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(54) DYNAMIC ATOMIZER ON CONDITIONER ASSEMBLIES USING HIGH VELOCITY WATER

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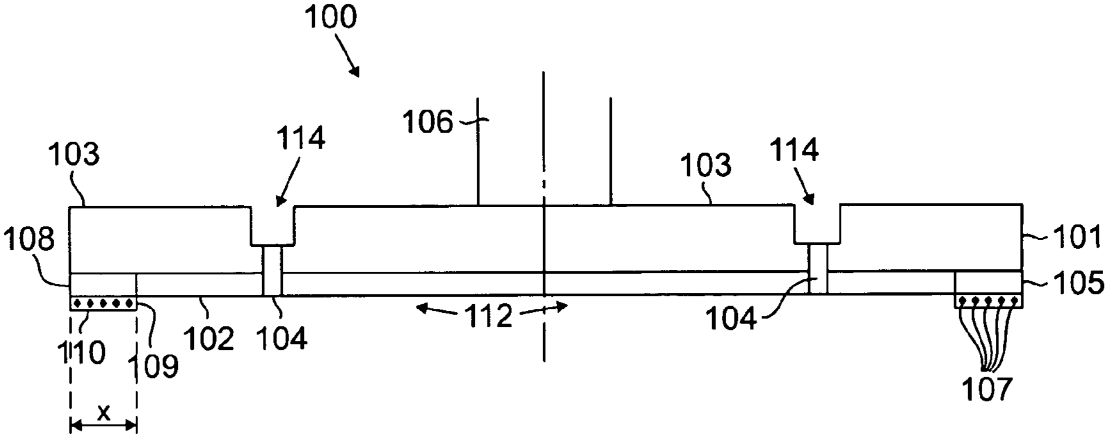
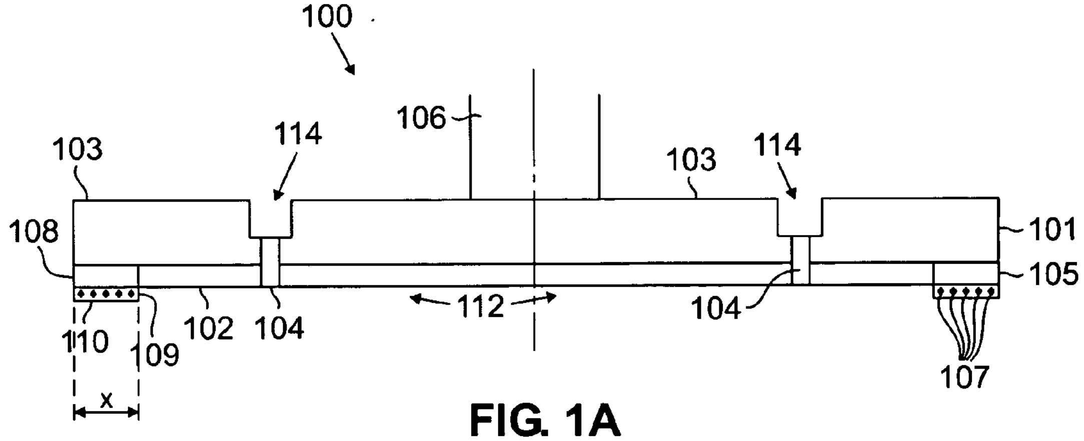
(57) ABSTRACT

A conditioner assembly is disclosed for conditioning a polishing pad used in chemical mechanical polishing of planar semiconductor wafer components. One embodiment of the conditioner assembly comprises a plate-type conditioner plate comprising a circular edge, having a first side and a second side, where on the first side is provided one or more diamond-impregnated abrasive elements, each comprising an abrasive surface disposed a distance from said first side comprising diamond particles, and one or more jets oriented to discharge fluid away from said first side. In operation the jets dispense high velocity fluid that hits the surface of the adjacent polishing pad with sufficient force to dislodge diamond particles that have loosened or broken off from the diamond-impregnated abrasive elements, thereby avoiding the embedding of such particles into the polishing pad surface. Another embodiment uses a ring-type conditioner plate assembly instead of a plate type, and also comprises one or more diamond-impregnated abrasive elements, each comprising an abrasive surface disposed a distance from said first side comprising diamond particles, and one or more jets oriented to discharge fluid away from said first side.




100
106
114
103
114
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110
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102
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112
104
107
x

FIG. 1A

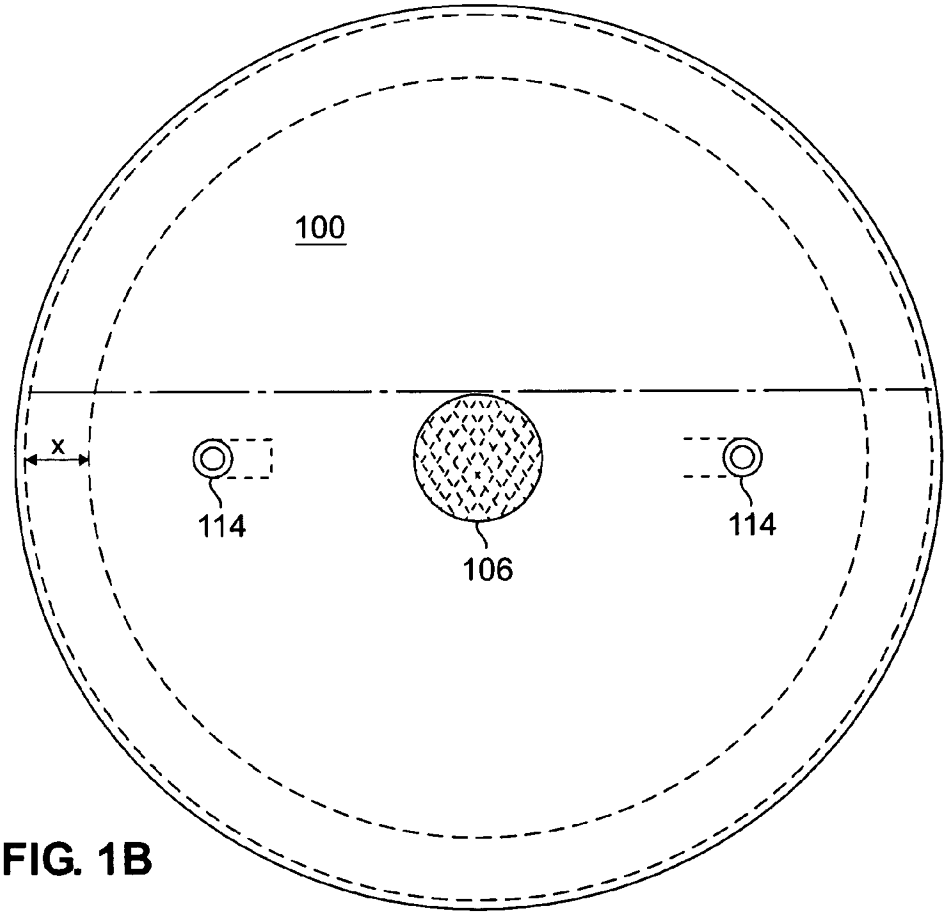
100
x
114
106
114

FIG. 1B

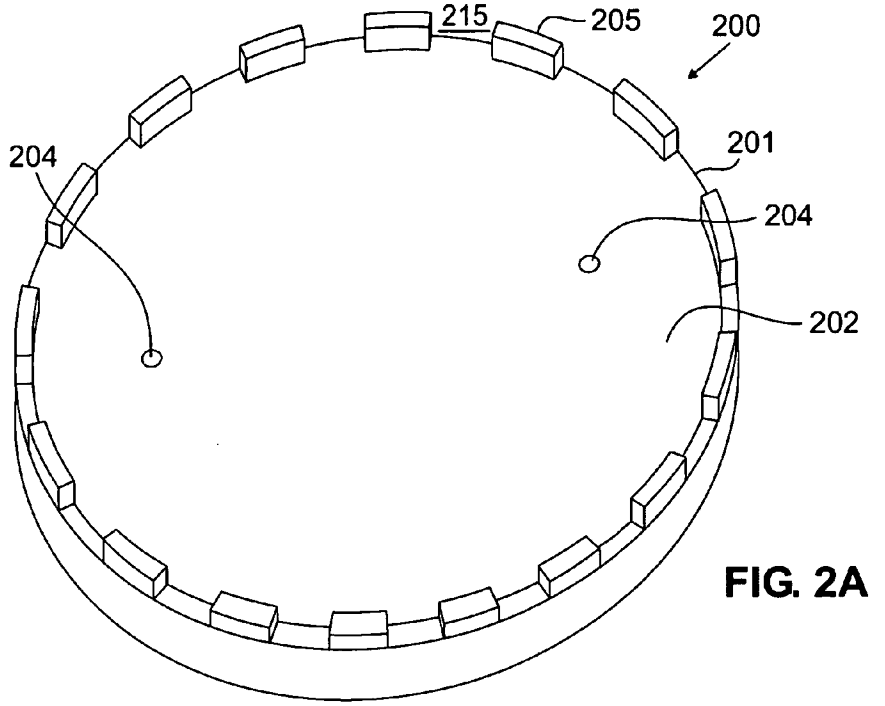

FIG. 2A

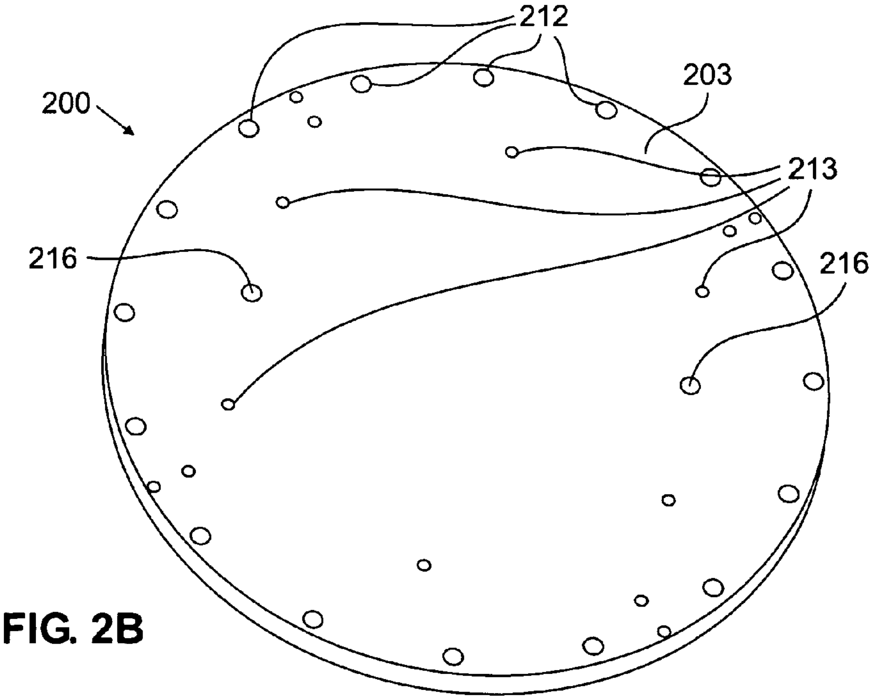

FIG. 2B

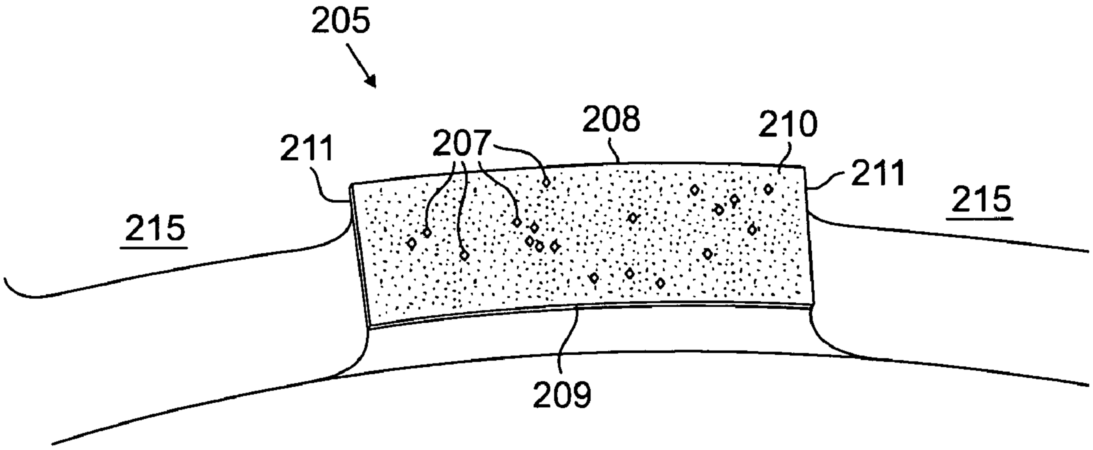

FIG. 2C

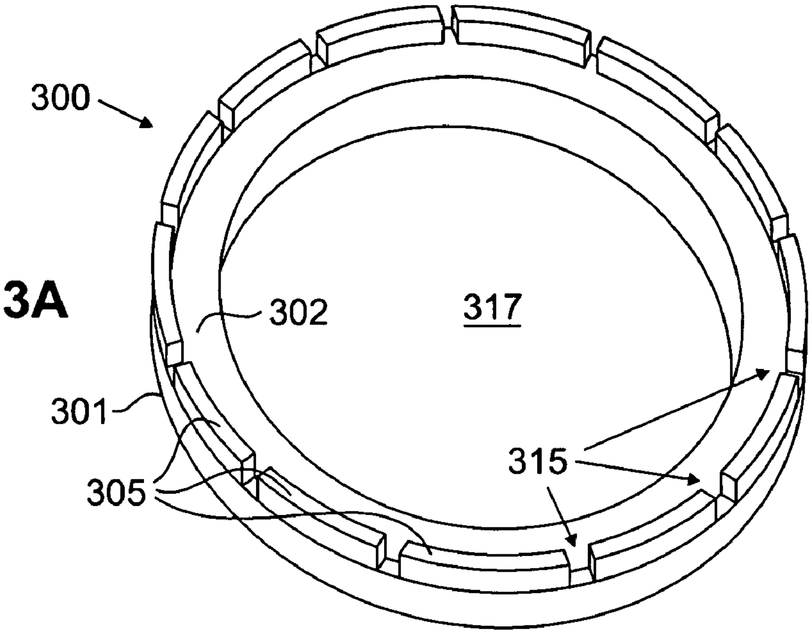
300
302
317
301
305
315

FIG. 3A

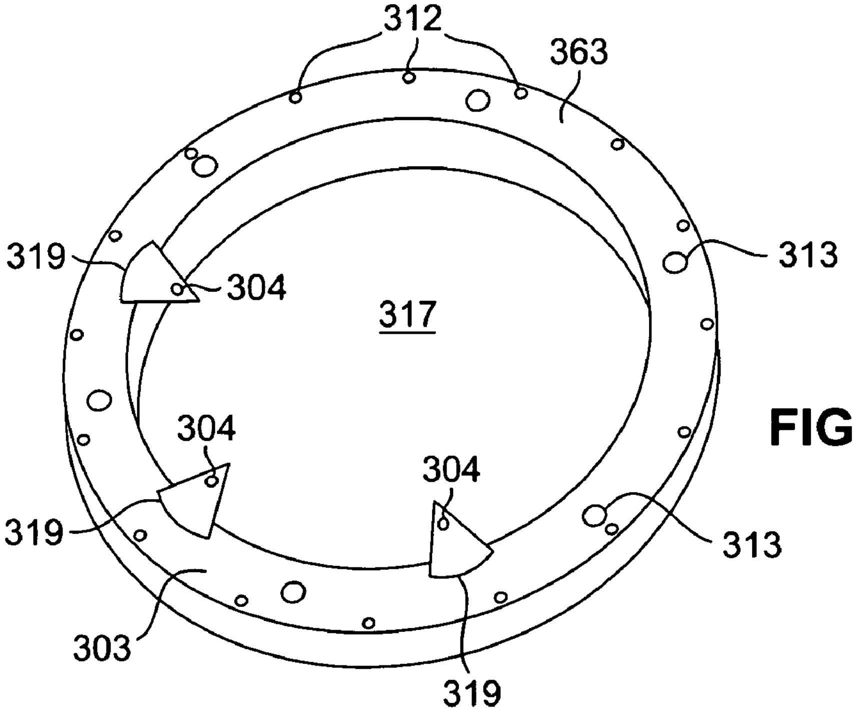
312
363
319
304
317
313
304
319
304
313
303
319

FIG. 3B

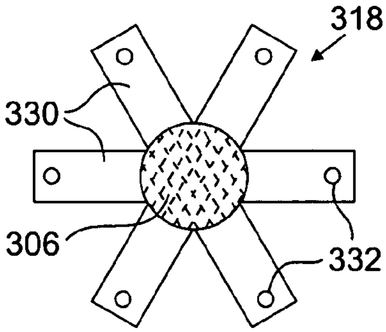

FIG. 3C

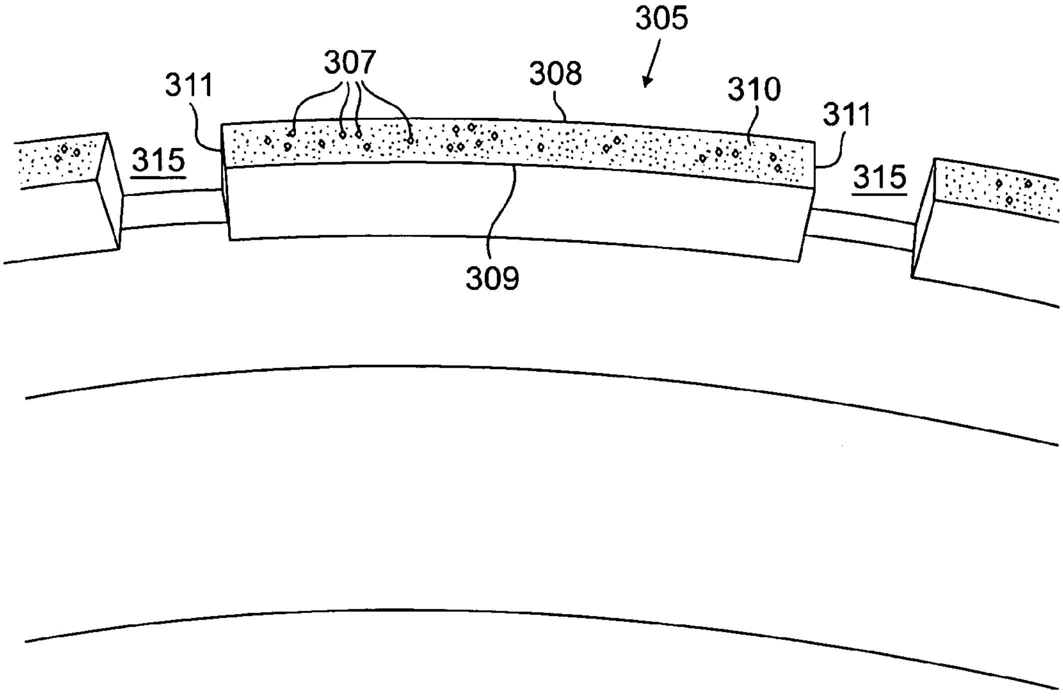

FIG. 3D

DYNAMIC ATOMIZER ON CONDITIONER ASSEMBLIES USING HIGH VELOCITY WATER

FIELD OF THE INVENTION

[0001] The present invention is directed to integrated circuit manufacture generally, and more specifically to abrading and renewing a polishing pad using a conditioning assembly comprising a forced-fluid particle-flushing feature.

BACKGROUND OF THE INVENTION

[0002] In semiconductor manufacture, semiconductor wafers need to be processed to be flat both initially and at various stages of manufacture. As device features become smaller and smaller, as in the submicron size range, and as such features have increasingly tight tolerances, the importance of achieving a desired level of flatness increases. Without attaining a desired level of flatness, other efforts toward obtaining consistent functionality in submicron size chips tend to falter. Further, in achieving such desired level of flatness, it is important to not impart any undesirable characteristic to the wafer.

[0003] Toward achieving consistently flat wafers, specific apparatuses and methods related to the process of chemical mechanical planarization (CMP) have been developed. CMP, which combines chemical etching and mechanical abrasion to produce a flat surface, is used in wafer preparation and in wafer fabrication. A polishing pad is used during CMP. In a typical CMP operation, this pad is placed in abrading contact with a semiconductor wafer surface, and a slurry is applied. The slurry typically contains a polishing agent, for instance alumina or silica, and other chemicals that etch or oxidize the wafer surface. Through such abrading contact, including with application of a slurry, the wafer surface is effectively polished and made more planar.

[0004] The typical polishing pad, comprised of material such as polyurethane, is manufactured to have pores or grooves. The pore or groove voids serve to carry the slurry into contact with the wafer surface being abraded and polished. However, particularly for uncoated polishing pads, these pores become filled with pad material and slurry particles over time during the polishing process. This can lead to what is known in the art as pad glazing or pad clogging.

[0005] Glazed and/or clogged polishing pads are processed to restore their functionality. This is done after a given period of use of a polishing pad, or upon observation of decreased performance. Typical processing involves abrading the polishing pad itself by use of a conditioner assembly. A conditioner assembly generally comprises a circular rigid conditioner body (also referred to as a “plate” or “ring,” or a “dresser”) comprising one or more abrasive elements on one side, and a drive mechanism emanating from a central point on the other side. During operation the drive mechanism positions and provides rotational force to turn the body. Rotation of the conditioner body while the surface of the abrasive elements contact the polishing pad provides a desired removal of accumulated material from the polishing pad surface.

[0006] When diamond particles are in the abrasive material, the conditioner body is known as a diamond conditioner body. Abrasive elements of a diamond conditioner body may be prepared by any of a number of methods using all electroplating, all brazing. Other fabrication approaches include electroplating in the diamonds, and sifting in powdered metal around the diamonds, then sintering at high temperature to anchor the diamonds. For instance, in some embodiments of a diamond conditioner body, an abrasive material is comprised of diamonds embedded in a nickel plating (i.e., diamond-impregnated nickel). As to shapes, in some embodiments a single abrasive element is an annular ring with its outer edge along the periphery of a circular conditioner plate or ring. In other embodiments there are breaks, or channels, formed between discrete abrasive elements that are similarly arranged with their outer edges along the periphery of a circular conditioner plate or ring.

[0007] In use, the surface of the abrasive material is pressed against the polishing pad in a manner to achieve an abrasion to restore the polishing pad surface. This restoration involves returning the polishing pad surface to a roughened but planar state in which new clean depressions, such as pores or grooves, are exposed.

[0008] An alternative to a diamond conditioner is a brush conditioner. However, a brush conditioner provides a lower removal rate, increasing the time to condition. Gas blowing and liquid rinsing are other techniques employed to remove materials that have become entrapped in the polishing pad.

[0009] Also known in the art is a fluid-based in-situ conditioning system, as described in U.S. Pat. No. 6,517,416 B1 (issued Feb. 11, 2003 to Crevasse et al.). Also known in the art are various apparatuses, methods and compositions are to increase the effectiveness of conditioning a polishing pad, and/or decrease the time to do this. For instance, the following references disclose apparatuses, methods and compositions in this field: U.S. Pat. No. 6,234,868 B1 (issued May 22, 2001 to Easter et al.); U.S. Pat. No. 6,524,523 (issued Feb. 25, 2003 to Jeng et al.); and U.S. Pat. No. 6,679,761 B1 (issued Jan. 20, 2004 to Sunahara et al.). These references, and all other references cited herein, whether patents, patent application publications, scientific or technical publications, or other publications, are hereby incorporated by reference for their teachings. As indicated below where appropriate, certain references are incorporated with particularity for indicated teachings.

[0010] Although use of diamond conditioner bodies offer advantages, a problem with such use has been recognized by the inventors. Whereas it was known that during abrasion that a dust is formed that requires removal, it was previously unknown that diamond particles may loosen and break off from the surface of the abrasive material. Once free on the surface of the polishing pad, these particles may become embedded in the polishing pad, such as due to the action and pressure of the conditioner assembly. When embedded, the diamond can cause diamond scratching on one or more wafers during subsequent polishing by the so-conditioned polishing pad. Ultimately, during a subsequent conditioning of the polishing pad, the embedded diamond may be removed, but not before having caused wafer damage.

[0011] As disclosed and claimed herein, the present invention provides apparatuses and methods directed to reduce and/or eliminate the occurrence of, and/or dislodge undesired embedded diamonds in a polishing pad during conditioning with a diamond conditioner assembly. This solves the identified problem, and improves the performance of conditioned polishing pads, and decreases the defect rate of semiconductor wafers polished by such pads.

SUMMARY OF THE INVENTION

[0012] In one embodiment of the present invention, a conditioner assembly is comprised of one or more jets that direct a flow of high velocity fluid, such as water, onto the surface of the polishing pad. Typically, the jets are positioned within a boundary formed by the interior border of the diamond-impregnated abrasive material of the conditioner body. The shape of this diamond-impregnated abrasive material, that is formed in or attached to the conditioner body, may be selected from: an annular ring; an annular ring broken by radially oriented channels; or other shapes and configurations as known in the art.

[0013] The one or more jets are adapted to deliver high velocity fluid, such as water, during a conditioning process. The high velocity fluid washes away diamond particles that may have loosened or broken off from the conditioner plate abrasive surface prior to becoming embedded in the polishing pad. A driving arm around which the conditioner body rotates is attached to the conditioner body, such as at its center, to provide for rotation of the conditioner body including the associated abrasive material. Fluid communication is provided between a fluid supply and the one or more jets wherein that fluid communication is maintainable during the rotation, such as by use of a rotary union.

[0014] In another embodiment of the present invention, a method of conditioning a polishing pad is comprised of contacting a conditioner body (i.e., its abrasive material), having components described above, with a polishing pad in need of polishing, effecting relative rotation between the conditioner body and the polishing pad, and supplying high velocity fluid during the contacting, wherein the fluid dislodges and/or washes away diamond particles that have loosened or broken off from the conditioner plate. The fluid also washes away debris and/or dried slurry that is being acted upon by the abrasive surface on the conditioner plate.

[0015] Other aspects, advantages and objects of the present invention are provided in the following description, which is to be considered with the appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] For a better understanding of the invention, reference is made to the following detailed description taken in conjunction with the accompanying drawings in which:

[0017] **FIG. 1A** provides a schematic cross-sectional side view of one embodiment of a plate-type conditioner assembly of the present invention having a continuous annular abrasive element. **FIG. 1B** provides a schematic top view of the plate-type conditioner body depicted in **FIG. 1A**.

[0018] **FIGS. 2A and 2B** provide bottom and top views, respectively, of a plate-type conditioner body of the present invention. **FIG. 2C** provides a close-up view of one abrasive element disposed on the bottom edge of the plate-type conditioner body.

[0019] **FIGS. 3A and 3B** provide bottom and top views, respectively, of a ring-type conditioner body of the present invention. **FIG. 3C** provides a top view of one embodiment of a drive transfer frame with central shaft. **FIG. 3D** provides a close-up view of one abrasive element disposed on the bottom edge of the ring-type conditioner body.

DETAILED DESCRIPTION OF THE INVENTION

[0020] For the figures described herein, unless otherwise indicated like reference numerals refer to the same or similar structures identified in previous figures.

[0021] As used herein, including the claims, the term "diamonds" and "diamond particles" are taken to mean the grains, powders, and dusts of diamonds, typically synthetic diamonds. Size-segregated (i.e., sieved) diamond powders from synthetic diamond sources commonly are used in the manufacture of abrasive elements used on conditioner plates, because this source provides greater uniformity. A representative particle size category for diamond particles used in a conditioner plate abrasive element is 200 mesh (i.e., particles passing through a mesh having 200 holes per linear inch). Smaller and larger sizes of diamond particles are used, depending on a particular purpose or preference.

[0022] As used herein, including the claims, an abrasive element that contains diamonds is identified as a "diamond-impregnated abrasive element" or, alternatively, as an "abrasive surface formed by a plurality of diamond particles embedded in the surface." This comprises diamond particles as defined above. When a diamond-impregnated abrasive element is associated with a conditioner body (i.e., plate-type or ring-type) of the present invention, whether formed integrally with or attached thereto, this combination is referred to herein variously as a "diamond conditioner body," or as a "diamond-type conditioner" or a "diamond conditioner" (the latter two terms optionally including other components of a conditioner assembly). However, in that it is the plate-type or ring-type conditioner body that is a standard functional unit in the art, this combination also is referred to as a conditioner body that comprises such abrasive element or surface.

[0023] As described in the embodiments below, a diamond-impregnated abrasive element may be shaped into an annular ring, with or without channels, and into other shapes suitable for the purpose of conditioning a polishing plate that is subsequently used to polish and flatten semiconductor wafers at the start, or during, wafer fabrication. Also as described herein, it is appreciated that a conditioner body of the present invention, to which is attached (or which is made integral with) a diamond-impregnated abrasive element, may be of a plate-type or of a ring-type or ring shape. A conditioner body of the present invention, when associated with one or more other components for the purpose of conditioning (such as an apparatus for positioning, etc.), is identified as a conditioner assembly.

[0024] The diamond-impregnated abrasive element comprises an abrasive surface that, during operation of a conditioner assembly, is placed in intimate contact with a polishing plate to be conditioned. The intimate contact over time has been found to result in the release or break-off of diamond particles. The diamond-impregnated abrasive element is formed by any means known in the art, and is formed with or attached to the conditioner body by any means known in the art. Without being limiting, examples of creating and attaching a diamond-impregnated abrasive element are taught in U.S. Pat. No. 6,524,523 (to Jeng et al.)

which is incorporated by reference with particularity for such teachings, including the discussion of the prior art in that patent, and for the designs of conditioner bodies.

[**0025**] **FIGS. 1A and 1B** provide side cross-sectional and top schematic views of one embodiment of a plate-type conditioner assembly of the present invention. A plate-type conditioner body **100** is disc-shaped (i.e., comprising a circular edge **101** with substantially flattened opposing sides) and comprises on a bottom side **102** two jets **104**. The two jets **104** are disposed within a peripherally located annular ring of abrasive **105**. To rotate the conditioner body **100**, a rotating arm **106** attaches to the top side **103** of said conditioner body **100**. The rotating arm **106** is adapted for connection to a motor (not shown) to drive the conditioner body **100** in a rotating manner. More generally, any type of rotating arm or drive as is known in the art may be employed, such as those incorporating rotary unions to supply water to the conditioner body **100**. Also, any means for attaching the conditioner body **100** to a rotational driving shaft, such as rotating arm **106**, may be employed as is known in the art. For instance, not to be limiting, U.S. Pat. No. 5,899,800 (to Shendon) teaches a rotary union associated with a drive shaft (i.e., rotating arm), and is incorporated by reference particularly for the teachings of a rotary union and of attachment to the conditioner body.

[**0026**] The annular ring of abrasive **105** is attached to or formed with the conditioner body **100**, and is one shape of a diamond-impregnated abrasive element of the present invention. When not formed with the conditioner body **100**, the annular ring of abrasive **105** is secured to the conditioner body **100** by means known in the art. The annular ring of abrasive **105** is comprised of diamonds **107** mixed interspersed in the annular ring of abrasive **105**, which may be otherwise comprised of a metal such as nickel. The annular ring of abrasive **105** and has an exterior edge **108** and interior edge **109**. In that the annular ring of abrasive **105** has a planar surface **110** that is disposed below bottom side **102** of conditioner body **100** interior to interior edge **109**, a recess **112** is formed within the confines of the annular ring of abrasive **105**.

[**0027**] As depicted in **FIGS. 1A and 1B**, the two jets **104** fluidly communicate with recess **112**. To the other end of each of the two jets **104** is a connector housing **114**, here shown disposed partially within the conditioner body **100**. The connector housing **114** receives a connector (not shown) that fluidly connects with a supply of high velocity water (not shown). Intervening fluid connections between the supply and the jets **104** are adapted to provide water during rotation of the conditioner body **100** by the rotating arm **106**, such as by any of various rotary unions known to those skilled in the art.

[**0028**] Accordingly, during operation, when the annular ring of abrasive **105** of conditioner **100** is disposed against a surface of polishing pad (not shown), which is to be conditioned thereby, and when the conditioner **100** is rotating to create an abrasive action, high velocity water also is flowing from the supply, through the connectors, and through the jets **104**. The water flow from these jets **104** is directed to the surface of the polishing pad (not shown), thereby serving to loosen and/or wash away diamond particles that are, respectively, embedded or lying on the surface of the polishing pad beneath the flow of water from the jets **104**. Given the rotating motion of the conditioner **100** about the rotating arm **106** (and, optionally, given the rotation of the polishing pad and/or the lateral movement of the conditioner across the polishing pad), the force of water from the jets **104** moves across a large surface area of the polishing pad.

[**0029**] As water from the jets **104** flows into recess **112**, it seeks a path of least resistance to flow out. From the space defined by recess **112** the water flows laterally to a lower pressure area, such as that open space external to the annular ring of abrasive **105**. When no breaks, or channels, in the annular ring of abrasive **105** exist, the water passes across the active interface of the annular ring of abrasive **105** rotating across the surface of the polishing plate. While not being bound to a particular theory, this is believed to provide additional cleaning action.

[**0030**] Also, regardless of the existence of breaks or channels in the annular ring of abrasive **105**, it is noted that the effects of the water impacting the polishing pad surface from jets **104** additionally remove and/or wash away debris and/or dried slurry from previous polish processes. Thus, one or more of the above interactions and phenomenon results in better defect performance and reduces or eliminates dried slurry scratches on a wafer later polished by a polishing pad so conditioned.

[**0031**] **FIG. 2A** provides a perspective view a plate-type conditioner body **200** having a circular edge **201**, and showing features of the bottom side **202**. On the bottom side **202** along the circular edge **201** are disposed abrasive elements **205** separated by channels **215**. Disposed more centrally are two jets **204** that provide high velocity water, as described herein, to flush away diamond particles.

[**0032**] **FIG. 2B** provides a perspective view of the top side **203** of the plate-type conditioner body **200** of **FIG. 2A**. Disposed near the circular edge are holes **212** for attachment of the conditioner body **200** to a drive mechanism (not shown). More centrally located are holes **213** for alternative attachment of a drive mechanism (not shown). Either set of holes **212** or **213** may be used for attachment of a drive mechanism that includes a rotary union (not shown) for supply of water during rotation. Also shown are two holes **216** through which water passes to supply jets **204**.

[**0033**] **FIG. 2C** provides a perspective view of one abrasive element **205** of **FIG. 2A**. A plurality of diamond particles **207** are apparent on the abrasive element surface **210**. The shape of abrasive element **205** also is defined by an exterior edge **208**, an interior edge **209**, and sides **211**. Between opposing sides **211** of adjacent abrasive elements **205** are channels **215**.

[**0034**] **FIG. 3A** provides a perspective view a ring-type conditioner body **300** having a circular edge **301**, and showing features of the bottom side **302** of the ring shape. On the bottom side **302** along the circular edge **301** are disposed abrasive elements **305** separated by channels **315**. A large open span **317** exists in the middle of the ring shape.

[**0035**] **FIG. 3B** provides a perspective view of the top side **303** of the ring-type conditioner body **300** of **FIG. 3A**. Disposed near the circular edge are holes **312** for attachment of the conditioner body **300** to a drive mechanism (not shown). More centrally located are larger holes **313** for alternative attachment of a drive mechanism (not shown).

Either set of holes **312** or **313** may be used for attachment of a drive mechanism that includes a rotary union (not shown) for supply of water during rotation. Jet braces **319** are attached to the top side of conditioner body **300** to hold jets **304** in desired positions. In other embodiments (not shown), the jets may be positioned directly on drive transfer frame, such as **318** in **FIG. 3C**. Drive transfer frame **318** depicts one embodiment by which a drive shaft **306** attaches to body **300** (not shown) via six arms **330**, each bearing a hole **332** to align with holes **313**. Jets may be placed in or on such arms **330**. Various arrangements for communicating a water supply to jets, and for providing rotational force, will become apparent to those skilled in the art.

[0036] During operation, as discussed above for other embodiments, the two jets **304** provide high velocity water, as described herein, to dislodge and/or flush away diamond particles, as well as other particulates.

[0037] **FIG. 3D** provides a perspective view of abrasive elements **305** of **FIG. 3A**. A plurality of diamond particles **307** are apparent on the abrasive element surface **310**. The shape of abrasive element **305** also is defined by an exterior edge **308**, an interior edge **309**, and sides **311**. Between opposing sides **311** of adjacent abrasive elements **305** are channels **315**.

[0038] It is appreciated that one general component of a conditioner assembly of the present invention is an apparatus for delivering a flow of fluid into an interface between said conditioner body and said planar surface of the polishing pad. Any approaches as known in the art for fluidly communicating a supply of fluid to a rotating conditioner body may be employed, such as the use of a rotary union. As to the outlets for such fluid, these are generally referred to as "jets," however appreciating that a range of outlets may be used so long as they fulfill the functional requirement of supplying high velocity fluid against a surface of a polishing pad that opposes the conditioner body surface comprising the abrasive surface. Thus, a simple hole (as shown in **FIG. 1A**) through which water passes may be used as an outlet, or, alternatively, a separate jet nozzle may be attached to such a hole, such as by threading the nozzle into such a hole.

[0039] As to the channels **215** and **315** of plate-type conditioner **200** and ring-type conditioner **300**, respectively, these provide more facile routes of exit than when water from jets **104** of conditioner **100** must pass through relatively small spaces between the non-interrupted abrasive surface **105** and the opposing polishing pad surface (not shown), as the latter are intimately contacting during operation. Not being constrained by frictional loss as would be higher through such small spaces, the flow through the channels is more rapid and is suitable to carry away dislodged diamond particles. As conditioner body **200** or **300** rotates, this exposes different surface areas of the polishing pad to such washing action. For a dislodged diamond particle (not shown) that is either lying on or partially embedded in the surface of the polishing pad (not shown), upon exposure to the transient flow of water through channels **215** or **315** during rotation, such flow may by its force carry away or dislodge and carry away such particle. Further, as the effective velocity of the water is increased at a distance from the impact area of the spray, along the polishing pad, the force increases for carrying away a diamond particle from that non-impact area. Thus, the optimization of the angling, positioning and flow rate (at the impact and at non-impact areas) for each outlet, in consideration of the exit pattern, can result in most or all diamond particles being dislodged and removed with re-lodging into the polishing pad surface.

[0040] Also, for any embodiment, the angle of the jet may be angled to deviate from 90 degrees relative to the planar surface of the polishing pad. For example, not to be limiting, in some embodiments the jet is angled outwardly (relative to the inward geometric center of the conditioner body, i.e., the centerline of the drive mechanism). That is, the angle is less than 90 degrees relative to degrees from the plane of said first side, and oriented toward the circular edge, specifically directed to pass fluid through a channel. Such outward angling provides an advantage of propelling at a greater velocity dislodged diamond particles so that they have a greater possibility of directly through a rotating channel without becoming re-embedded due to action of the rotating abrasive element(s). The degree of this directionality is balanced with the loss of some force of impact against the surface, as occurs when the angle is 90 degrees from the plane of the polishing pad.

[0041] Further as to the location and angling of jets, in certain embodiments the jets are positioned near to the interior edges of diamond-impregnated abrasive elements, and are angled outward and positioned so the water spray strikes near or in the space of a channel between two adjacent elements. This more directly directs dislodged diamonds through the channel. In certain embodiments, a jet is disposed to direct water near or in the space of each of the channels. In other embodiments, to conserve water flow, only a portion of the channels have a water spray outlet directing water through the channel.

[0042] For plate-type conditioner embodiments such as the one depicted in FIGS. 2A-C, during operation water flows outward through the channels **215**. For ring-type conditioner embodiments such as the one depicted in FIGS. 3A-C, the water may flow outward through the channels **315**. However, water also may spray up and pass through the open span **317**. This will in part depend on the flow rate and other factors, such as the style of opening of the jets **304**, and their angles relative to the plane of the polishing pad.

[0043] The compositional characteristics and design of the abrasive surface, and the flow rate of the fluid, such as water, may be varied to achieve a desired level of cleaning appropriate to a particular polishing pad being conditioned. Without being limiting, in an illustrative embodiment the range of total fluid flow rate is about 1 to about 5 liters per minute for a total of two jets. However, it is believed that a total fluid flow rate of about 1 to about 3 liters per minute for the two jets is sufficient to achieve the desired objectives of this invention. These rates are for a conditioner (plate or ring type) having a diameter about 10 inches, and provide water velocity and pressure sufficient to achieve the dislodging of diamond particles that are embedded in the conditioning pad. Higher flow rates may be used, depending on the conditions and the priority of conserving fluid consumption (or the cost of recycling it). Total flow rates increase or decrease as the size of a plate increases or decreases. Also, total flow rates increase as the total number of jets increases, to provide per jet water velocity and pressure sufficient to achieve the dislodging of diamond particles that are embedded in the conditioning pad.

[0044] Methods of operation using the conditioner assemblies of the present invention are described as follows. In one embodiment, a method of conditioning a polishing pad with a diamond-impregnated conditioner assembly comprises the steps of:

> **[0045]** 1. contacting a polishing pad surface with a surface of a diamond-impregnated abrasive element of a diamond conditioner plate assembly, said diamond conditioner plate assembly comprising a jet, the jet in fluid communication with a supply of water or other fluid;
>
> **[0046]** 2. providing effective rotation of the conditioner plate assembly with the planar surface of the polishing pad; and
>
> **[0047]** 3. directing a flow of high velocity water through said jet against the surface of the polishing pad;
>
> **[0048]** wherein said high velocity water carries away diamond particles loosened from said diamond-impregnated abrasive element during said contacting.

[0049] In another method, in addition to the contacting and supplying described above, there is a step of flowing the high velocity water through one or more channels formed in the diamond-impregnated abrasive element.

[0050] Although water is stated to flow through the jets in the examples above, it is appreciated that any fluid may be utilized so long as it is suitable for the purpose of washing away particulate matter, and/or dislodging diamond particles, from the surface of a polishing pad. Also, while it is appreciated that the force of the high pressure water is the primary force to remove dislodged diamond particles and other undesirable debris, the high velocity water or other fluid may advantageously contain foaming agents, surfactants, cleaners and the like. Such additions to the water or other fluid aid in the removal, cleaning and reconditioning of the polishing pad. Typically when such additives are used, prior to completion of the conditioning, the source of high velocity water is changed to provide a rinsing using water without such additives.

[0051] In other embodiments of the present invention, the diamond conditioner assembly comprising a jet directing water against a polishing plate surface is provided in conjunction with a polishing apparatus for wafers. An example of a polishing apparatus to which this may be combined is found in U.S. Pat. No. 6,517,416, **FIGS. 2A and 2B**, incorporated by reference specifically for this teaching. The diamond conditioner plate and its associated abrasive elements are disengaged from contact with the polishing plate when the polishing plate is polishing a wafer. Then, when conditioning is desired, the diamond conditioner plate is engaged so as to contact the polishing pad. During such contacting a flow of high velocity water passes through the jet(s) of the conditioner plate and serves to flush away any of dislodged diamond particles, debris formed from the abrading contacting, and, more particularly, dried slurries from a previous polishing process.

[0052] While the preferred embodiments of the present invention have been shown and described herein in the present context, such embodiments are provided by way of example only, and not of limitation. Numerous variations, changes and substitutions will occur to those of skilled in the art without departing from the invention herein. For example, the present invention need not be limited to best mode disclosed herein, since other applications can equally benefit from the teachings of the present invention. Accordingly, it is intended that the invention be limited only by the spirit and scope of the appended claims.

What we claim in the invention is:

1. A conditioner assembly for conditioning a polishing pad used in chemical mechanical polishing of semiconductor wafer comprising:

- a. a polishing pad conditioner body comprising an abrasive surface formed by a plurality of diamond particles embedded in the surface;
- b. an apparatus for positioning said conditioner body in abrasive relationship with a planar surface of the polishing pad and for effective rotation of the conditioner body with the planar surface of the polishing pad; and
- c. an apparatus for delivering a flow of fluid into an interface between said conditioner body and said planar surface of the polishing pad;

wherein the flow of fluid is sufficient to dislodge diamond particles which have become embedded in the planar surface of the polishing pad.

2. The conditioner assembly of claim 1 wherein said apparatus for delivering a flow of fluid is comprised of at least one jet.

3. The conditioner assembly of claim 1 wherein said abrasive surface is comprised of an annular ring.

4. The conditioner assembly of claim 1 wherein said abrasive surface is comprised of a plurality of sections separated by channels.

5. The conditioner assembly of claim 1 wherein said conditioner body is plate-shaped.

6. The conditioner assembly of claim 1 wherein said conditioner body comprises a ring shape and comprises a central void within said ring shape.

7. The conditioner assembly of claim 1 wherein said apparatus for delivering a flow of fluid is comprised of a plurality of jets, each said jet oriented at an angle less than 90 degrees, to direct fluid through one of said channels.

8. The conditioner assembly of claim 2, apparatus for delivering a flow of fluid comprises a rotary union adapted for rotation, and a conduit attaching to said rotary union, fluidly communicating said at least one jet with a supply of water in fluid communication with said rotary union.

9. A conditioner sub-assembly employed in conditioning a polishing pad used in chemical mechanical polishing of semiconductor wafer comprising:

- a. a polishing pad conditioner body;
- b. an abrasive surface formed by a plurality of diamond particles embedded in the surface, on one side of said conditioner body; and
- c. one or more jets in fixed communication with said conditioner body, positioned to deliver a flow of fluid into an interface between said conditioner body and said planar surface of the polishing pad, wherein the flow of fluid is sufficient to dislodge diamond particles which have become embedded in the planar surface of the polishing pad.

10. A method of conditioning a polishing pad with a diamond-impregnated conditioner body comprising the steps of:

a. contacting said polishing pad with an abrasive surface of said conditioner body, of a conditioner plate assembly plate comprising:

i. said conditioner body comprising said abrasive surface formed by a plurality of diamond particles embedded in the surface;

ii. an apparatus for positioning said conditioner body in abrasive relationship with a planar surface of the polishing pad and for effective rotation of the conditioner body with the planar surface of the polishing pad; and

iii. an apparatus for delivering a flow of fluid into an interface between said conditioner body and said planar surface of the polishing pad;

b. effecting relative rotation between said polishing pad and said conditioner body; and

c. supplying high velocity water through said apparatus for delivering a flow of fluid, directed to the surface of said polishing pad;

wherein said high velocity water carries away diamond particles loosened from said diamond-impregnated abrasive element during said contacting.

11. The method of claim 10, wherein said diamond-impregnated abrasive element additionally comprises at least one channel communicating between an interior edge and an exterior edge of said diamond-impregnated abrasive element, additionally comprising flowing said high velocity water through said at least one channel.

12. A method of assuring removal of particulate matter from a surface of a polishing pad during conditioning, comprising the steps of:

a. positioning a conditioner body in abrasive relationship with a planar surface of the polishing pad;

b. providing effective rotation of the conditioner body with the planar surface of the polishing pad; and

c. supplying high velocity water through said conditioner body for delivering a flow of fluid, directed to the surface of said polishing pad;

wherein said high velocity water carries away said particulate matter.

13. The method of claim 12, wherein said supplying directs water of a force effective to loosen diamond particles embedded in said surface of said polishing pad.

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