assembly **103** into plating cell **104**, where an electrolyte plating solution may be contained by an inner base and **105**. The substrate may be lowered into the plating solution in a manner configured to prevent bubbles from forming or attaching to the substrate surface during the immersion process. For example, had assembly **102** may be configured to immerse the substrate to be plated into the plating solution at an angle so that any bubbles on the substrate surface may be urged upward via the angle and off or away from the substrate surface. Further still, had assembly **102** may be configured to rotate the substrate during the immersion process to further facilitate the removal of bubbles from the substrate surface. Regardless of the particular immersion process, embodiments of the invention generally provide advantages over conventional electrochemical plating cells, as the present invention do not utilize any sort of front side substrate contact. This is an important feature the invention, as conventional electrochemical plating cells utilizing front side contacts, i.e., contact seals, electrical contacts, or mechanical contacts used to secure the substrate to a support surface, are known to cause bubble formation on the substrate surface during the immersion process, as the contacts trap bubbles at the surface during immersion. These trapped bubbles lead to uniformity problems, as the bubbles have a different conductivity than the electrolyte plating solution, and therefore, the substrate surface below the bubbles will plate differently than the substrate surface in contact with the electrolyte solution. Additionally, during the immersion process, an electrical bias may be applied to the substrate, as the electrolyte solutions are generally acidic, and therefore, will catch the conductive seed layer deposited on the substrate. The application of the electrical bias generally operates to offset the chemical etching process with a slight plating process, and therefore, prevents damage to the seed layer during the immersion process as a result of acidic etching.

[**0030**] Once the immersion process is completed and the production surface of the substrate is in contact with the electrolyte solution, then an electrical plating bias may be applied to the production surface of the substrate by the backside electrical contacts. More particularly, the backside electrical contacts extending from the substrate support surface are in electrical engagement with the seed layer extension deposited on the backside of the substrate, and therefore, the backside electrical contacts may be utilized to supply electrical bias to the production surface of the substrate in order to facilitate electrochemical plating thereon. The electrical bias, which is supplied to the backside electrical contact pins by a power supply (not shown), generally travels from the backside electrical contact pins into the conductive seed layer extension deposited on the backside and bevel edge of the substrate being plated. The electrical bias, therefore, travels through the seed layer extension and around the bevel edge of the substrate into the seed layer formed on the production surface of the substrate. Since the seed layer is in fluid communication with the electrolyte solution, the electrical bias causes metal ions in the electrolyte solution to plate on the seed layer as a result of the polarity of the electrical bias applied thereto. For example, in a copper electrochemical plating system of the invention, the electrolyte solution may contain a copper rich solution, such as copper sulfate, for example, and the backside electrical contact pins may be in electrical communication with the cathode of a power supply, while the anode of the power supply may be in electrical communication with an anode positioned in the electrolyte solution. In this configuration, the seed layer of the substrate being plated is biased as a cathode, and therefore, attracts the positive copper ions in the electrolyte solution to plate on the seed layer. During the plating process, the head assembly may rotate, tilt, or otherwise move the substrate support surface (and the substrate supported thereon) in the electrolyte solution to obtain desired flow or circulation properties of the electrolyte solution to the production surface of the substrate.

[**0031**] Once the desired electrochemical plating processing recipe has been executed and the metal layer deposited on the production surface of the substrate, head assembly **102** may retract the substrate support **103** from the electrolyte solution. Once the substrate is retracted from the solution, it may be removed from the substrate support **103** and transferred to an adjacent position for cleaning, rinsing, drying, and/or bevel material removal process, as desired for the particular process. In particular, since the seed layer extension layer was deposited onto the bevel edge and backside of the substrate in order to allow the backside contact pins to be in electrical communication with the production surface seed layer, the substrate will generally be transported to a bevel edge cleaning chamber configured to remove the seed layer extension layer once the plating process is complete. Generally, a bevel edge cleaning chamber will include one or more nozzles configured to dispense an acidic or etchant solution onto the seed layer extension layer while the substrate is rotated. The solution operates to etch away the seed layer extension layer, thus leaving a clean bevel edge and backside of the substrate. It will be understood by those skilled in the art that generally all conventional electrochemical processing parameters, such as plating voltages, current densities, rotation rates, plating durations, solution chemical compositions, etc. may be applied to the processing of substrates in the plating cell of the present invention, and therefore, these parameters will not be discussed in detail.

[**0032**] 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.

1. An electrochemical plating cell, comprising:

a plating solution reservoir configured to contain a volume of an electrochemical plating solution;

a substrate support member positioned above the plating solution reservoir, the substrate support member being configured to electrically engage a non-production side of a substrate secured thereto, the substrate support member comprising:

a substrate support surface having at least one vacuum channel formed therein, the substrate support surface facing the plating solution reservoir;

a plurality of electrical contact pins extending from the substrate support surface and being positioned to engage a perimeter of the non-production side of the substrate secured thereto; and

at least one annular seal positioned on the substrate support surface radially outward of the plurality of electrical contact pins, the at least one annular seal being configured to prevent flow of the electrochemical plating solution to the plurality of electrical contact pins; and

a power supply in electrical communication with an anode positioned in the electrochemical plating solution and the plurality of electrical contact pins.

2. The electrochemical plating cell of claim 1, wherein the volume of the electrochemical plating solution in the plating solution reservoir comprises between about 1.0 liters and about 5 liters.

3. The electrochemical plating cell of claim 1, wherein the volume of the electrochemical plating solution comprises between about 1.75 liters and about 2.25 liters.

4. The electrochemical plating cell of claim 1, further comprising a head assembly in mechanical communication with the substrate support member, the head assembly being configured to impart at least one of rotational, vertical, horizontal, and pivotal movement to the substrate support member.

5. The electrochemical plating cell of claim 1, wherein the plating solution reservoir further comprises:

an inner basin;

an outer basin positioned around the inner basin and being configured to collect overflow fluid from the inner basin;

an anode positioned in a lower portion of the inner basin;

a diffusion plate positioned above the anode; and

a separation membrane positioned between the anode and the diffusion plate.

6. The electrochemical plating cell of claim 5, wherein the inner basin is configured to hold a volume of between about 0.5 liters and about 5 liters of the electrolyte solution.

7. The electrochemical plating cell of claim 1, wherein the at least one vacuum channel is selectively in fluid communication with a vacuum source and is configured to vacuum chuck the non-production side of the substrate to the substrate support surface.

8. The electrochemical plating cell of claim 1, wherein the substrate support surface is configured to secure a substrate thereto using only contacts on the non-production side of the substrate.

9. The electrochemical plating cell of claim 1, wherein the plurality of electrical contact pins are manufactured from at least one of copper, platinum, and gold.

10. An apparatus for electrochemically plating metal onto a substrate, comprising:

a substrate support member having a substrate support surface formed thereon, the substrate support member being configured vacuum chuck a non-production side of the substrate to the substrate support surface and electrically engage non-production side of the substrate;

plating bath positioned below the substrate support member, the plating bath being configured to contain an electrochemical plating solution and an anode therein; and a head assembly in mechanical communication with the substrate support member, the head assembly being configured actuate the substrate support member in at least one of horizontally, vertically, pivotally, and rotationally to support the substrate in a face down configuration in the plating bath.

11. The apparatus of claim 10, wherein the plating bath comprises an inner basin configured to contain a plating solution, the inner basin being positioned within an outer basin that is configured to collect overflow from the inner basin.

12. The apparatus of claim 10, wherein the substrate support surface comprises at least one vacuum channel in fluid communication with vacuum source.

13. The apparatus of claim 10, wherein the substrate support surface comprises a plurality of electrical contact pins extending therefrom.

14. The apparatus of claim 13, wherein the plurality of electrical contact pins are positioned substantially in a circular pattern proximate a perimeter of the substrate support surface.

15. The apparatus of claim 10, wherein the substrate support surface comprises at least one seal positioned radially outward from a plurality of electrical contact pins, the at least one seal being configured to prevent the electrochemical plating solution from flowing to the plurality of electrical contact pins during plating operations.

16. A method for electrochemically plating metal onto a substrate, comprising:

depositing a seed layer on a production surface of the substrate, the seed layer extending around a bevel edge of the substrate onto at least a portion of a non-production surface of the substrate;

vacuum chucking the non-production surface of the substrate to a substrate support member;

immersing the production surface of the substrate in an electrochemical plating solution having an anode positioned therein; and

providing an electrical plating bias between the production surface of the substrate and the anode via electrically connecting the portion of the seed layer that extends onto at least a portion of the non-production surface with a cathode terminal of a power supply and electrically connecting the anode with an anode terminal of a power supply.

17. The method of claim 16, wherein depositing the seed layer comprises using a first physical vapor deposition process to form a production surface seed layer and using a second physical vapor deposition process to form a seed layer extension that extends over a bevel edge of the substrate and onto at least a portion of the non-production surface of the substrate.

18. The method of claim 17, wherein the second physical vapor deposition process comprises positioning a ring member between a deposition target and the non-production surface of the substrate.

19. The method of claim 16, wherein vacuum chucking the substrate comprises providing low pressure to at least one vacuum channel formed into a substrate support surface of the substrate support member.

20. The method of claim 16, wherein the production surface of the substrate is free of mechanical, electrical, and sealing contacts.

21. The method of claim 16, wherein providing an electrical plating bias between the production surface of the substrate and the anode further comprises positioning a plurality of electrical contact pins that are in electrical communication with the cathode terminal of the power supply on the substrate support member.

22. The method of claim 16, wherein providing the electrical bias comprises electrically engaging the non-production surface of the substrate with a plurality of electrical contact pins positioned on the substrate support member, the plurality of contact pins operating to electrically engage the substrate once the substrate is vacuum chucked to the substrate support member.

23. The method of claim 22, further comprising positioning a seal member radially outward of the plurality of contact pins, the seal member operating to prevent the electrochemical plating solution from flowing to the plurality of contact pins.

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