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(54) **METHOD AND SYSTEM FOR CONTROLLED MATERIAL REMOVAL BY ELECTROCHEMICAL POLISHING**

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(60) Continuation-in-part of application No. 10/302,755, filed on Nov. 21, 2002, now Pat. No. 7,204,917, Continuation-in-part of application No. 10/152,793, filed on May 23, 2002, now Pat. No. 7,378,004, which is a division of application No. 09/511,278, filed on Feb. 23, 2000, now Pat. No. 6,413,388.

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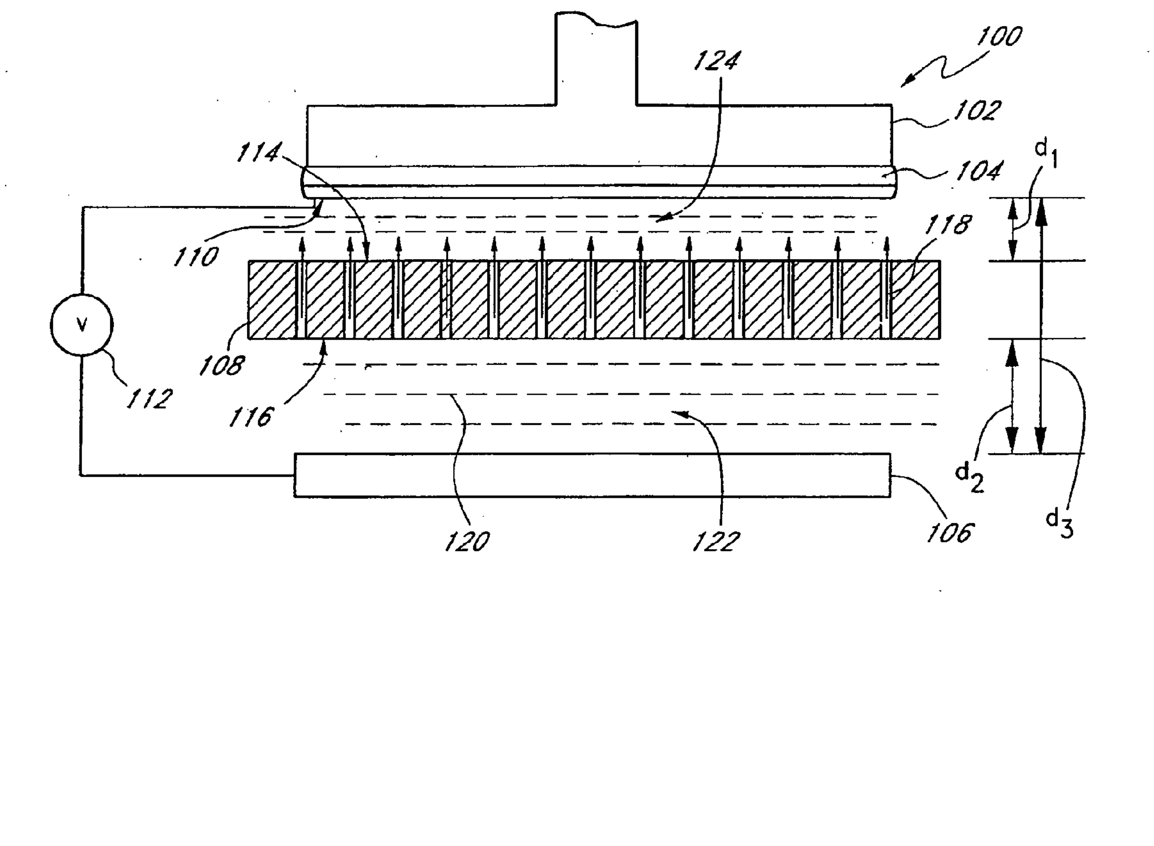
(57) **ABSTRACT**

A method and apparatus for electropolishing a conductive layer on a wafer is provided. The apparatus includes an electrode and a conductive member having openings permitting an electropolishing solution to flow through it. Surface of the conductive member includes a surface profile. During the electropolishing process, the surface of the conductive element is placed across from the conductive layer and a potential difference is applied between the conductive layer and the electrode. The process forms a conductive layer profile of the conductive layer.



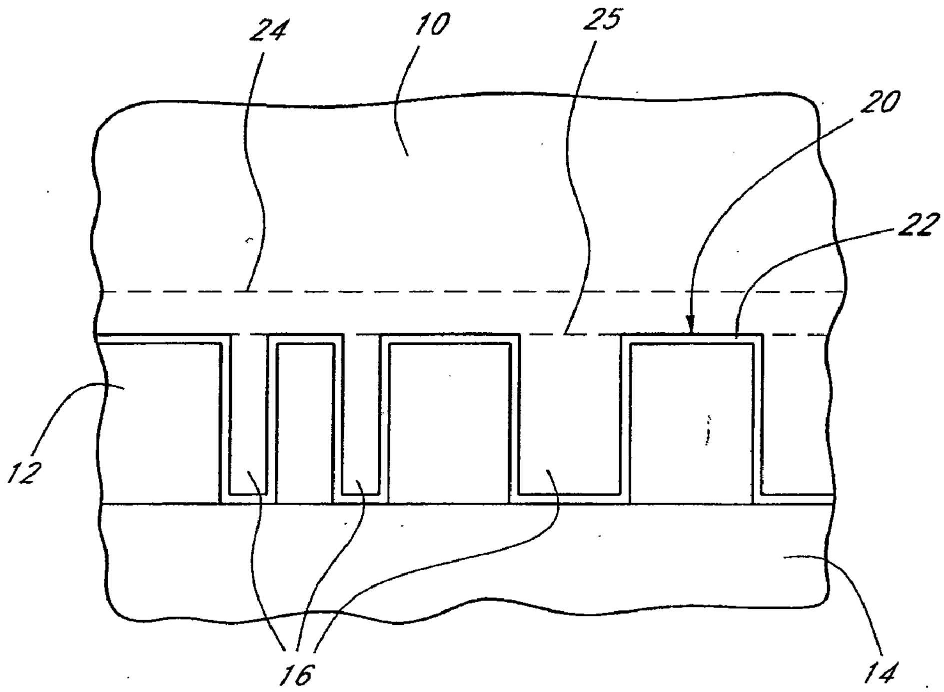


FIG. 1
(PRIOR ART)

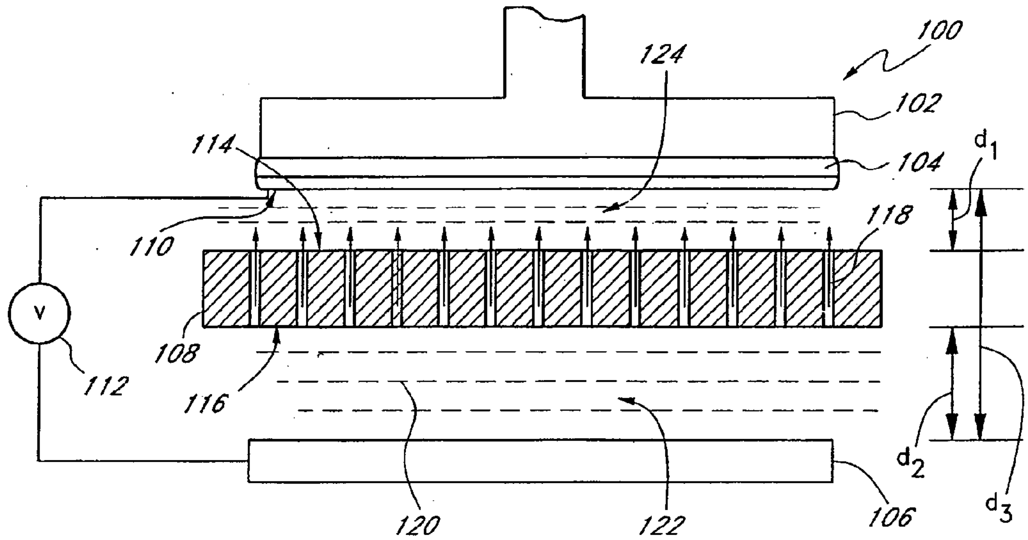

100
124
102
114
104
d_1
118
110
V
108
112
116
d_2
d_3
120
122
106

FIG. 2

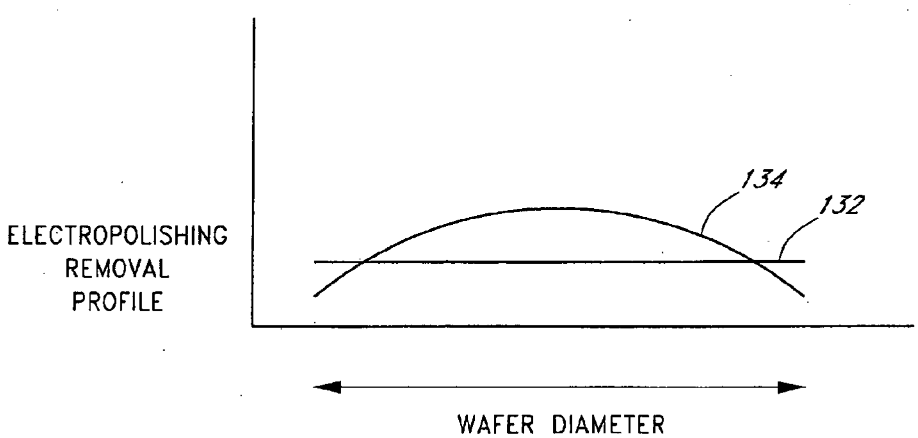

134
132
ELECTROPOLISHING
REMOVAL
PROFILE
WAFER DIAMETER

FIG. 3

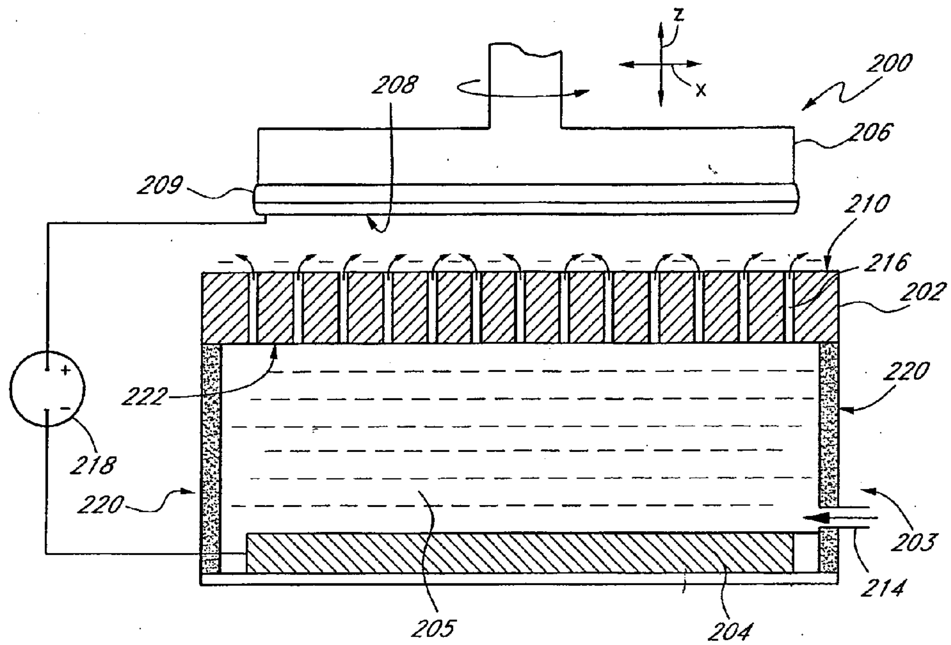


FIG. 4

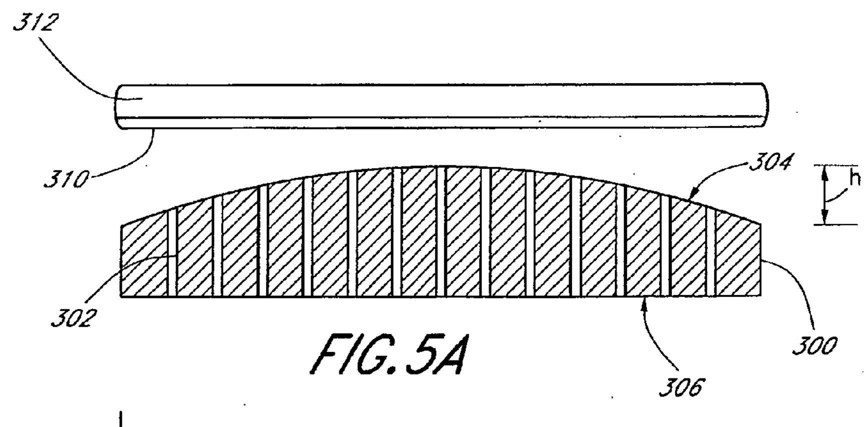


FIG. 5A

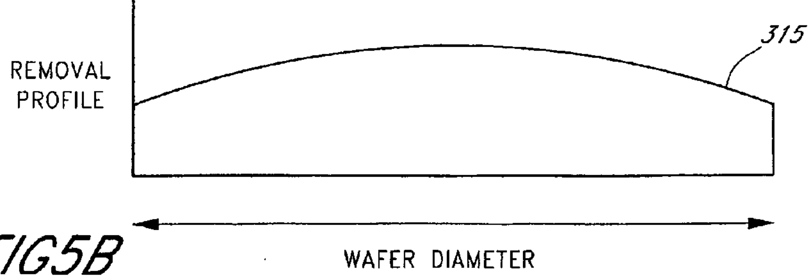


FIG5B

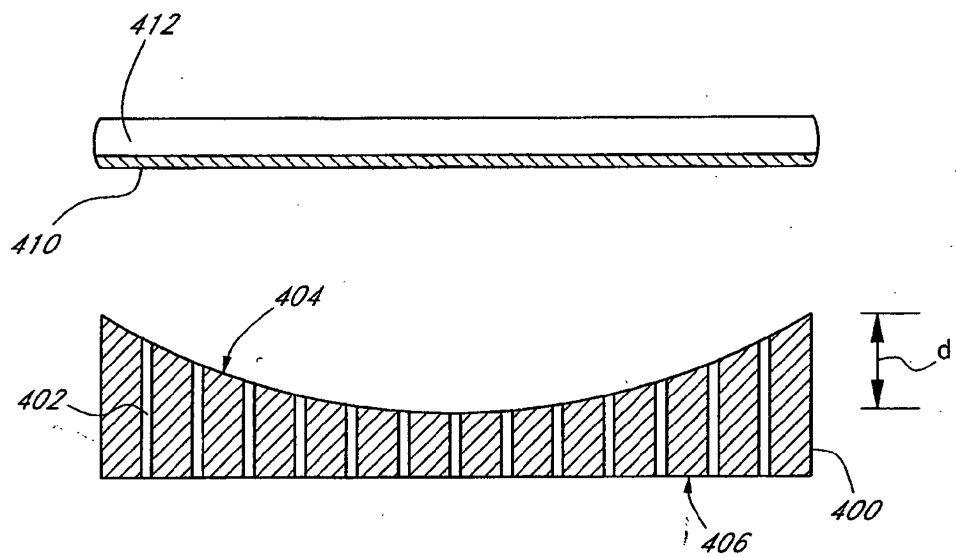


FIG. 6A

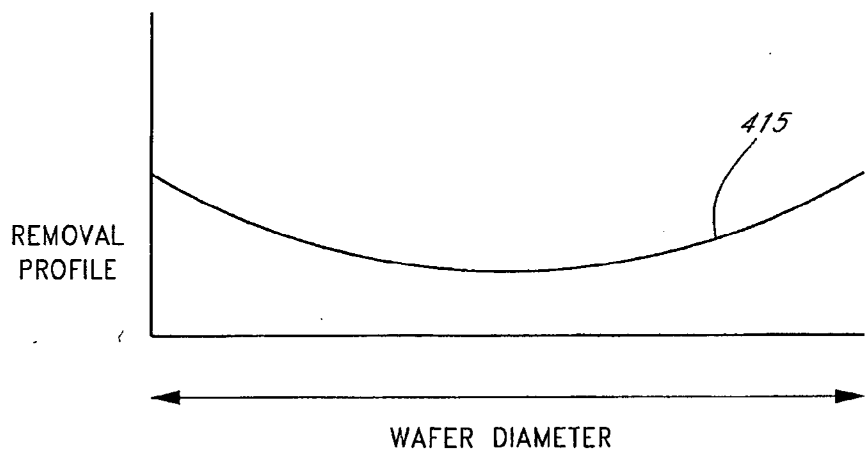


FIG. 6B

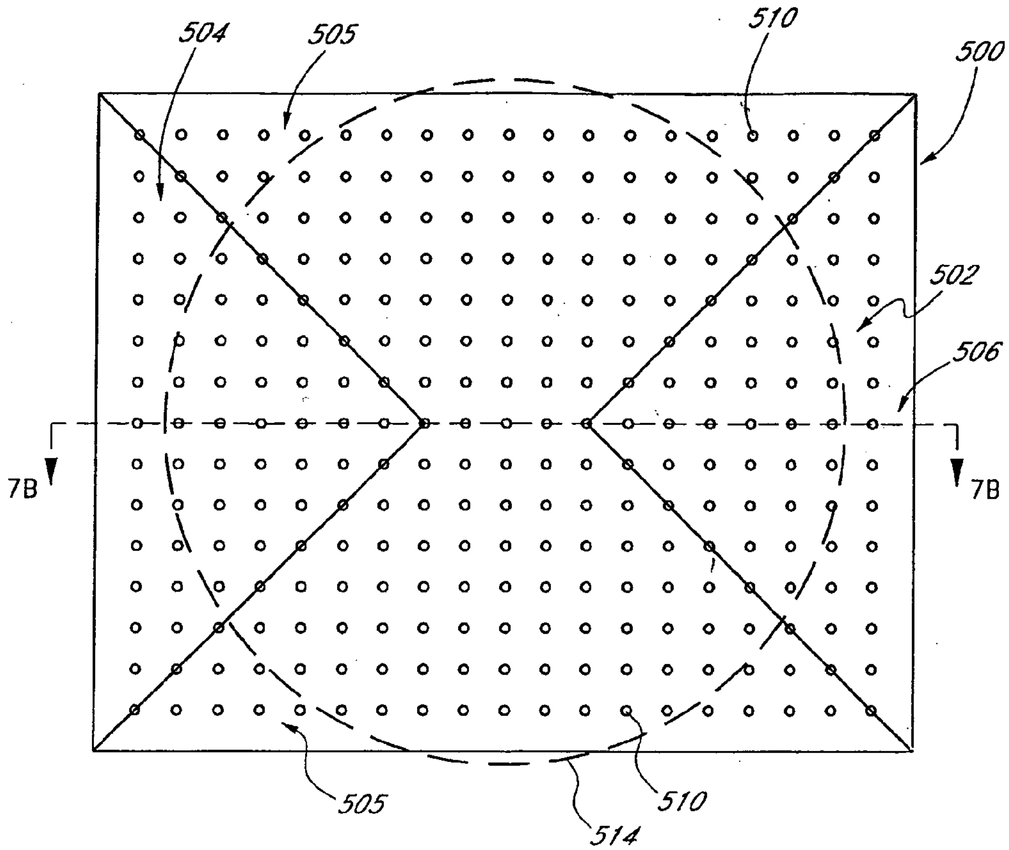

504
505
510
500
502
506
7B
7B
505
514
510

FIG. 7A

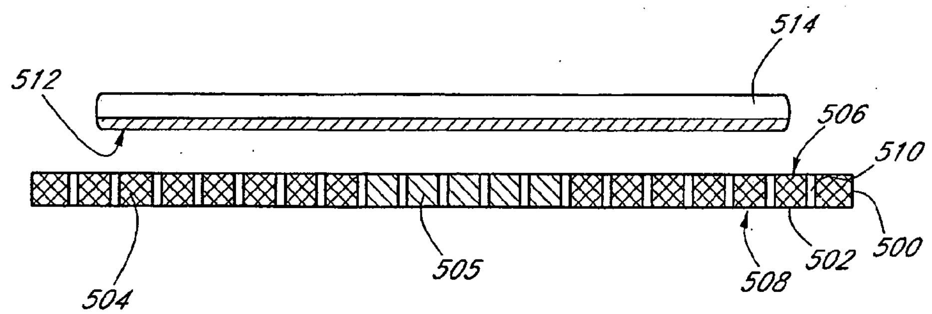

514
512
506
510
504
505
508
502
500

FIG. 7B

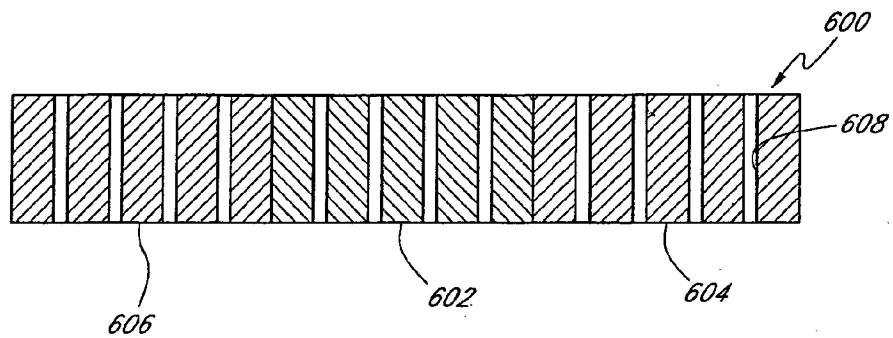


FIG. 8A

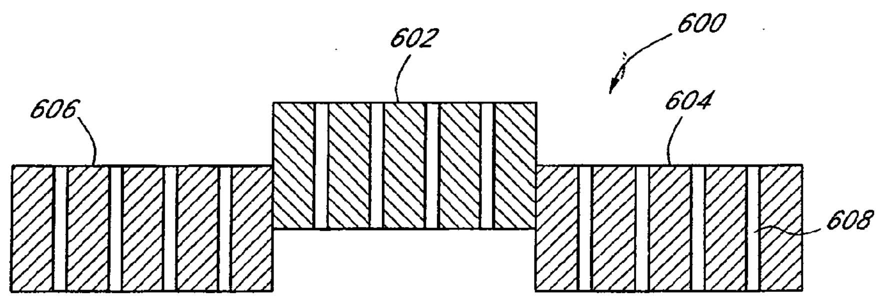


FIG. 8B

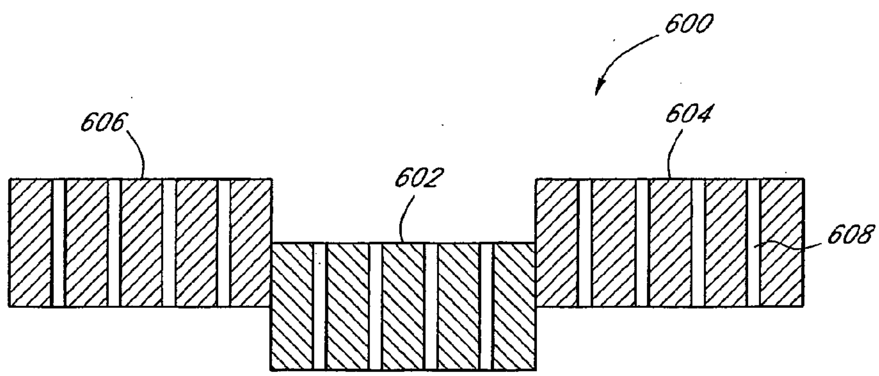


FIG. 8C

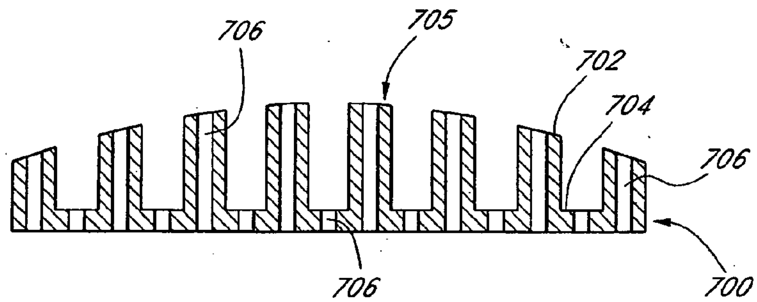


FIG. 9A

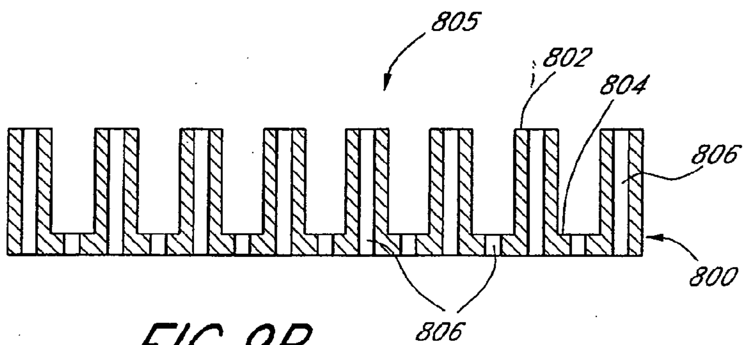


FIG. 9B

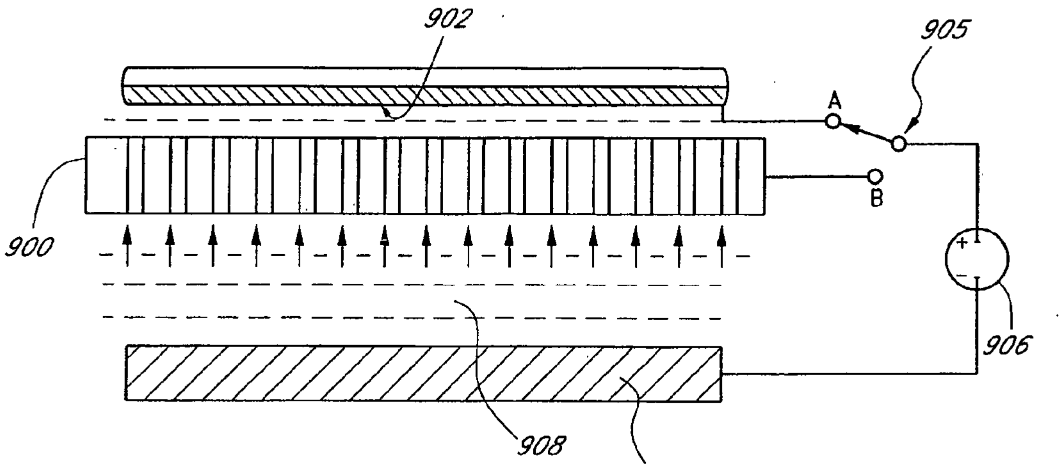


FIG. 10

METHOD AND SYSTEM FOR CONTROLLED MATERIAL REMOVAL BY ELECTROCHEMICAL POLISHING

RELATED APPLICATIONS

[0001] This application claims priority from Provisional Application Ser. No. 60/491,470 filed Jul. 30, 2003 (NT-305 P). This application is a continuation in part of U.S. patent application Ser. No. 10/302,755 filed Nov. 21, 2002 (NT-205); and U.S. patent application Ser. No. 10/152,793 filed May 23, 2002 (NT-102 D) which is a divisional application of U.S. patent application Ser. No. 09/511,278 filed Feb. 23, 2000 (NT-102), now U.S. Pat. No. 6,413,388, all incorporated herein by reference.

FIELD

[0002] The present invention relates to manufacture of semiconductor integrated circuits and, more particularly to a method for electrochemically or electrochemical-mechanically polishing of conductive layers.

BACKGROUND

[0003] Conventional semiconductor devices generally include a semiconductor substrate, usually a silicon substrate, and a plurality of sequentially formed dielectric layers and conductive paths or interconnects made of conductive materials. Interconnects are usually formed by filling a conductive material in trenches etched into the dielectric layers. In an integrated circuit, multiple levels of interconnect networks laterally extend with respect to the substrate surface. Interconnects formed in different layers can be electrically connected using vias or contacts.

[0004] The filling of a conductive material into features such as vias, trenches, pads or contacts, can be carried out by electrodeposition or electroplating. In electrodeposition method, a conductive material, such as copper is deposited over the substrate surface including into such features. Then, a material removal technique is employed to planarize and remove the excess metal from the top surface, leaving conductors only in the features or cavities. Conventionally, chemical mechanical polishing (CMP) and electropolishing is employed to planarize and remove excess metal layers deposited on semiconductor wafers.

[0005] Chemical mechanical polishing (CMP) process planarizes and reduce the thickness of the copper layer to the level of the barrier layer coating the top surface so that copper is only left inside the etched features. CMP can further remove all of the conductors from the top surface so that copper-filled features are electrically isolated from one another. However, CMP process is a costly and time-consuming process that reduces production efficiency. Furthermore, although CMP can be used with the conventional interlayer dielectrics, it may create problems with porous low-k dielectrics because of the mechanical force applied on the wafer surface during the CMP process. During the CMP step, the porous low-k materials may be stressed and may delaminate or other defects may form due to the low mechanical strength of such materials.

[0006] Another material removal technique involves well-known electropolishing processes. During an electropolishing process, both the material to be removed and a conductive electrode remain in an electropolishing solution. Typically, an anodic (positive) voltage is applied to the material to be removed with respect to the conductive electrode. With the applied voltage, the material is electrochemically dissolved and removed from the wafer surface.

[0007] In interconnect manufacturing, electropolishing process can be used to reduce the thickness of the overburden or excess copper layers deposited on the semiconductor substrates, as exemplified in FIG. **1**. Copper **10** is electrodeposited on a dielectric layer **12** that is previously formed on the semiconductor substrate **14**. Features **16** as well as the surface **20** of the dielectric layer **14** are filled with copper **10**. Before the copper deposition, a barrier layer **22** such as Tantalum layer and a copper seed layer (not shown) are coated in the features and the surface of the dielectric layer **12**. The conventional method for removal of the excess copper from the surface **20** is CMP. As mentioned above, electropolishing can also be used to reduce the thickness of this copper layer to an exemplary level indicated by dashed line **24**, or even eliminate all copper from the surface as indicated by line **25**. However, to be able to achieve these results without removing any copper from the features, the electropolishing process needs to be highly efficient and uniform. In cases where the thickness of copper on the wafer surface is not uniform but has a profile, the electropolishing technique should provide capability to tune the removal rate profile to match the initial copper thickness profile on the wafer.

SUMMARY

[0008] Present invention provides an electrochemical or electrochemical mechanical material removal system and an electrochemical or electrochemical mechanical material removal method employing a device made of a conductive material. The device is positioned between an electrode of the system and a conductive surface of a workpiece that is being electrochemically removed. The device includes openings or pores, which allow a process solution, such as an electroetching or electropolishing solution, to flow through the device.

[0009] The solution contacts the electrode, the device and the conductive surface when a material removal potential is applied between the conductive surface (anode) and the electrode (cathode).

[0010] In one aspect of the present invention, material removal rate is controlled by adjusting the distance between the conductive surface and a device surface that faces the conductive surface.

[0011] In another aspect of the present invention, material removal profile from the conductive surface can be controlled with the geometry or topography of the device surface.

[0012] A device surface, when placed substantially parallel to the conductive surface, the electropolishing of the conductive surface is efficient and produces a substantially uniform material removal rate.

[0013] A device surface with a center high and edge low profile causes a material removal rate which is higher near the center of the conductive surface.

[0014] A device surface with an edge high and center low profile causes a material removal rate which is lower near the center of the conductive surface.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. **1** is a schematic illustration of a substrate having an electroplated copper layer;

[0016] FIG. **2** is a schematic illustration of an embodiment of an electropolishing system of the present invention;

[0017] FIG. **3** is a graph shoving a conventional electropolishing removal profile and an electropolishing removal profile of the present invention;

[0018] FIG. **4** is a schematic illustration of another embodiment of an electropolishing system of the present invention;

[0019] FIG. **5**A is a schematic illustration of an embodiment of a conductive element of the present invention;

[0020] FIG. **5**B is a graph shoving an electropolishing removal profile obtained using the conductive element shown in FIG. **5**A;

[0021] FIG. **6**A is a schematic illustration of another embodiment of a conductive element of the present invention;

[0022] FIG. **6**B is a graph shoving an electropolishing removal profile obtained using the conductive element shown in FIG. **6**A;

[0023] FIG. **7**A is a schematic plan view of an embodiment of a conductive element of the present invention;

[0024] FIG. **7**B is a schematic side view of an embodiment of the conductive element of the present invention shown in FIG. **7**A;

[0025] FIGS. **8**A-**8**C are schematic illustrations of a conductive element with movable sections;

[0026] FIGS. **9**A-**9**B are schematic illustrations of embodiments of various conductive elements; and

[0027] FIG. **10** is a schematic illustration of a switch system for electrochemically cleaning the conductive element at process intervals.

DETAILED DESCRIPTION

[0028] Present invention provides an electropolishing system and a method using a conductive member positioned between an electrode and a workpiece surface that is being electropolished. The conductive member may be a perforated or porous plate, which allows a process solution to flow through it. The electropolishing solution contacts the electrode, the conductive member and the workpiece surface while an electropolishing potential is applied between the workpiece surface (anode) and the electrode (cathode). Material removal rate may be controlled by adjusting the distance between the conductive member surface and the workpiece surface as well by the adjustment of the voltage applied between (or current passing through) the workpiece surface and the electrode. In this respect, as the conductive member surface gets closer to the workpiece surface, the material removal rate is increased. Further, material removal profile from the workpiece surface can be controlled with the geometry or topography of the conductive member surface that faces the workpiece surface. For example, if the conductive member surface is flat and parallel to the workpiece surface, the electropolishing of the workpiece surface produces a substantially uniform removal rate. If the conductive member surface has a center high and edge low profile, material removal rate at the center of the workpiece surface is higher than the edge of the workpiece. As a result, electropolishing process results in a center low profile for the removal rate. Similarly, if the conductive member has an edge high and center low profile, the material etching or polishing rate at the center of the workpiece surface will be lower than the edge of the workpiece. This, in turn, results in a removal rate profile, which is edge low. Here, the profile of the conductive member surface refers to three dimensional shape of the surface or topography of the surface.

[0029] FIG. **2** shows an exemplary electropolishing system **100** to perform process of the present invention. The system **100** comprises a carrier **102** to hold a workpiece **104** or a wafer, an electrode **106** placed across the wafer **104** and a conductive member **108** positioned between a front surface **110** of the wafer **104** and the electrode **106**. The conductive member **108** may be a conductive perforated plate and, in this embodiment, is not connected to any power source. Since the described process is an electrochemical removal or electropolishing process, the electrode **106** becomes cathode of the system **100** while the front surface **110** of the wafer **104** becomes the anode. In other words, the front surface **110** may be defined as anodic compared to the cathode electrode **106**. The conductive member **108**, although not connected to any power source, is electrically more cathodic compared to the front surface **110** of the wafer and more anodic compared to the cathode electrode **106**. Further, since the conductive member **108** is between the front surface **110** and the electrode **106**, which is a cathode, its voltage is expected to be positive but lower than the front surface voltage of the wafer **104**. The front surface **110** and the electrode **106** are connected to a power supply **112** through electrical contacts (not shown). The electrical contacts may be conductive brushes contacting the perimeter of the wafer **104** while the wafer is moved or rotated. Such electrical contacts are described in U.S. patent application Ser. No. 10/282,930 entitled Method and System to Provide Electrical Contacts for Electrotreating Processes filed Oct. 28, 2002, which is owned assignee of the present application. Alternately, other contacting methods well known in the art may be used. The wafer **104** may be a semiconductor wafer and the front surface **110** may include a previously deposited copper layer to be electropolished, such as exemplified in FIG. **1**. The carrier **102** is able to rotate and move wafer **104** vertically and laterally during the process.

[0030] The conductive member **108** includes a first surface **114** and a second surface **116** and a plurality of openings **118** extending between the first and the second surfaces. The first surface **114** faces the front surface **110** of the wafer **104**, and the second surface **116** is placed across the electrode **106**. In this embodiment, the first surface **114** is flat and placed parallel to the front surface **110** to facilitate uniform electropolishing of the front surface. However, as will be described more fully below, the first surface **114** of the conductive member **108** may have different geometrical profiles to shape removal profile of the front surface **110** of the wafer **104**. Preferably, a plurality of openings **118** extends between the first surface **114** and the second surface **116** of the conductive member **108**. A process solution **120** such as an electropolishing solution flow through the openings **118**.

[0031] Referring back to FIG. **2**, the conductive member **108** divides system **100** into two sections, namely a cathodic section **122** and an anodic section **124**. Openings **118** allow the electropolishing solution **120** to flow between the cathodic section **122** and the anodic section **124** of the system **100**. In the cathodic section **122**, the electropolishing solution **120** is in contact with the cathode electrode **106** and the conductive member **108**, and in the anodic section **124**, the solution **120** is in contact with the front surface **110** (conductive surface) of the wafer **104** and the conductive member **108**. Although FIG. **2** exemplifies the cathode electrode **106**, the conductive member **108** and the wafer **104** in a lateral configuration, they can be aligned vertically or in upside down geometry and this is within the scope of this invention.

[0032] The conductive member **108** is made of a conductive material, such as a metal or metal alloy, or coated with a conductive material. The conductive member **108** can also be a conductive porous material or a mesh, instead of having openings **118** which are well defined, as shown in FIG. **2**. However, in any case the conductive member should allow solution flow between the anodic section and the cathodic section. The conductive member **108** is separated from the front surface of the wafer **104** by a distance d_1 and from the electrode **106** by a distance d_2. Preferably, the distance d_1 is smaller than the distance d_2. The distance between the front surface **110** of the wafer **104** and the electrode is d_3. In one exemplary embodiment d_2 may be larger than 50 millimeters (mm) and d_1 is smaller than 5 mm.

[0033] In one exemplary electropolishing process of the present invention, the front surface of the wafer **104** is moved closer to the first surface **114** of the conductive member **108** while the electropolishing solution **120** is flowed through the conductive member **108**. As the wafer **104** is rotated or moved, or rotated and moved in proximity of the first surface **114** of the conductive member, a potential difference is applied between the front surface and the electrode **106** to electropolish the copper of the front surface **110**. In this example, the distance d_1 is 2-4 mm. During electropolishing, the front surface **110** of the wafer **104** may get very close to the first surface of the conductive member **108** but it never touches the conductive member.

[0034] In an alternative embodiment, the front surface **110** of the wafer may be occasionally or continuously swept with a pad material (not shown) during the electrochemical removal process. The sweeping process may be used to planarize the front surface **110** as it is electropolished. An example of use of pad material during electrochemical mechanical processes can be found in U.S. application Ser. No. 09/607,567 entitled Method and Apparatus for Electrochemical Mechanical Deposition, filed Jun. 29, 2000, which is owned by the assignee of the present application and which is incorporated herein by reference. This process is sometimes referred to as electrochemical mechanical etching (ECME) or electrochemical mechanical polishing (ECMP). In one embodiment, the pad material may be mounted on the first surface **114** of the conductive member itself. The pad material may have openings to let the process solution flow through or it may be made of a porous pad material. The pad material may also be attached on the first surface **114** of the conductive member **108** as pad pieces or strips. It should be noted that in FIGS. **2** and **3** the electropolishing solution **120** is shown to flow from the cathode electrode **106** towards the front surface **110** of the wafer **104**. This is the preferred process solution flow direction. However, the present invention can be also performed by reversing the direction of the process solution. Further, in one embodiment, the process solution does not flow but forms a process solution pool in which electropolishing is carried out. Furthermore, although not shown, the electropolishing solution **120** may be re-circulated after filtering and cleaning.

[0035] In FIG. **3**, the curve **132** shows material removal profile across the diameter of the wafer **104** when the electropolishing process of the present embodiment is applied. Removal profile depicted in curve **132** shows a flat removal profile with less than 2% non-uniformity. As shown in FIG. **3** for comparison reasons, when the same electropolishing process is repeated after replacing the conductive member **108** with a non-conductive member or by taking it out of the process solution altogether, the removal profile depicted with curve **134** is non-uniform and consequently non-repeatable. It should be appreciated that when the electrochemical removal process is applied to a large numbers of wafers, copper removed from the wafer surface is mostly deposited on the electrode surface. However, this copper may be porous or powdery and as it deposits on the electrode it may change the shape of the electrode and its surface conductance. Consequently, in time, as more and more wafers are processed, electric field lines between the electrode and the substrate are expected to change. This causes changes in the material removal profiles. In other words, the removal profile may not be repeatable for processing large number of wafers. This is not acceptable in a semiconductor IC production environment. Presence of the conductive element, which is positioned very close to the front surface of the wafer, assures uniform copper removal rate irrespective of the number of wafers processed.

[0036] FIG. **4** shows another exemplary system to perform the electropolishing process of the present invention. In system **200**, a conductive member **202** encloses a solution chamber **203** including a cathode electrode **204** in a process solution **205**. The process solution **205** may be an electropolishing solution or electrolyte. It should be noted that the cathode electrode **204** does not have to be in the solution chamber **203**. It may be placed at a different location as long as there is fluid communication between it and the solution chamber **203** through the process solution **205**. A wafer carrier **206** holds a conductive surface **208** of a workpiece **209** or wafer close to an upper surface **210** of the conductive member **202**. Process solution **205** is delivered into the solution chamber **203** through a delivery port **214** and flowed through openings **216** of the conductive member **202** towards the conductive surface **208** of the wafer **204**. During the process, wafer **209** is rotated and/or laterally moved above the upper surface **210** of the conductive member **202** while a potential difference is applied between the conductive surface **208** and the cathode electrode **204** from a power source **218**. In this embodiment, sidewalls **220** of the solution chamber **203** are made of a non-conductive, isolating material to prevent electrical shorting between the cathode electrode **204** and the conductive member **202**. It should be noted that other components such as filters, bubble reduction means, shaping plates, etc., may be included in the solution chamber design of FIG. **4**. For example, a filter element may be attached to a lower surface **222** of the conductive member **202** to reduce or eliminate particles that may come to the front surface **208** of the wafer **209**. Another filter element may be placed over the cathode electrode **204** confining particles generated on the electrode during the process to the region close to the electrode.

[0037] As shown in FIGS. **5**A and **6**A, the conductive members can be shaped depending on desired removal profile of the conductive surface of the wafer. FIG. **5**A shows a conductive member **300** with center high design with openings **302** extending between a first surface **304** and a second surface **306**. The first surface **304** has a convex shape. The conductive surface **310** of the wafer **312** faces the first surface **304**. For the purpose of clarity, in FIG. **5**A, the center high shape of the first surface **304** is exaggerated. In practice, the height 'h' of the convex surface may be in the range of 0.5-3 mm or less. As shown in FIG. **5**B with curve **315**, electropolishing process with the conductive member **300** yields a center high material removal profile.

[0038] FIG. **6**A shows another example of a conductive member **400** with edge high design with openings **402** extending between a first surface **404** and a second surface **406**. The first surface **404** has a concave shape. The conductive surface **410** of the wafer **412** faces the first surface **404**. For the purpose of clarity, in FIG. **6**A, the center low shape of the first surface **404** is exaggerated. In practice, depth 'd' of the surface may be in the range of 0.5-3 mm or less. As shown in FIG. **6**B with curve **415**, electropolishing process with the conductive member **400** yields a center low and edge high material removal profile. The second surfaces **306**, **406** are shown flat in FIGS. **5**A and **6**A. It should be understood that shapes of these surfaces may be different. What is most effective in determining removal profile is the shape of the first surfaces **304** and **404**.

[0039] In another example, conductive member may have insulating or high resistivity portions juxtaposed with the conductive portions. Shape, geometry and the location of the insulating portions shape the removal profile. One example of a conductive member **500** having insulated regions **502**, **504** and conductive region **505** is shown in FIGS. **7**A-**7**B. The conductive member **500** has a first surface **506** and a second surface **508**. Openings **510** extend between the first and the second surfaces. The insulated regions **502**, **504** of the conductive member **500** may be made of an electrical insulation material or may just be an electrically insulating film or layer partially coated or attached on the first surface of the conductive member **500**. Insulated regions **502**, **504** as well as the conductive region **505** may not be co-planar but they may be formed as recesses or raised regions. For example, the insulated regions **502**, **504** may form the recessed regions and the conductive region **505** may form the raised region. As a front surface **512** of a wafer **514** is electropolished, when a portion of the front surface **512** moves over the insulated regions **502**, **504**, that portion is electropolished in a reduced rate for that time duration. As shown in FIG. **7**A in plan view and in FIG. **7**B in cross section, in this embodiment, as the wafer **514** is rotated, edge region of the front surface **512** is partially exposed to the insulated regions **502**, **504** and material removal from the edge region will be less than the center of the front surface **512** which is exposed to the conductive region **505** of the conductive member **500**. This electropolishing process yields a center high removal profile similar to the one shown in FIG. **5**B. During the electropolishing process, electrical contact to the front surface may be made along the edge of the wafer using conductive brush or other type contacts. Such contacts are described in the above mentioned U.S. application Ser. No. 10/282,930 which is incorporated herein by reference.

[0040] FIGS. **8**A-**8**C exemplifies a conductive member **600** having movable sections **602**, **604** and **606** and openings **608**. By moving the sections **602**, **604** and **606** up and down with respect to one another, various configurations of the conductive member **600** may be obtained. Such configurations can be used to obtain different material removal profiles that have been described above. For example, conductive member configuration shown in FIG. **8**A can be used to obtain uniform material profiles. Conductive member configuration shown in FIG. **8**B can be used to obtain center high-edge low material removal profile and the configuration in FIG. **8**C can be used to obtain center low-edge high material removal profile.

[0041] Conductive members may have discontinuous surface profiles including raised and recessed portions. Raised or recessed portions may be aligned along certain profiles. FIG. **9**A shows a conductive member **700** having raised portions **702** and recessed portions **704** formed along a primary surface **705** of the conductive member **700**. Openings **706** may be formed through the raised portions **702** and recessed portions **704**. In this embodiment, a plurality of raised portions **704** form a center high profile, which in turn enables center high material removal profile during the electropolishing. The surface to be electropolished must face the raised and recessed portions, or primary surface **705** of the conductive member **700**, during the process. FIG. **9**B shows another conductive member **800** having raised portions **802** and recessed portions **804** formed along a primary surface **805** of the conductive member. Openings **806** are formed through the portions **802** and **804**. In this embodiment, raised portions **804** have the same height, which enables uniform material removal profile during the electropolishing. The surface to be electropolished must face the raised and recessed portions, or primary surface of the conductive member, during the process. The recessed portions may be coated with an insulating material leaving only the raised portions conductive and active during the process.

[0042] FIG. **10** illustrates a method for cleaning a conductive member **900**. As described above, after a certain time of use or process cycles, a conductive material accumulation may occur on the conductive member **900** since the conductive member is more cathodic compared to a conductive surface **902** of a wafer **904**. Therefore, conductive member needs to be cleaned with certain intervals. One possible way of cleaning may be done by anodically polarizing the conductive member **900** and dissolving the accumulated material at certain intervals. FIG. **10** shows one embodiment of the cleaning process. In this embodiment, when a switch **905** is connected position "A", power source **906** applies a potential difference between the conductive surface **902** and the cathode electrode **907**. In presence of electropolishing solution **908**, this connection results in electropolishing of the conductive surface **902**. Most of the removed material deposits on the cathode electrode **907**. However, depending on the distance between the surface **902** and the top surface of the conductive member **900**, some deposition can also take place on the conductive member **900**. This deposited conductive material affects the electropolishing uniformity provided by the conductive member **900** and needs to be cleaned at intervals. Typically, larger distances would result in more deposition on the conductive member. For cleaning the conductive member **900**, the switch **905** is turned to position "B" and a potential difference, which may or may not be the same as the one applied when switch **905** was in "A" position, is applied between the conductive member **900** and the electrode **907** making the conductive member an anode. This action cleans the accumulated material on the conductive member **900**. After the cleaning, electropolishing process may continue on other wafers by moving the switch **905** to position "A".

[0043] Although the present invention has been particularly described with reference to the preferred embodiments, it should be readily apparent to those of ordinary skill in the art that changes and modifications in the form and details may be made without departing from the spirit and scope of the invention.

We claim:

1. An apparatus for electropolishing a conductive layer on a workpiece using a process solution, comprising:

a carrier to hold the workpiece;

an electrode; and

a conductive element placed between the electrode and the conductive layer, the conductive element having openings permitting process solution to flow through the conductive element and the conductive element having a surface placed across from the conductive layer, the surface of the conductive element including a surface profile to control the material removal profile of the conductive layer.

2. The apparatus of claim **1**, wherein the surface profile is a convex surface profile.

3. The apparatus of claim **1**, wherein the surface profile is a concave surface profile.

4. The apparatus of claim **1**, wherein the surface profile is flat.

5. The apparatus of claim **1** further comprising a power supply to apply a potential difference between the electrode and the conductive surface.

6. The apparatus of claim **1**, wherein the surface of the conductive element includes a pad to polish the conductive layer.

7. The apparatus of claim **1**, wherein the carrier is configured to vary the distance between the conductive layer and the surface of the conductive layer.

8. The apparatus of claim **5**, wherein the power supply is configured to vary the potential difference between the conductive layer and the electrode.

9. The apparatus of claim **5**, wherein the power supply is configured to apply a potential difference between the conductive element and the electrode to electrochemically clean the conductive element at process intervals.

10. The apparatus of claim **1**, wherein the conductive layer is copper.

11. A method of electropolishing a conductive layer on a wafer using a process solution and an electrode, the method comprising:

placing a surface of a conductive element across from the conductive layer, the surface of the conductive element having a first surface profile; and

applying a potential difference between the conductive layer and the electrode; and

forming a first conductive layer profile of the conductive layer.

12. The method of claim **11**, wherein the step of forming comprises electropolishing the conductive layer according to a first material removal profile.

13. The method of claim **11**, wherein the step of placing comprises placing a surface of another conductive element, the surface having a second surface profile.

14. The method of claim **13** further comprising:

applying a potential difference between the conductive layer and the electrode; and

forming a second conductive layer profile of the conductive layer.

15. The method of claim **14**, wherein the step of forming comprises electropolishing the conductive layer according to a second material removal profile.

16. The method of claim **13** further comprising varying the potential difference during the step of applying to vary material removal rate from the conductive layer.

17. An apparatus for electropolishing a conductive layer on a workpiece using a process solution, comprising:

a carrier to hold the workpiece;

an electrode; and

a conductive element placed between the electrode and the conductive layer, the conductive element having openings permitting process solution to flow through the conductive element and the conductive element having a surface placed across from the conductive layer; and

wherein the conductive element is comprised of movable sections to alter the profile of the surface by moving the movable sections to control the material removal profile of the conductive layer.

18. The apparatus of claim **17** further comprising a power supply to apply a potential difference between the electrode and the conductive surface.

19. The apparatus of claim **17**, wherein the surface of the conductive element includes a pad to polish the conductive layer.

20. The apparatus of claim **17**, wherein the carrier is configured to vary the distance between the conductive layer and the surface of the conductive element.

21. The apparatus of claim **18**, wherein the power supply is configured to vary the potential difference between the conductive layer and the electrode.

22. The apparatus of claim **18**, wherein the power supply is configured to apply a potential difference between the conductive element and the electrode to electrochemically clean the conductive element at process intervals.

23. The apparatus of claim **17**, wherein the conductive layer is copper.

24. A method of electropolishing a conductive layer on a wafer using a process solution and an electrode, the method comprising:

placing a surface of a conductive member across from the conductive layer, the conductive element having openings permitting process solution to flow through the conductive element and the conductive element comprising movable sections;

changing the profile of the surface of the conductive member to a predetermined profile by moving the movable sections;

applying a potential difference between the conductive layer and the electrode; and

forming a predetermined conductive layer profile of the conductive layer.

25. The method of claim **24**, wherein the step of forming comprises electropolishing the conductive layer according to a predetermined material removal profile.

26. The method of claim **24**, wherein the step of changing comprises changing the profile of the surface of the conductive member to another predetermined profile by moving the movable sections.

27. The method of claim **26** further comprising:

applying a potential difference between the conductive layer and the electrode; and

forming another predetermined conductive layer profile of the conductive.

28. The method of claim **24**, wherein the step of forming comprises electropolishing the conductive layer according to another predetermined material removal profile.

29. The method of claim **24** further comprising varying the potential difference during the step of applying to vary material removal rate from the conductive layer.

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