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(54) **IN-SITU PRE-CLEAN FOR ELECTROPLATING PROCESS**

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(75) Inventors: **Rajeev Bajaj**, Fremont, CA (US);
Ramin Emami, San Jose, CA (US)

(57) **ABSTRACT**

Correspondence Address:
APPLIED MATERIALS, INC.
2881 SCOTT BLVD. M/S 2061
SANTA CLARA, CA 95050 (US)

Embodiments of the invention generally provide a waveform to be applied to a seed layer prior to initiating plating operations, wherein the waveform is configured to remove organic contaminants from the seed layer. The application of the waveform generally includes applying a plurality of anodic pulses to the seed layer prior to an electrochemical deposition process and subsequent to the seed layer contacting a plating solution, and applying a cathodic pulse to the seed layer immediately following each of the plurality of anodic pulses. The waveform is generally provided by a power supply in electrical communication with a system controller configured to supply controlling signals to the power supply.

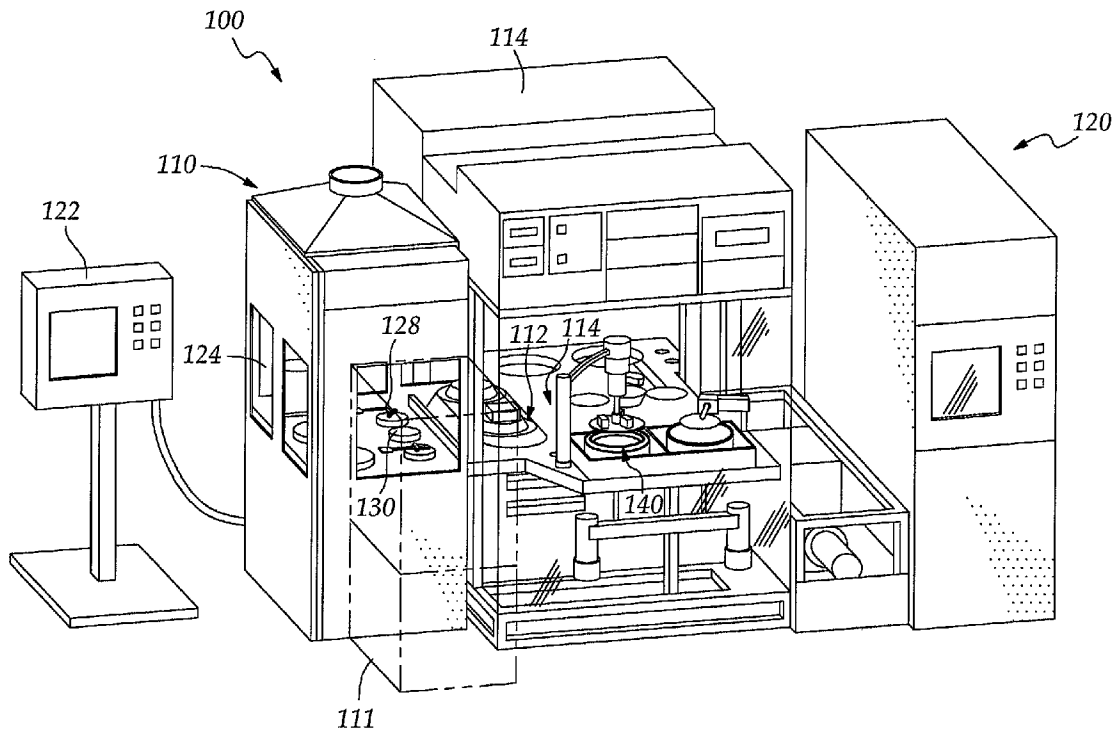
(73) Assignee: **Applied Materials, Inc.**

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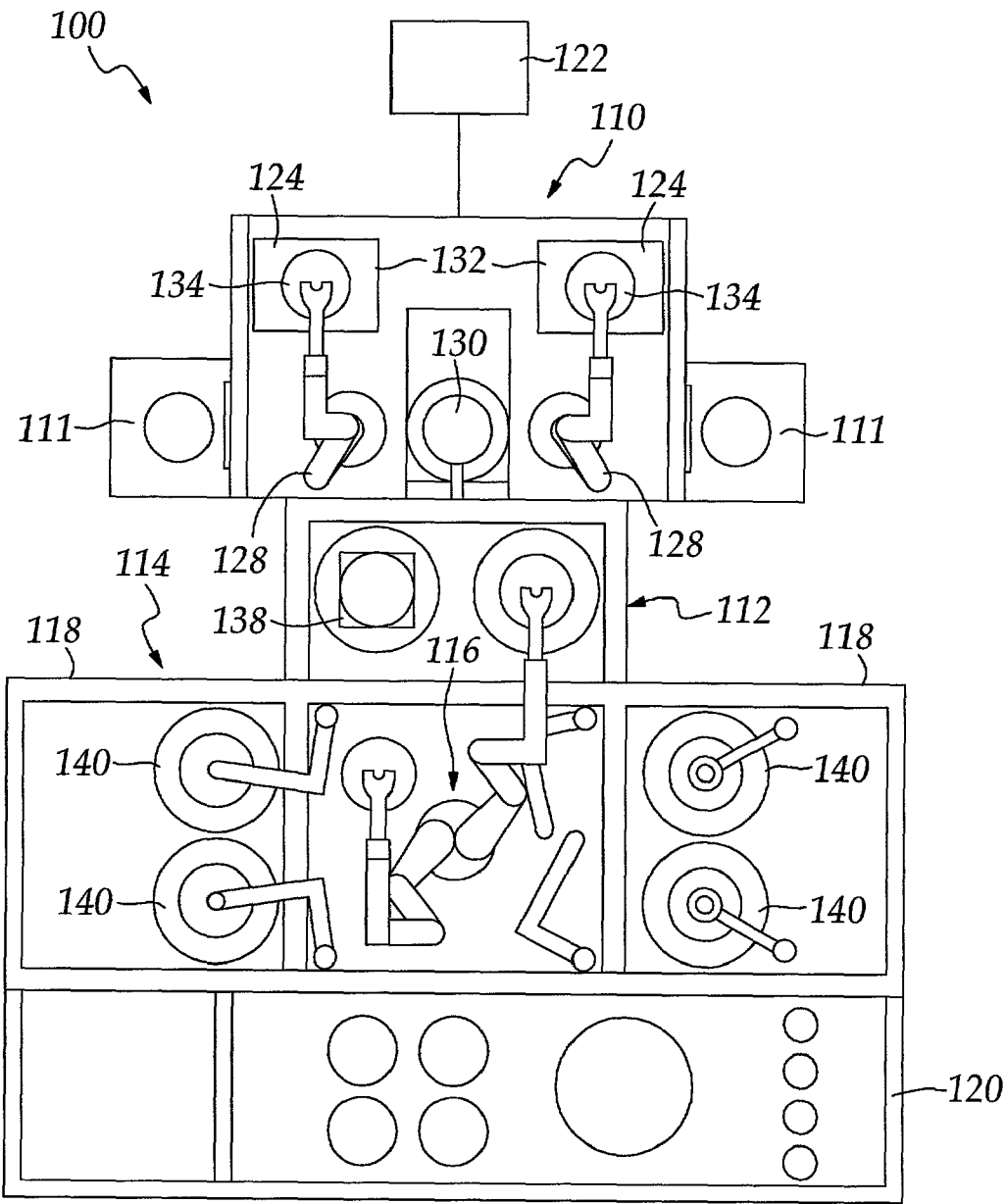


FIG. 2

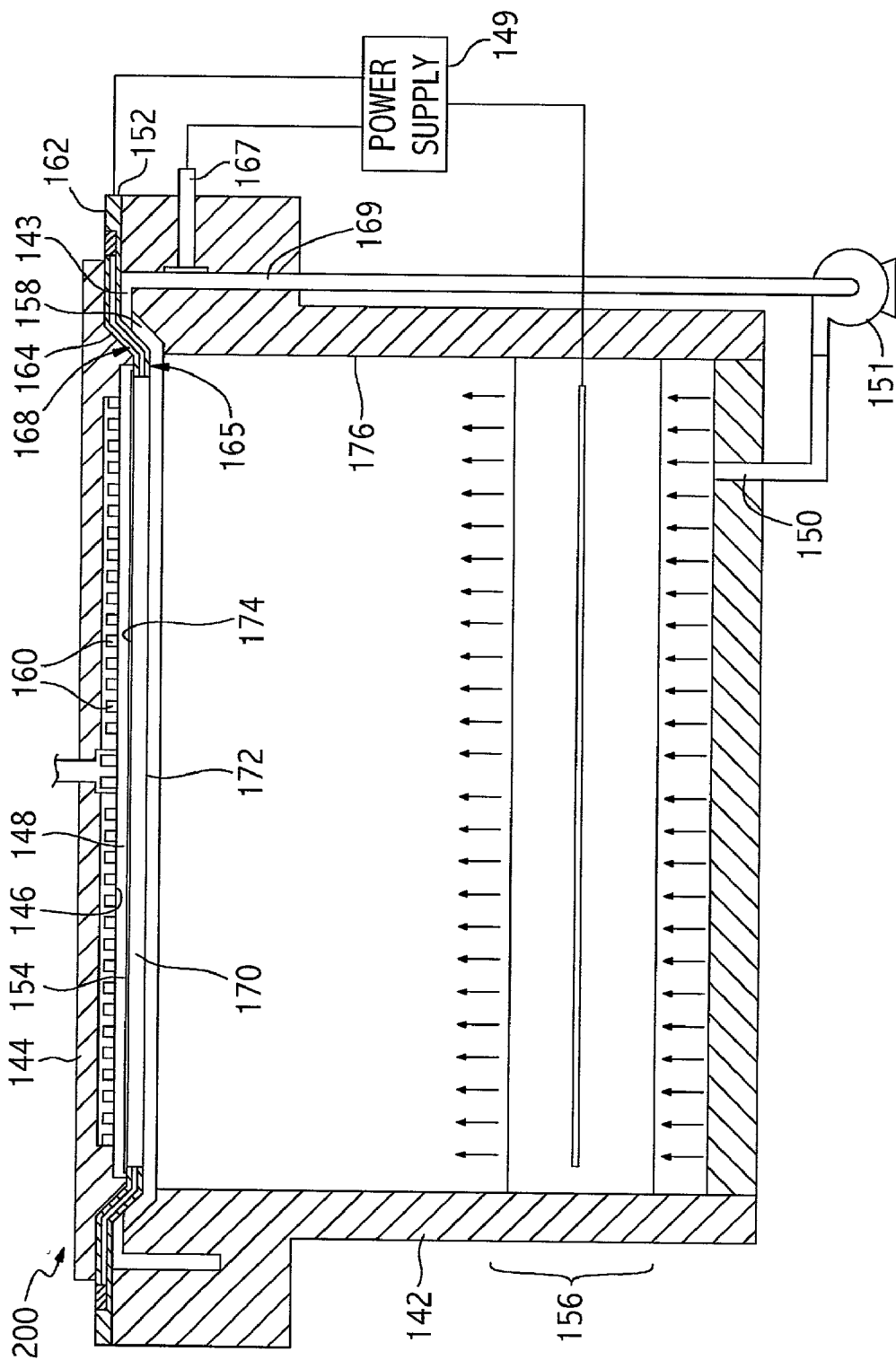


FIG. 2A

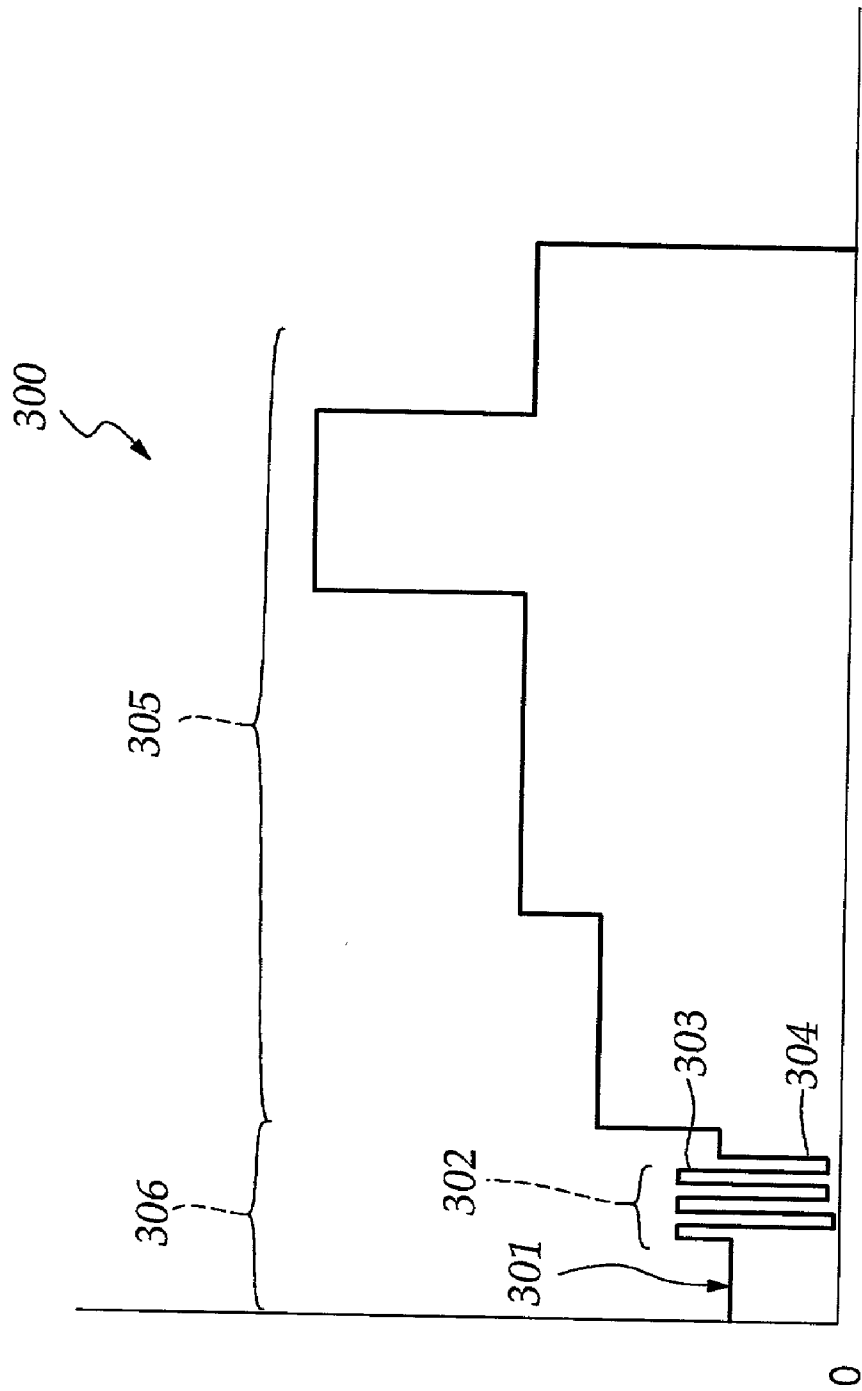
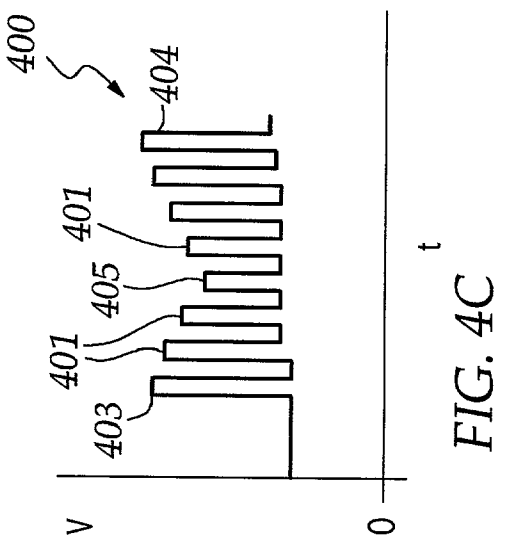
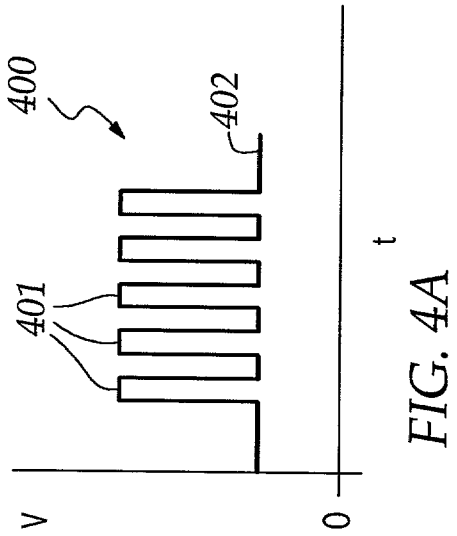
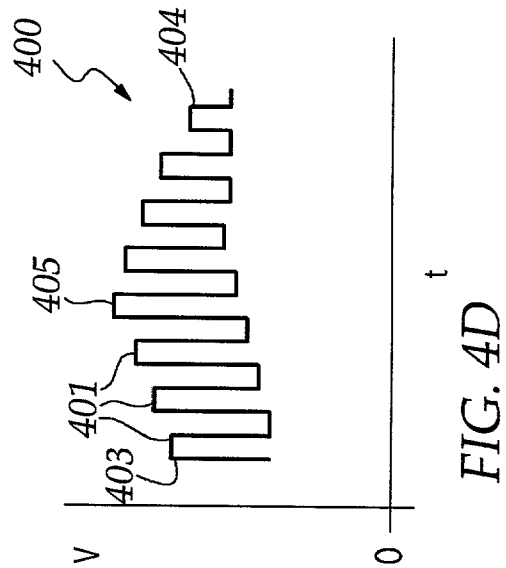
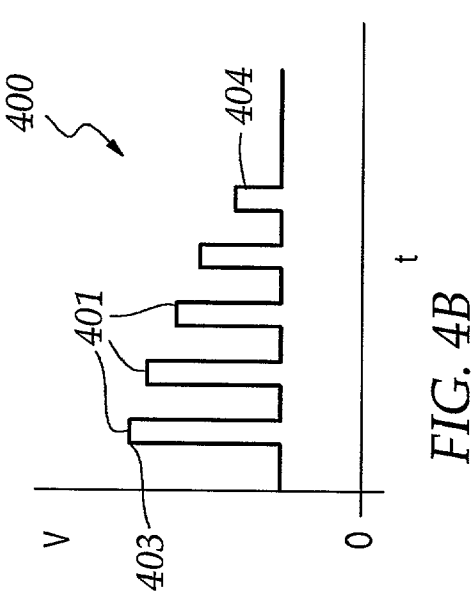


FIG. 3



IN-SITU PRE-CLEAN FOR ELECTROPLATING PROCESS

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention generally relates to removal of organic contaminants from a seed layer in an electroplating process.

[0003] 2. Description of the Related Art

[0004] Metallization for 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 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), for example, have been used to fill these interconnect features. However, as 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 viable processes for filling 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 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 an 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] However, one challenge associated with ECP processes is that the surface of the seed layer may become contaminated with organic material between the time the seed layer is deposited and the time the seed layer is exposed to the electrolyte solution for plating, as the seed layer is generally deposited on the substrate in a separate chamber/apparatus from the plating system. Organic material contamination may therefore result, for example, from exposure of the seed layer to air in the transfer process between a deposition chamber used to deposit the seed layer and an ECP chamber. This organic material contamination poses significant problems, as organic material contamination on the surface of the seed layer has been shown to affect plating uniformity in the areas above the organic contamination. Therefore, there is a need for an apparatus and method for removing organic contamination from the surface of a seed layer prior to the initiating an ECP process.

SUMMARY OF THE INVENTION

[0007] Embodiments of the invention generally provide a waveform to be applied to a seed layer prior to initiating plating operations, wherein the waveform is configured to remove organic contaminants from the seed layer. The application of the waveform generally includes applying a plurality of anodic pulses to the seed layer prior to an electrochemical deposition process and subsequent to the seed layer contacting a plating solution, and applying a cathodic pulse to the seed layer immediately following each of the plurality of anodic pulses.

[0008] Embodiments of the invention further provide a method for removing organic contamination from a copper seed layer. The method generally includes applying a cleaning waveform to the seed layer once the seed layer is immersed in an electrolyte solution. The cleaning waveform generally includes at least one deposition pulse, and at least one etch pulse, wherein the at least one deposition pulse has a long duration low magnitude positive current density, and wherein the at least one etch pulse has a short duration high magnitude negative current density.

[0009] Embodiments of the invention further provide a method for electrochemically plating copper onto a seed layer, wherein the method includes immersing the seed layer in a plating solution while applying an electrical loading bias to the seed layer. Thereafter, the method includes applying a cleaning waveform to the seed layer prior to initiating plating operations, wherein the cleaning waveform includes a plurality of cathodic pulses, and a plurality of anodic pulses, the plurality of anodic pulses having a short duration and high current density. Thereafter, the method initiates plating operations via the application of an electrical plating bias to the seed layer to plate copper thereon.

[0010] Embodiments of the invention further provide an electrochemical plating cell, wherein the plating cell includes a plating cell container configured hold a plating solution therein and a pivotally mounted lid member configured to support a substrate on a lower surface thereof such that the substrate is in electrical communication with a contact ring. The plating cell further includes a power supply in electrical communication with the contact ring, the power supply being configured to apply a plurality of anodic pulses to a seed layer deposited on the substrate prior to an electrochemical deposition process and subsequent to the seed layer contacting a plating solution and apply a cathodic pulse to the seed layer immediately following each of the plurality of anodic pulses.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] So that the manner in which the above-recited features of the present invention are obtained may 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 exemplary embodiments of the invention, and are therefore, not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

[0012] FIG. 1 illustrates a perspective view of an exemplary plating system of the invention.

[0013] FIG. 2 illustrates a plan view of the exemplary plating system illustrated in FIG. 1.

[0014] FIG. 2a illustrates a sectional view of an exemplary plating cell of the invention.

[0015] FIG. 3 illustrates an exemplary substrate processing recipe implementing an embodiment of the cleaning method of the invention.

[0016] FIGS. 4A-4D illustrate exemplary cleaning pulse waveforms of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0017] FIG. 1 illustrates a perspective view of an exemplary plating system 100 of the invention. FIG. 2 illustrates a plan view of the exemplary plating system 100 illustrated in FIG. 1. As cooperatively illustrated in FIGS. 1 and 2, plating system 100 may generally include a loading station 110, a thermal anneal chamber 111, a spin-rinse-dry (SRD) station 112, a mainframe 114, and an electrolyte replenishing system 120. Mainframe 114 generally includes a mainframe transfer station 116 and a plurality of processing stations 118. Each processing station 118 may include one or more processing cells 140. A fluid replenishing system 120 is generally positioned adjacent the electroplating system 100 and individually in fluid communication with process cells 140 in order to circulate processing fluids thereto. System 100 also generally includes a control system 122, which may be a programmable microprocessor-type control system configured to interface with the various components of system 100 and provide controlling signals thereto. Loading station 110 generally includes one or more substrate cassette receiving areas 124, generally termed pod loaders, one or more loading station transfer robots 128, and at least one substrate orientor 130. As such, a substrate cassette 132 containing substrates 134 may be loaded onto the substrate cassette receiving area 124 in order to introduce substrates 134 into the electroplating system 100. The loading station transfer robot 128 may transfer the substrates 134 between the substrate cassette 132 and the substrate orientor 130. The substrate orientor 130 generally operates to position each substrate 134 in a desired orientation to ensure that the substrate is properly oriented and referenced for processing. The loading station transfer robot 128 may also transfer substrates 134 between the loading station 110 and the SRD station 112, and between the loading station 110 and the thermal anneal chamber 111, for example, for processing.

[0018] FIG. 2a illustrates a sectional view of a plating cell 200 of the invention. The electroplating cell 200 generally includes a container body 142 having an opening on a top portion of the container body 142 to receive and support a lid 144. The container body 142 is preferably made of an electrically insulative material, such as a plastic, Teflon, or ceramic. The lid 144 serves as a top cover having a substrate supporting surface 146 disposed on the lower portion thereof. A substrate 148 is shown in parallel abutment to the substrate supporting surface 146, and may be secured in this orientation via conventional substrate chucking methods. The container body 142 is preferably cylindrically shaped in order to accommodate the generally circular substrate 148 at one end thereof. However, other substrate shapes can be used as well.

[0019] An electroplating solution inlet 150 is disposed at the bottom portion of the container body 142. An electroplating solution may be pumped into the container body 142 by a suitable pump 151 connected to the inlet 150. The solution may flow upwardly inside the container body 142 toward the substrate 148 to contact the exposed deposition surface 154. A consumable anode 156 may be disposed in the container body 142 and configured to dissolve in the electroplating solution in order to provide metal particles to be deposited onto the substrate 148 to the plating solution. The anode 156 generally does not extend across the entire width of the container body 142, thus allowing the electroplating solution to flow between the outer surface of the anode 156 and the inner surface of the container body 176 to the deposition surface 154. Alternatively, an anode 156 consisting of an electrode and consumable metal particles may be encased in a fluid permeable membrane, such as a porous ceramic plate, to provide metal particles to be deposited onto the substrate to the plating solution. A porous non-consumable anode may also be disposed in the container body 142 so that the electroplating solution may pass therethrough. However, when a non-consumable anode is included, the electroplating solution should include a metal particle supply to continually replenish the metal particles to be deposited on the substrate 148.

[0020] The container body 142 generally includes an egress gap 158 bounded at an upper limit by a shoulder 164 of a cathode contact ring 152. The gap 158 generally leads to an annular weir 143 that is substantially coplanar with (or slightly above) the substrate seating surface 168, and thus, the deposition surface 154. The weir 143 is positioned to ensure that the deposition surface 154 is in contact with the electroplating solution when the electroplating solution is flowing out of the egress gap 158 and over the weir 143. During processing, the substrate 148 is secured to the substrate supporting surface 146 of the lid 144 by a plurality of vacuum passages 160 formed in the surface 146, wherein passages 160 are generally connected at one end to a vacuum pump (not shown). The cathode contact ring 152, which is shown disposed between the lid 144 and the container body 142, is connected to a power supply 149 to provide power to the substrate 148. Power supply 149 may be in electrical communication with system controller 122, which may control the operation of power supply 149, i.e., controller 122 is generally configured to control the output of power supply in a time varying manner, or alternatively, in a sensed or feedback-type of control system. The contact ring 152 generally has a perimeter flange 162 partially disposed through the lid 144, a sloping shoulder 164 conforming to the weir 143, and an inner substrate seating surface 168, which defines the diameter of the deposition surface 154. The shoulder 164 is provided so that the inner substrate seating surface 168 is located below the flange 162. This geometry allows the deposition surface 154 to come into contact with the electroplating solution before the solution flows into the egress gap 158 as discussed above.

[0021] The substrate seating surface 168 preferably extends a minimal radial distance inward below a perimeter edge of the substrate 148, but a distance sufficient to establish electrical contact with a metal seed layer on the substrate deposition surface 154. The exact inward radial extension of the substrate seating surface 168 may be varied according to application. However, in general this distance is minimized so that a maximum deposition surface 154 is

exposed to the electroplating solution. In an exemplary embodiment, the radial width of the seating surface 168 is 2 mm from the edge.

[0022] In operation, system 100 may receive a cassette 132 in one of substrate receiving areas 124, wherein the cassette 132 contains substrates 134 having a conductive seed layer deposited thereon. Individual substrates 134 may be removed from cassette 132 by a robot 128 for processing in system 100. The substrates 134 may be delivered to orienter 130, annealing chamber 111, and/or SRD chamber 112, as required prior to plating by the particular processing recipe. However, the seed layer, which may have been deposited by a separate deposition apparatus, may have organic contamination on the surface thereof as a result of the seed layer being exposed to organic elements between the seed layer deposition apparatus and system 100. As such, prior to initiating plating operations on the substrate, embodiments of the present invention operate to remove the organic contamination from the surface of the substrate, so that the conductive metal layer deposited over the seed layer in the plating process will have optimum uniformity characteristics and be substantially free of defects.

[0023] The contamination removal process of the present invention generally includes contacting the surface of the substrate having the seed layer deposited thereon with an electrolyte solution. This step may, for example, may include supporting a substrate in a face down-type ECP plating cell, and immersing the substrate surface in the electrolyte solution. During the immersion process, an electrical loading bias 301, which is illustrated in the loading portion 306 of the exemplary plating processing recipe 300 shown in FIG. 3, may be applied to the substrate surface, such that dissolution of the seed layer as a result of contact with the electrolyte solution prior to initiating the plating process may be minimized. Once the substrate surface is immersed the electrolyte solution, the processing recipe 300 may apply a cleaning pulse waveform 302 to the substrate prior to initiating a plating process portion 305 of the processing recipe 300. The cleaning pulse waveform 302 generally includes a series of alternating cathodic 303 and anodic pulses 304, which may, for example, be centered around the loading bias voltage 301, as illustrated in FIG. 3. The cleaning pulse waveform 302 may be configured to essentially etch the surface of the seed layer deposited on the substrate, so that contamination, and in particular, organic contamination residing on the surface of the seed layer, may be removed therefrom prior to initiating the plating process portion 305 of the processing recipe 300. However, it is to be noted that the amplitude and duration of cleaning pulse waveform 302 is specifically configured to remove only surface contamination from the seed layer, as it is undesirable to remove any significant quantity of the seed layer itself, as excess removal of the seed layer has been shown to facilitate unequal current density distribution across the surface of the substrate during plating operations, and therefore, and generate uneven plating uniformity.

[0024] The cleaning pulse waveform 302 illustrated in the exemplary processing recipe 300 generally includes a sequence of alternating cathodic 303 and anodic 304. Pulses 303 and 304 may be centered around the load bias voltage 301, as illustrated in FIG. 3. Alternatively, the respective pulses may be of varying magnitudes and durations, independent of the load bias voltage. The individual cathodic

pulses 303 may be configured to be slightly greater in magnitude than the load bias voltage 301, while the anodic pulses 304 may be substantially less in magnitude than the load bias voltage 301, thus facilitating a slight etching of organic contamination from the substrate surface while not removing a substantial portion of the seed layer. The individual pulses may have a duration of between about 5 milliseconds and about 50 milliseconds, for example. For example, preferably the individual pulse duration may generally be between about 10 and about 20 milliseconds per pulse. Further, the total duration of the cleaning pulse waveform 302 may be between about 10 milliseconds and about 100 milliseconds, for example, and therefore, there may be between about 2 and 20 individual pulses in the cleaning pulse waveform 302. The magnitude of the negative portion of the pulses may be up to about -0.5 volts (where -0.2 volts is assumed to be the etch crossover threshold), for example, and the current density thereof may be between, for example, about 50 mA/cm² and about 150 mA/cm². More particularly, the current density may be between about 75 mA/cm² and about 125 mA/cm², and the duration of the anodic pulses may be between about 5 milliseconds and about 50 milliseconds. More particularly, the duration of the individual anodic pulses may be between about 10 milliseconds and about 20 milliseconds, for example. Similarly, the current density of the positive pulses may be up to about 125 mA/cm², for example, and may generally be in the range of about 75 mA/cm² and about 125 mA/cm², and more particularly, between about 90 mA/cm² and about 100 mA/cm², for example. The duration of the cathodic pulses is generally substantially longer than the duration of the anodic pulses. For example, the duration of the cathodic pulses may generally be between about 10 milliseconds and about 150 milliseconds, depending upon the duration of the anodic pulse. For example, if the duration of the anodic pulse is near the shorter into the range, i.e., five milliseconds, then the duration of the cathodic pulse may also be near the shorter into the range, i.e., 10 milliseconds. Similarly, if the anodic pulse is longer, within the cathodic pulse will also generally be longer.

[0025] Cleaning pulse waveform 300 is generally applied to the substrate prior to beginning the plating process, i.e., cleaning pulse waveform 300 is generally applied to the substrate prior to applying a current density to the substrate sufficient to cause accumulation of the plating material thereon. Therefore, for example, cleaning pulse waveform 300 is generally applied to the substrate either during the substrate loading process, or alternatively, immediately after the substrate is loaded into the plating chamber and contacted by the electrolyte.

[0026] In order to maintain seed layer integrity, a system controller generally controls the magnitude and duration of the respective pulses. For example, in order to keep from damaging the seed layer during the etching process, i.e., during the application of the cathodic pulses that are configured to etch contaminants from the surface of the seed layer, the magnitude and duration of the anodic pulse may be carefully controlled. More particularly, assuming that a 200 mm substrate is being processed, for example, the current density of the etch pulses may be controlled to be approximately 111.5 mA/cm², which will generally produce an etch rate of approximately 409 Å/second (36.7×111.5/10=409). Therefore, inasmuch as the total time for each individual etch pulse is approximately 20 milliseconds, each pulse will

generally etch approximately 8.2 \AA ($409 \times 20 / 1000$) of the material on the seed layer. Therefore, if five etch pulses are used, then approximately 41 \AA of contaminants may be removed from the seed layer. If the layer of contaminants has a thickness of less than 41 \AA , then the etching pulses will begin to etch into the seed layer.

[0027] Similarly, the deposition rate of the cathodic pulses may also be calculated and utilized to determine when to stop etching so that the seed layer will not be damaged. For example, again assuming a 200 mm substrate, a deposition current density of 5 mA/cm^2 may be used, which may generally generate a deposition rate of about 18.35 \AA/sec ($36.7 \times 5 / 10 = 18.35$). Therefore, inasmuch as the total deposition pulse time may generally be about 500 milliseconds, the deposition for one pulse may be about 9.2 \AA . These calculations, both for the anodic and cathodic pulses, may be used to determine the amplitude and duration of the respective pulses that is optimal for a particular configuration. For example, if a particular configuration requires that a certain thickness of contaminants be removed from a seed layer surface, i.e., if substrate inspection processes such as metrology, for example, determine the thickness of a contamination layer, then the appropriate amplitude and duration of both the anodic and cathodic pulses may be calculated to remove the desired thickness of contaminants, without damaging the underlying seed layer. This calculation may be manually entered into a system controller configured to monitor and control the respective pulses, or alternatively, a system controller may be configured to automatically calculate the appropriate amplitude and duration of the respective pulses given either a user input or a measurement input representing the thickness of a layer of contaminants on the seed layer. As such, the above noted exemplary calculations are not in any way meant to be limiting upon the scope of the invention. Rather, the exemplary calculations are intended to be merely illustrative of an exemplary process for calculating the removal and deposition rates of the respective pulses. These calculations may then be used to determine the appropriate amplitude in duration of cleaning waveform pulses to be applied in a plating system.

[0028] The end result of the application of the cleaning waveform is that organic contaminants residing on the surface of the seed layer may be removed therefrom prior to initiating plating operations. Further, inasmuch as the cleaning waveform is applied for a relatively short period of time, i.e., generally much less than one minute, there generally is not any substantial etching of the seed layer, however, the sudden high current density of the anodic pulse operates to repel and desorb organics at the seed layer surface. As a result thereof, organic contaminants on the seed layer may be removed to the application of the cleaning waveform prior to plating, and more particularly, through the application of the high current density short duration anodic pulses prior to plating.

[0029] Once the substrate loading process is complete and the cleaning waveform 302 has been applied to the substrate to remove organic contamination from the surface thereof, the remainder of the semiconductor processing recipe 300 may be executed. The remainder of recipe 300, which is designated as 305 in FIG. 3, may include one or more recipe steps having an increased current density or voltage applied thereto for the purpose of facilitating plating on the substrate. Once the plating steps 305 are concluded, then the

substrate having the plated layer deposited thereon may be removed from the plating apparatus as a finished substrate.

[0030] FIGS. 4A through 4D illustrate additional embodiments for the cleaning pulse waveform of the invention. In FIG. 4A, for example, cleaning pulse waveform 400 includes a plurality of positive or anodic waveform pulses 401 that use the load voltage 402 as a baseline voltage. As such, each of the anodic pulses 401 extend upwardly towards the positive voltage region of the graph illustrated in FIG. 4A. Although 5 anodic pulses 401 are illustrated in FIG. 4A, the present invention contemplates that between about 10 and about 100 anodic pulses may be implemented in the cleaning pulse waveform 400. Additionally, the pulse duration of each of the anodic pulses 401 may be between about 5 milliseconds and about 30 milliseconds, for example. More particularly, the pulse duration of each of the anodic pulses 401 may be between about 10 and about 20 milliseconds. The amplitude of the anodic pulses 401 is generally configured to be a large magnitude of current density applied during a very short time duration, which generally provides for desorption of organic contamination from the seed layer surface. As such, the current density of anodic pulses for one may be as high as about 100 mA/cm^2 , for example. However, the current density of anodic pulses for one may be between about 10 mA/cm^2 and about 60 mA/cm^2 , or between about 15 mA/cm^2 and about 30 mA/cm^2 , for example.

[0031] FIG. 4B illustrates another embodiment of a cleaning pulse waveform 400. In this embodiment, waveform 400 generally includes a waveform of anodic pulses 401, wherein the magnitude of the anodic pulses 401 begins at a first current density 403 and ends at a second current density 404, and descends from the first current density 403 to the second current density 404 during the progression of the waveform 400. Thus, the magnitude of the first anodic pulse 401 in waveform 400 may be up to about 100 milliamps, for example, while the magnitude of the last anodic pulse 401 in waveform 400 may be only about 20 milliamps, for example. In this configuration, the interstitial pulses may gradually decrease from the first current density to the last current density in either a linear or a nonlinear manner, as preferred by the specific implementation. In similar fashion to the previous embodiment, the pulse duration of anodic pulses for one may be between about 5 milliseconds and about 100 milliseconds, for example, depending on the implementation. However, the pulse duration of anodic pulses 401 may be between about 10 and about 20 milliseconds, for example.

[0032] FIG. 4C illustrates another embodiment of a cleaning pulse waveform 400. In this embodiment, from the magnitude of anodic pulses 401 begins at the first magnitude 403, decreases to a middle magnitude 405, and then increases to a second magnitude 404, wherein the second magnitude may be approximately equal to the first magnitude 403. In this configuration, the magnitude of the anodic pulses 401 may be up to about 100 milliamps, and the duration of the individual pulses may be between about 5 milliseconds and about 100 milliseconds, wherein the preferred duration may be between about 10 milliseconds and about 30 milliseconds, for example. FIG. 4D illustrates another embodiment of a cleaning pulse waveform 400, however, in this embodiment the magnitude of the individual anodic pulses 401 is opposite of the waveform

illustrated in FIG. 4C. For example, in FIG. 4D, the anodic pulses 401 may begin at a first magnitude 403, increased to a middle magnitude 405, and in decrease to a second magnitude 404.

[0033] The exemplary cleaning pulse waveforms 400 illustrated in FIGS. 4A-4D generally includes anodic pulses 401, i.e., positive pulses. Therefore, organic contamination on the surface of the seed layer is not removed via an etch process, as the anodic/positive pulses 401 did not cause an etching process. Rather, experimental data indicates that the positive anodic pulses applied to the substrate may operate to generate oxygen at the surface of the seed layer. This oxygen may then operate to attack or break up the organics attached to the seed layer by reducing the adhesion between the seed layer and the organic. Therefore, the cleaning pulse waveform 400 using positive/anodic pulses 401 is also effective in removing organic contaminants from the surface of the seed layer. Additionally, experimental data indicates that the sudden change in charge resulting from the cleaning pulse waveform 400 also operates to dissolve organic material residing on the surface of the seed layer.

[0034] 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. A method for cleaning organic contaminants from a copper seed layer in an electrochemical plating system, comprising:

applying a plurality of anodic pulses to the seed layer prior to an electrochemical deposition process and subsequent to the seed layer contacting a plating solution; and

applying a cathodic pulse to the seed layer immediately following each of the plurality of anodic pulses.

2. The method of claim 1, wherein an amplitude of a current density of each of the plurality of anodic pulses is between about 50 mA/cm² and about 150 mA/cm².

3. The method of claim 1, wherein an amplitude of a current density of each of the plurality of anodic pulses is between about 75 mA/cm² and about 125 mA/cm².

4. The method of claim 1, wherein a duration of each of the plurality of anodic pulses is between about 5 milliseconds and about 50 milliseconds.

5. The method of claim 1, wherein a duration of each of the plurality of anodic pulses is between about 10 milliseconds and about 20 milliseconds.

6. The method of claim 1, wherein an amplitude of a current density for the cathodic pulse is between about 75 mA/cm² and about 125 mA/cm².

7. The method of claim 1, wherein an amplitude of a current density for the cathodic pulse is between about 90 mA/cm² and about 100 mA/cm².

8. The method of claim 1, wherein a duration of the cathodic pulse is between about 10 milliseconds and about 100 milliseconds.

9. The method of claim 1, wherein a duration of the cathodic pulse is at least five times a duration of each of the plurality of anodic pulses.

10. The method of claim 1, wherein the plurality of anodic pulses comprises between about 2 and about 10 anodic pulses.

11. The method of claim 1, wherein the plurality of anodic pulses comprises between about 3 and about 6 anodic pulses.

12. A method for removing organic contamination from a copper seed layer overlying sub-quarter micron sized features formed onto a semiconductor substrate in an electrochemical plating system, the method comprising applying a cleaning waveform to the seed layer once the seed layer is immersed in an electrolyte solution, the cleaning waveform comprising:

at least one deposition pulse; and

at least one etch pulse, wherein the at least one deposition pulse has a long duration low magnitude positive current density, and wherein the at least one etch pulse has a short duration high magnitude negative current density.

13. The method of claim 12, wherein the long duration low magnitude positive current density deposition pulse further comprises a deposition pulse having a current density of between about 50 mA/cm² and about 125 mA/cm² and a duration of between about 10 milliseconds and about 150 milliseconds.

14. The method of claim 12, wherein the short duration high magnitude negative current density etch pulse further comprises an etch pulse having a current density of between about 50 mA/cm² and about 150 mA/cm² and a duration of between about 10 milliseconds and about 50 milliseconds.

15. The method of claim 13, wherein the current density is between about 75 mA/cm² and about 100 mA/cm².

16. The method of claim 13, wherein the duration is between about 50 milliseconds and about 150 milliseconds.

17. The method of claim 14, wherein the current density is between about 75 mA/cm² and about 125 mA/cm².

18. The method of claim 14, wherein the duration is between about 10 milliseconds and about 30 milliseconds.

19. The method of claim 12, wherein the at least one deposition pulse comprises between about 3 and about 10 deposition pulses.

20. The method of claim 12, wherein the at least one etch pulse comprises between about 3 and about 10 etch pulses.

21. A method for electrochemically plating copper onto a seed layer, comprising:

immersing the seed layer in a plating solution while applying an electrical loading bias to the seed layer;

applying a cleaning waveform to the seed layer prior to initiating plating operations, the cleaning waveform comprising:

a plurality of cathodic pulses; and

a plurality of anodic pulses, the plurality of anodic pulses having a short duration and high current density; and

applying a electrical plating bias to the seed layer to plate copper thereon.

22. The method of claim 21, wherein each of the plurality of cathodic pulses comprises a deposition pulse having a duration of between about 10 milliseconds and about 100 milliseconds and a current density of between about 75 mA/cm² and about 125 mA/cm².

23. The method of claim 21, wherein each of the plurality of anodic pulses comprises an etch pulse having a duration

of between about 5 milliseconds and about 20 milliseconds and a current density of between about 75 mA/cm² and about 125 mA/cm².

24. The method of claim 21, wherein the plurality of anodic pulses comprises between about 2 and about 10 anodic pulses and wherein the plurality of cathodic pulses comprises between about 2 and about 10 cathodic pulses.

25. A method for cleaning contaminants from a copper seed layer, comprising alternating the application of an anodic pulse and a cathodic pulse, wherein the cathodic pulses have a duration of between about 10 milliseconds and about 100 milliseconds and a current density of between about 75 mA/cm² and about 125 mA/cm², and wherein the anodic pulses have a duration of between about 5 milliseconds and about 20 milliseconds and a current density of between about 75 mA/cm² and about 125 mA/cm², the alternating application of the anodic pulse and the cathodic pulse occurring prior to commencing a plating process on the seed layer.

26. The method of claim 25, wherein the alternating cathodic pulse and anodic pulse comprises between about 4 and about 20 total pulses.

27. An electrochemical plating cell, comprising:

a plating cell container configured hold a plating solution therein;

a pivotally mounted lid member configured to support a substrate on a lower surface thereof such that the substrate is in electrical communication with a contact ring; and

a power supply in electrical communication with the contact ring, the power supply being configured to apply a plurality of anodic pulses to a seed layer deposited on the substrate prior to an electrochemical deposition process and subsequent to the seed layer contacting a plating solution and apply a cathodic pulse to the seed layer immediately following each of the plurality of anodic pulses.

28. The electrochemical plating cell of claim 27, wherein the power supply is configured to generate an amplitude of between about 50 mA/cm² and about 150 mA/cm² for each of the plurality of anodic pulses.

29. The electrochemical plating cell of claim 27, wherein the power supply is configured to generate a duration of between about 5 milliseconds and about 50 milliseconds between each of the plurality of anodic pulses.

29. The electrochemical plating cell of claim 27, wherein the power supply is configured to generate an amplitude of between about 75 mA/cm² and about 125 mA/cm² for each of the cathodic pulses.

30. The electrochemical plating cell of claim 27, wherein a duration of the cathodic pulse is at least five times a duration of each of the plurality of anodic pulses.

31. An electrochemical plating cell, comprising:

a plating cell container configured hold a plating solution therein;

a pivotally mounted lid member configured to support a substrate on a lower surface thereof such that the substrate is in electrical communication with a contact ring;

means for applying a plurality of anodic pulses to a seed layer deposited on the substrate prior to an electrochemical deposition process and subsequent to the seed layer contacting a plating solution; and

means for applying a cathodic pulse to the seed layer immediately following each of the plurality of anodic pulses.

32. The electrochemical plating cell of claim 31, wherein the means for applying comprises a power supply in electrical communication with a system controller configured to control the operation of the power supply.

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