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(54) **FIXED ABRASIVE PAD HAVING DIFFERENT REAL CONTACT AREAS AND FABRICATION METHOD THEREOF**

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(57) **ABSTRACT**

Disclosed is a method for fabricating a fixed abrasive pad in use of a chemical mechanical polishing process. The method includes: forming one or more etching molds providing a plurality of different real contact areas; attaching the etching mold(s) to a roller or press; and forming a fixed abrasive pad using the roller or press, The fixed abrasive pad has a plurality of polishing portions, each having a different real contact area. Especially, the fixed abrasive pad can comprise a low-density polishing portion having a real contact area less than 20% and a high-density polishing portion having a real contact area of 20%~50%.

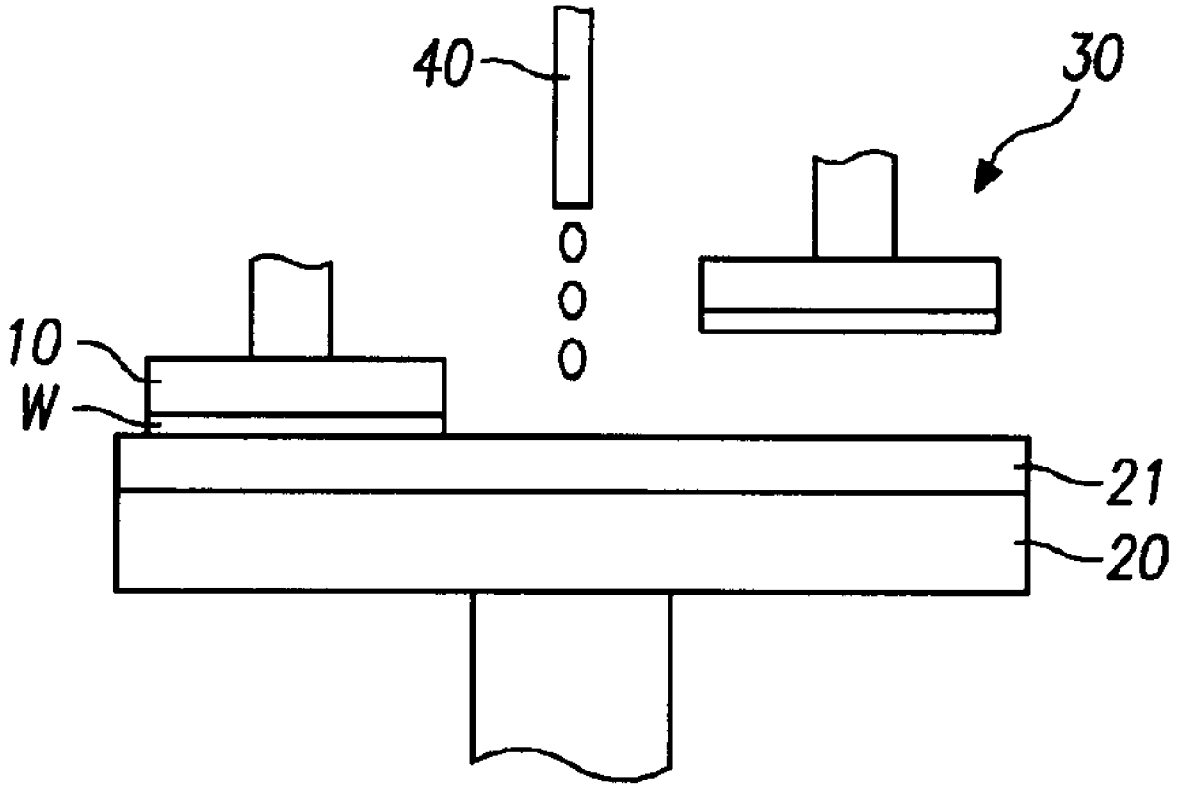


FIG. 1

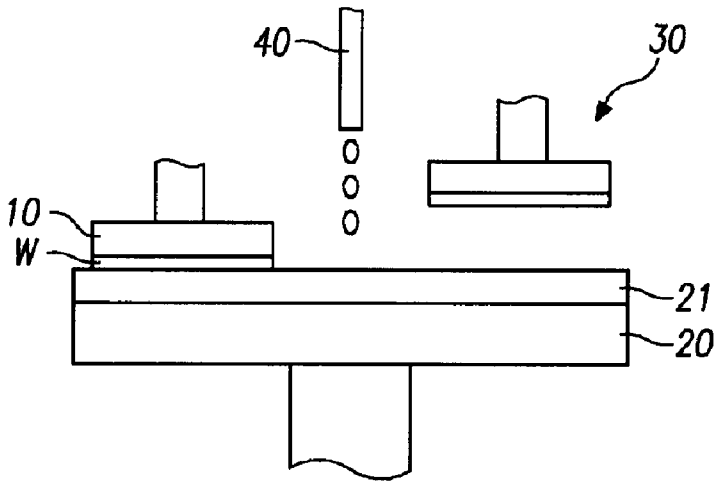

40
30
10
W
21
20

FIG. 2

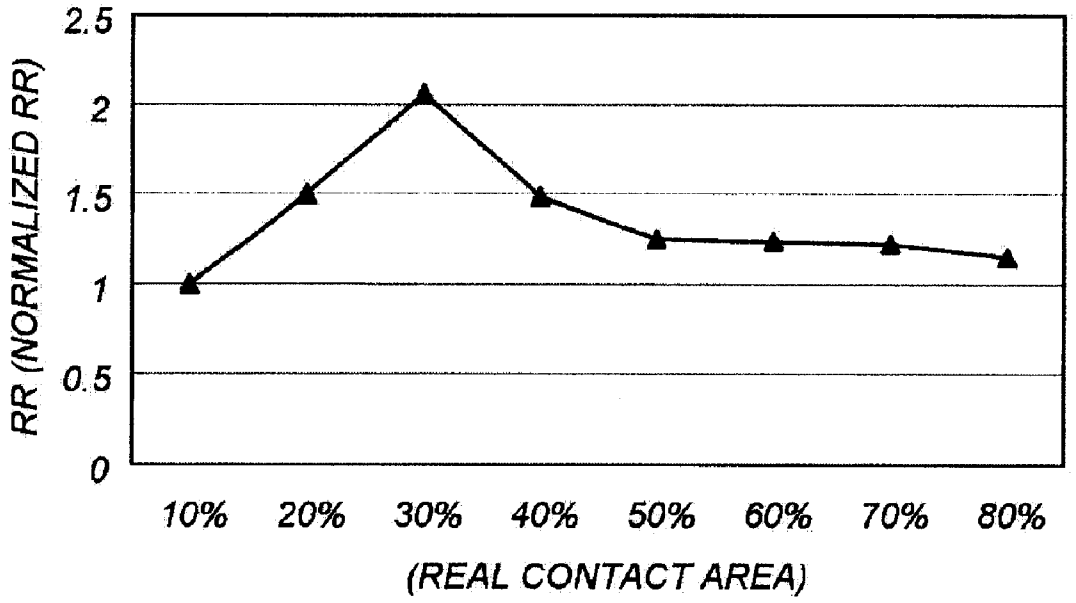

2.5
2
1.5
1
0.5
0
RR (NORMALIZED RR)
10%
20%
30%
40%
50%
60%
70%
80%
(REAL CONTACT AREA)

FIG. 3

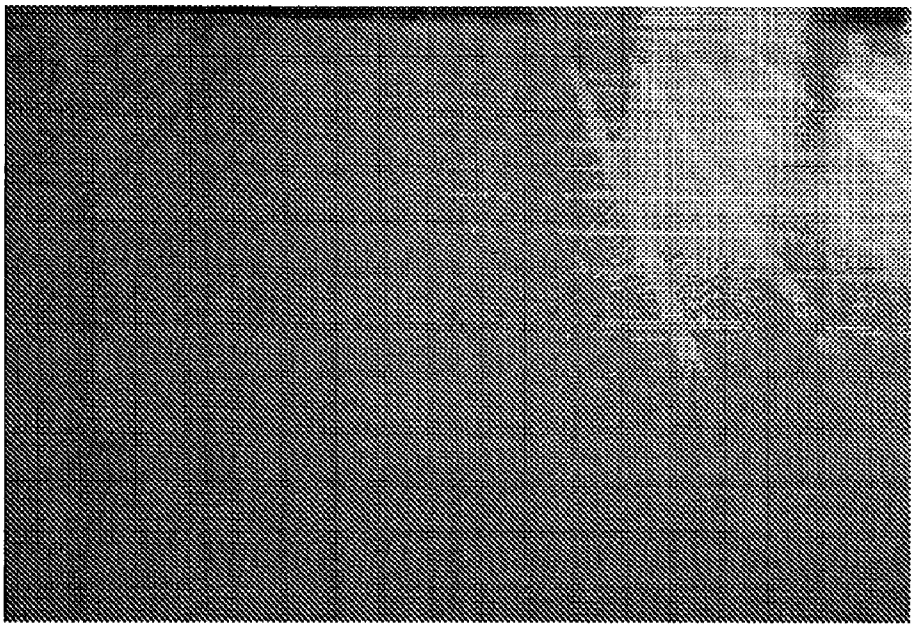


FIG. 4

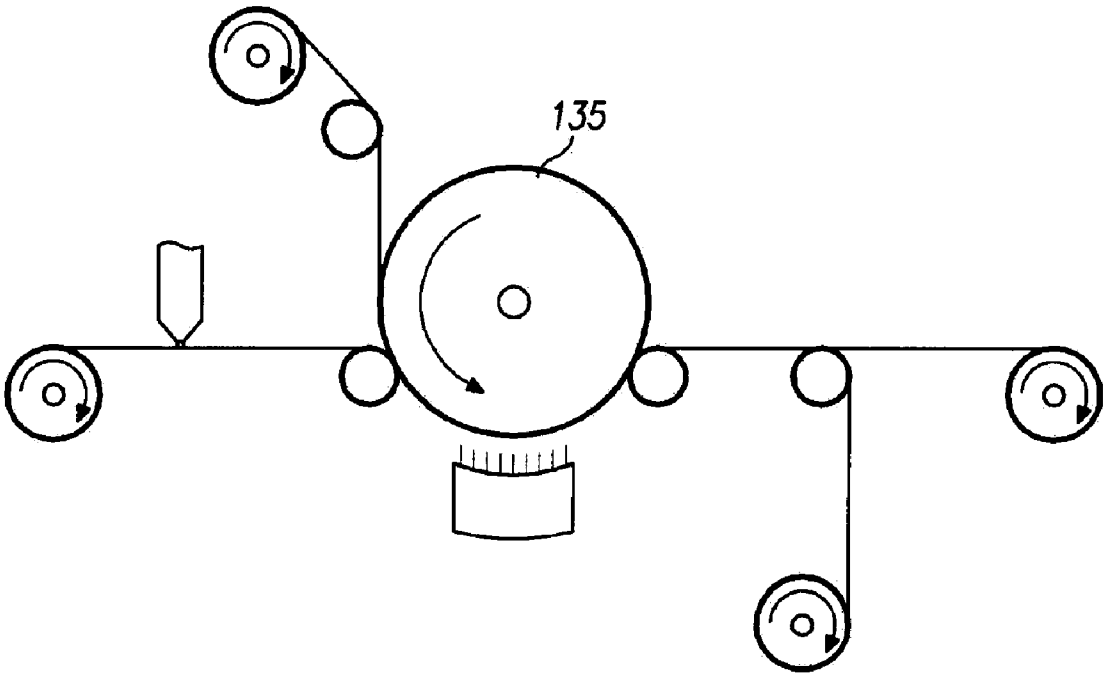


FIG. 5

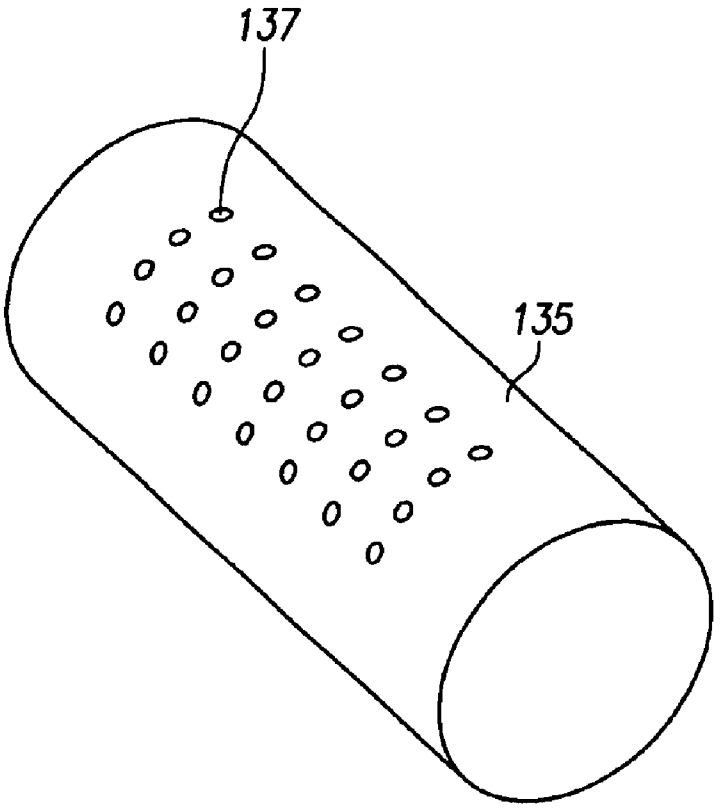


FIG. 6

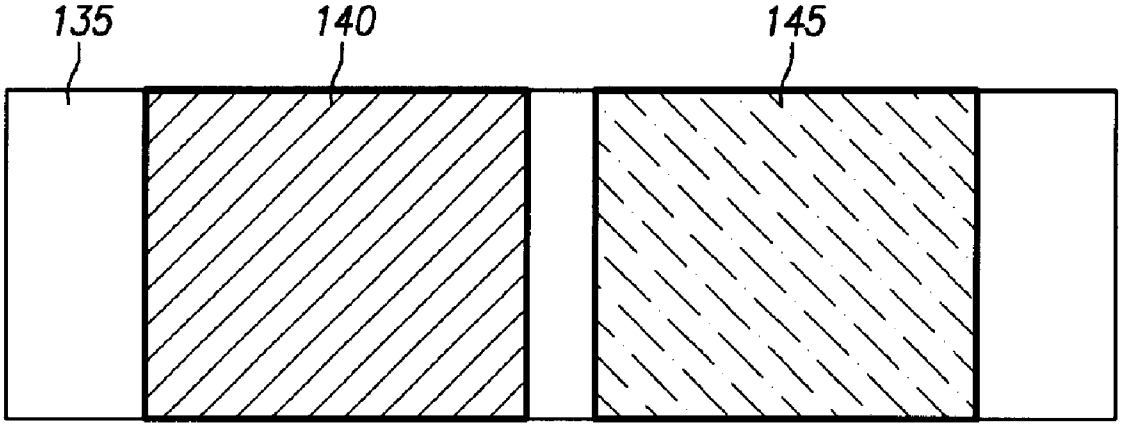


FIG. 7

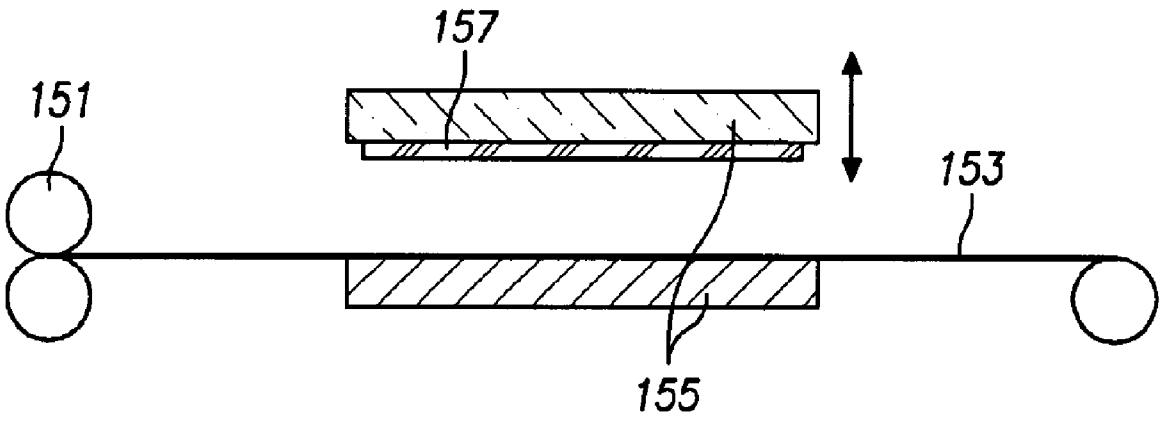
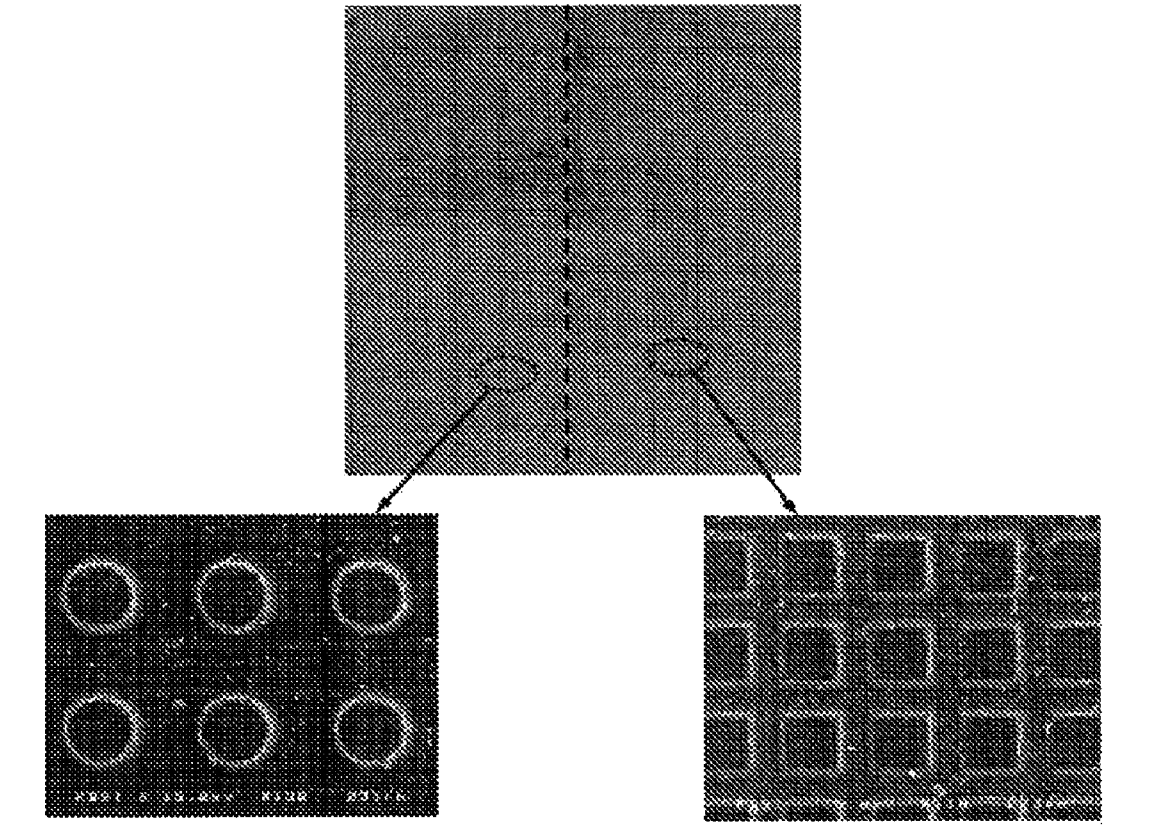


FIG. 8



FIXED ABRASIVE PAD HAVING DIFFERENT REAL CONTACT AREAS AND FABRICATION METHOD THEREOF

[0001] This application is a divisional of pending U.S. patent application Ser. No. 11/484,527, filed Jul. 10, 2006 (Attorney Docket No. OPP-GZ-2007-0400-US-00), which is incorporated herein by reference in its entirety and which claims the benefit of Korean Patent Application No. 10-2005-0061837, filed on Jul. 8, 2005, which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a fixed abrasive pad and fabrication method thereof. More specifically, the present method relates to a fixed abrasive pad having different real contact areas in use in a chemical mechanical polishing (CMP) process, and a method for forming different real contact areas on a fixed abrasive pad.

[0004] 2. Description of the Related Art

[0005] There have been a variety of alterations in structural and material aspects for the purpose of achieving a higher operational speed and integration of a semiconductor device. In the structural aspect, the number of metallization layers has been increased, and a shallow trench isolation (STI) technique has been employed. In the material aspect, copper (Cu) has been used as a metallization layer, and a low-k insulating material has been used as an interlevel dielectric. A CMP process has been frequently employed according to such alterations.

[0006] FIG. **1** shows conventional equipment for a CMP process.

[0007] Referring to FIG. **1**, the conventional CMP equipment comprises: a turn table **20** which is rotated, with a polishing pad **21** mounted thereon; a wafer carrier **10** which transfers a wafer W according to processing sequences and rotates the wafer while it is in contact with the polishing pad **21**; a polishing slurry supplier **40** over the turn table **20**, supplying a slurry to the polishing pad **21**; and a diamond dresser **30**. In such structured CMP equipment, the wafer W is positioned on the polishing pad **21**, and simultaneously forced downwardly by the wafer carrier **10**. According to rotation of the turn table **20** and continuous supply of the slurry solution, a material of the wafer is removed or polished mechanically by friction between the polishing pad **21** and the semiconductor wafer W, and chemically by chemical ingredients of the polishing slurry.

[0008] The above-described CMP process has been widely used as a planarization process of metallization layers, however, the CMP process often results in a problem where the yield of semiconductor devices decreases due to failures such as a dishing or erosion phenomenon.

[0009] In order to reduce or eliminate dishing and erosion phenomena, recently improved CMP process involves using a high selectivity slurry, forming dummy patterns on a chip, or using a reverse etch technique. In addition, because the dishing and erosion phenomena occur ultimately due to the polishing pad in the CMP process, a polishing method utilizing a fixed abrasive pad instead of a slurry has been developed and is partially applied, wherein the fixed abrasive pad includes abrasive particles adhering to a pad.

[0010] A method for fabricating a fixed abrasive pad involves applying a mixture of abrasive particles, a binding agent, and a hardening agent on a polycarbonate film, and then forming a polishing pad using a roller of which the surface has the shape opposite or complementary to a desired shape to be formed in the polishing pad. In one case, the roller may be fabricated using a cutting tool. However, fabricating a roller by a cutting tool consumes a relatively large working time, and may also disable or disfigure the minute surface topology of the roller. Thus, in other cases, the roller may have a uniform surface topology so that the polishing pad fabricated by the roller has a uniform real contact area in a pad.

[0011] In general, a fixed abrasive pad has a uniform surface topology, resulting in a wide difference between polishing rates of wafers with and without predetermined patterns. Therefore, different polishing pads may be separately used for wafers with and without patterns. As a result, two different CMP apparatuses or equipment are necessary to simultaneously polish wafers with and without patterns, which is not desirable in the aspect of processing efficiency and/or efficient use of fab/clean room floor space.

SUMMARY OF THE INVENTION

[0012] It is, therefore, an object of the present invention to provide a fixed abrasive pad comprising a plurality of polishing portions or areas in one pad. In use of a fixed abrasive pad according to the present invention, a wafer with a predetermined pattern is initially polished on a low real contact area (or low contact polishing portion) of the fixed abrasive pad. After polishing the patterned region of the wafer, the wafer is additionally polished on a high real contact area (or high contact polishing portion) of the fixed abrasive pad. Thereby, it can reduce or prevent adverse effects due to variations in removal rates according to the surface morphology of the wafer in a CMP process.

[0013] To achieve the above object, an embodiment of a method for fabricating a fixed abrasive pad in use of a chemical mechanical polishing process according to the present invention, comprises the steps of: forming a plurality of etching molds, each etching mold having a different real contact area from another; attaching the plurality of etching molds to a roller; forming a fixed abrasive pad using the roller; wherein the fixed abrasive pad comprises a plurality of polishing portions in one pad, and each polishing portion has a different real contact area from another. Here, the roller can comprise a plurality of through-holes whereby a vacuum is applied, and the plurality of etching molds are attached to the roller by a vacuum absorption mechanism. Especially, the fixed abrasive pad can comprise a low-density polishing portion having a real contact area less than 20% and a high-density polishing portion having a real contact area of 20%~50%.

[0014] In addition, a method for fabricating a fixed abrasive pad in use of a chemical mechanical polishing process, can comprise the steps of: forming a plurality of etching molds, each etching mold having a different real contact area from another; attaching the plurality of etching molds to a press; and forming a fixed abrasive pad using the press. Here, the fixed abrasive pad can comprise a plurality of polishing portions in one pad, and each polishing portion has a different real contact area from another.

[0015] These and other aspects of the invention will become evident by reference to the following description of the invention, often referring to the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

[0016] FIG. **1** is a cross-sectional view illustrating conventional CMP equipment.

[0017] FIG. **2** shows a graph illustrating variation in normalized RR ratio according to a real contact area of a polishing pad.

[0018] FIG. **3** is a photograph illustrating an etching mold according to an embodiment of the present invention.

[0019] FIG. **4** is a cross-sectional view illustrating a method for fabricating a fixed abrasive pad according to a first embodiment of the present invention.

[0020] FIG. **5** is a perspective view illustrating a roller including through-holes, according to the first embodiment of the present invention.

[0021] FIG. **6** is a plane view illustrating the state that etching molds having different real contact areas are attached on the roller according to the first embodiment of the present invention.

[0022] FIG. **7** is a cross-sectional view illustrating a method for fabricating a fixed abrasive pad according to a second embodiment of the present invention.

[0023] FIG. **8** is a photograph illustrating a fixed abrasive pad fabricated according to the embodiments of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0024] FIG. **2** shows a graph illustrating a variation in normalized RR ratio, representing a ratio of a real removal rate (real RR) to a mean or reference removal rate (reference RR), according to a real contact area of a polishing pad. In the context of the present invention, "real contact area" may refer to the average surface areas of the abrasive particles in the fixed abrasive pad and the wafer that actually come into contact with each other under predetermined polishing conditions.

[0025] Referring to FIG. **2**, there is a wide difference between RR ratios according to the real contact area. For a given wafer (e.g., a wafer having a relatively high density of patterned features), the normalized RR for a pad or pad region having a 30% real contact area can be about two, relative to a polishing pad having a 10% real contact area. A wafer having patterns, or at least one region with a relatively high density of patterned features, for example, may have patterned features of a width (or minimum dimension) of from about 90 nm to about 1 μm and an inter-feature spacing of from about 125 nm to about 2 μm, over an area containing at least 4 (and, in some embodiments, at least 8, 16 or 30) such features.

[0026] In the case where a wafer with patterns is polished, using a fixed abrasive pad having different real contact areas in one pad can prevent deterioration of the removal rate according to a real contact area of a polishing pad. In such case, a patterned region of a wafer is initially polished on the region of the polishing pad that has a low real contact area. After initial polishing of the patterned wafer is finished, the wafer is additionally polished on the region of the polishing pad that has a high real contact area. Accordingly, the wafer with patterns can be polished using one pad, thus decreasing the total processing time and improving efficiency of the CMP equipment (in terms of throughput and/or clean room floor space).

[0027] Hereinafter, a method for fabricating a fixed abrasive pad having different real contact areas in one pad will be described.

A First Embodiment

[0028] Firstly, an etching mold is formed, having a surface morphology opposite or complementary to the shape that is desired on a surface (e.g., the polishing surface) of the polishing pad. An exemplary etching mold is shown in FIG. **3**. A metal material such as stainless steel is etched using a metal etching technique to form the mold, such as that shown in FIG. **3**. The etching molds may be formed in at least two separate pieces, wherein one etching mold provides a polishing pad or pad region that has a different real contact area from another polishing pad or pad region. Alternatively, the mold may be formed in one unitary piece.

[0029] Next, the etching mold(s) providing different real contact areas are attached to a surface of roller. Preferably, the roller includes through-holes whereby a vacuum can be applied (e.g., to the inside of the roller), and the etching molds may be attached to the surface of the roller by a vacuum absorption mechanism.

[0030] A fixed abrasive pad can be formed using the roller provided with the etching molds providing different real contact areas on the surface thereof.

[0031] FIG. **4** shows a first embodiment of a method for fabricating a fixed abrasive pad according to the present invention.

[0032] Referring to FIG. **4**, a mixture of abrasive particles (which may have a predetermined, relatively uniform particle size distribution and/or a relatively uniform shape), a binding agent, and (optionally) a hardening agent is applied onto a base of the fixed abrasive pad (e.g., a polycarbonate film or other relatively stiff film capable of having particles fixed thereto and withstanding typical wafer polishing conditions). The particles may comprise any known particles for such fixed abrasive pads, such as alumina, silica, ceria, aluminosilicates, silicon carbide, or other ceramics). Then, the polishing pad is formed by a rolling method using the roller **135**. Here, the roller **135** comprises the etching molds having the surface morphology opposite or complementary to the shape to be formed on the polishing pad, which applies pressure to the polishing pad base (supplied by one of the rollers on the left-hand side of FIG. **4**) and the abrasive particle mixture (supplied by the other of the rollers on the left-hand side of FIG. **4** [preferably the lower roller], and which may be partially hardened by the time it is applied to the polishing pad base and/or pressure-bonded to the base by roller **135**) and which may receive a gas-based heat and/or drying treatment applied thereto (see, e.g., the heat and/or gas source located below roller **135** in FIG. **4**). In one embodiment, the abrasive particle mixture is applied directly to the base, and a protective film is placed between the abrasive particle mixture and the roller as the roller applies pressure to the abrasive particle mixture applied onto the base.

[0033] FIG. **5** shows the surface of roller **135** including through-holes **137** thereon, and FIG. **6** shows a layout diagram of the etching molds having different real contact areas respectively attached to (or prior to attachment to) the roller **135**, according to the present invention.

[0034] Referring to FIG. **6**, a low-density etching mold **140** having a real contact area equal to or less than 20% and a high-density etching mold **145** having a real contact area of 20%~50% are respectively attached to the roller **136**.

A Second Embodiment

[0035] The second embodiment of a method for fabricating a fixed abrasive pad having different real contact areas utilizes a press.

[0036] Firstly, a mixture of abrasive particles, a binding agent, and (optionally) a hardening agent is applied on a polycarbonate film constituting a base of the fixed abrasive pad, and then a polishing film is formed by a rolling method using a roller. Here, the roller has no surface morphology, and the polishing film is temporarily hardened in a constant thickness. Next, the etching molds having different real contact areas are respectively attached to a press.

[0037] Subsequently, the temporarily hardened polishing film is positioned on the press, and then is pressed or deformed by the press under a predetermined heat and pressure. After then, the polishing film is cooled, thus forming a fixed abrasive pad having one or more regions of relatively low real contact area and one or more regions of relatively high real contact area.

[0038] FIG. **7** illustrates a method for fabricating a fixed abrasive pad according to the second embodiment.

[0039] Referring to FIG. **7**, the polishing film **153** temporarily hardened by the roller **151** in a constant thickness is pressed and deformed by the press **155** on which the etching molds **157** are attached. Here, the etching molds comprise a low-density etching mold providing a real contact area less than 20% and a high-density etching mold providing a real contact area of 20%~50%.

[0040] FIG. **8** shows a fixed abrasive pad fabricated by the present method.

[0041] Referring to FIG. **8**, a low-density polishing portion having a real contact of about 10% and a high-density polishing portion having a real contact area of about 40% are formed on one pad.

[0042] According to the present invention, a wafer with patterns can be polished using one polishing pad, thus enabling reduction of a processing time and improvement of efficiency of a CMP equipment.

[0043] While the invention has been shown and described with reference to certain preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A fixed abrasive pad, comprising a first polishing portion having a relatively low real contact area and a second polishing portion having a relatively high real contact area.

2. The fixed abrasive pad of claim **1**, wherein the low-density polishing portion has a real contact area of less than 20% and the high-density polishing portion has a real contact area of 20%~50%.

3. The fixed abrasive pad of claim **2**, wherein the second polishing portion has a real contact area that is at least 10% greater than a real contact area of the first polishing portion.

4. The fixed abrasive pad of claim **1**, adapted for chemical mechanical polishing a wafer using chemical mechanical polishing equipment.

5. A method for polishing a wafer, comprising the steps of:
polishing the wafer on a first polishing portion of a fixed abrasive pad comprising a plurality of polishing portions, the first polishing portion having a relatively low real contact area; and
polishing the wafer on a second polishing portion of the fixed abrasive pad, the second polishing portion having a relatively high real contact area.

6. The method of claim **5**, wherein the first polishing portion has a real contact area of less than 20% and the second polishing portion has a real contact area of 20%~50%.

7. The method of claim **6**, wherein the second polishing portion has a real contact area that is at least 10% greater than a real contact area of the first polishing portion.

8. The method of claim **5**, wherein the wafer has a predetermined pattern thereon.

9. The method of claim **5**, comprising polishing the wafer initially on the low real contact area.

10. The method of claim **9**, comprising polishing the wafer on the high real contact area after initially polishing the wafer on the low real contact area.

11. A polishing apparatus, comprising:
a turn table;
a fixed abrasive pad on the turn table, comprising a first polishing portion having a relatively low real contact area and a second polishing portion having a relatively high real contact area; and
a wafer carrier adapted to hold a wafer and rotate the wafer against the fixed abrasive pad.

12. The apparatus of claim **11**, further comprising a chemical supplier over the turn table.

13. The apparatus of claim **11**, wherein the first polishing portion has a real contact area of less than 20% and the second polishing portion has a real contact area of 20%~50%.

14. The apparatus of claim **13**, wherein the second polishing portion has a real contact area that is at least 10% greater than a real contact area of the first polishing portion.

15. An apparatus for making a fixed abrasive pad, comprising:
one or more etching molds having a first region providing a relatively low real contact area and a second region providing a relatively high real contact area;
a roller or press to which the etching mold(s) are attached, adapted to press an abrasive particle mixture onto a pad base; and
one or more mechanisms for supplying the pad base and the abrasive particle mixture to the roller or press.

16. The apparatus of claim **15**, wherein the first region has a real contact area of less than 20% and the second region has a real contact area of 20%~50%

17. The apparatus of claim **15**, further comprising a plurality of etching molds, each etching mold having a different real contact area.

18. The apparatus of claim **17**, wherein the etching molds have a surface morphology opposite or complementary to a shape formed on the fixed abrasive pad.

19. The apparatus of claim **15**, wherein the roller comprises a plurality of through-holes.

20. The apparatus of claim **16**, wherein the second polishing portion has a real contact area that is at least 10% greater than a real contact area of the first polishing portion.

* * * * *