(54) Title: POLISHING PADS, CONDITIONER AND METHODS FOR POLISHING USING THE SAME

* RR RATIO = REMOVAL RATIO/AVERAGE REMOVAL RATIO

(57) Abstract: The present invention relates to a polishing pad for performing effective polishing and conditioning in a 5 chemical mechanical polishing (hereinafter referred to as "CMP"), a conditioner suitable for the polishing pad, and a CMP process using the polishing pad and the conditioner.

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POLISHING PADS, CONDITIONER AND METHODS FOR POLISHING USING THE SAME

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a polishing pad for performing effective polishing and conditioning in a chemical mechanical polishing (hereinafter referred to as 'CMP'), a conditioner suitable for the polishing pad, and a CMP process using the polishing pad and the conditioner.

Description of the Related Art

In production of semiconductor devices, CMP process is performed to planarize the surface of wafers. This CMP process is a kind of precise/mirror face grinding. In the CMP process, slurry is supplied between the polishing pad and the wafer to chemically corrode the surface of the wafer and mechanically polish the corroded surface of the wafer.

The polishing pad used in the CMP process employs the conditioning method, i.e., the surface of the pad is scraped by using a diamond cutter concurrently with the start of the
CMP process, or in the mid course of the CMP process, to thereby remove sludge precipitated on the surface of the pad and prevent grazing of surface.

The conventional conditioning is configured suitable for a conventional pad, which is made by a foaming method or an infiltration method to have a plurality of pores with a diameter of 30 - 70 micrometers therein. In case of the conventional pad, if the surface of the pad is not scraped by a conditioning cutter concurrently with the start of the CMP process or in the mid course of the CMP process, glazing phenomenon is generated on the pad to have a bad influence on the surface quality of the wafer. Accordingly, the conditioning process is essential.

However, if the conditioning of the surface of the polishing pad is performed, the abraded amount of the polishing pad is accumulated as the polishing process advances, so that the thickness of the pad is varied depending on time. This variation in thickness has a bad influence on the polished surface shape of the wafer. Also, the broken pieces of the cutter blade generated during the conditioning act as a serious contamination source of the wafer, so that macro-scratch can be generated on the surface of the wafer.
SUMMARY OF THE INVENTION

Accordingly, the present invention has been devised to improve various influences generated during the conditioning process when the conventional polishing pad is employed.

An object of the present invention is to provide a polishing pad for performing effective polishing and conditioning in a chemical mechanical polishing (hereinafter referred to as ‘CMP’), a conditioner suitable for the polishing pad, and a CMP process using the polishing pad and the conditioner.

Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are
intended to provide further explanation of the invention as claimed.

**BRIEF DESCRIPTION OF THE DRAWINGS**

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings:

FIGs. 1A and 1B are SEM photographs showing surfaces of an inventive polishing pad on which micro holes and/or grooves are formed; and

FIG. 2 is a graph illustrating results of a CMP process according to the present invention in which polishing is performed without conditioning of the polishing pad.

**DETAILED DESCRIPTION OF THE INVENTION**

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.
The present invention uses a polishing pad without pores therein instead of the conventional pad. In case of the conventional pad with pores, as the CMP process time increases, glazing of pores on the surface of the polishing pad is accelerated. The glazing of the polishing pad surface hinders the role of the pad allowing slurry to be well introduced and flow in the course of polishing. Also, in a process for forming pores, the formation of pores due to the introduction of foreign particles or the physical and chemical foaming fails to uniformly control the size and distribution of the pores. Accordingly, the conventional pad has a drawback in that physical properties are not uniform depending on parts of the polishing pad. To improve this drawback, a polishing pad without pores therein is proposed. This polishing pad without pores is formed not by the conventional foaming or dispersion process but by a pre-polymer process. The polishing pad without pores, which is obtained by the pre-polymer process, has uniform physical properties throughout the overall surface of the pad. Also, the polishing pad without pores removes a factor capable of varying the polishing process and also minimizes the glazing.

To minimize the conventional conditioning process, the polishing pad has micro holes having a diameter of 100 - 250 micrometers and/or grooves having a width of 100 - 1000
micrometers. The pad is fixed on the rotational platen of a CMP apparatus, and the surface of the pad with a plurality of micro holes and a plurality of grooves helps slurry flow from the center portion of the pad to edges and sufficiently permeate into the entire surface of the wafer. As an actual example, the inventive pad has micro holes and grooves formed on the surface thereof as shown in FIGs. 1A and 1B.

The pad can be fabricated from at least one selected from the group consisting of polyurethane, PVC, polyvinyl alcohol, poly acrylic acid, poly acrylic amide, polyethylene oxide, maleic acid copolymer, methyl cellulose and carboxymethyl cellulose.

The pad fabricated as above has no pores therein, and has a hardness of 50 - 90 shore D and a compression rate of 1 - 8%.

Also, a conditioner according to the present invention is fabricated having similar physical properties to the inventive polishing pad so as to solve scratch induction and wafer contamination problems of the conventional conditioner. In other words, in case that the conditioning is performed by the inventive conditioner made of polymer like the inventive polishing pad, the scratch phenomenon can be basically prevented.
Also, since the conditioner has the similar physical properties to the polishing pad, the conditioning of the CMP process prevents excessive abrasion of the polishing pad having a bad influence on the surface shape of the wafer as a workpiece, thereby remarkably reducing the abraded amount of the polishing pad.

In the conventional CMP process using the conventional conditioner, diamond tip and housing materials that are elements of a diamond conditioner have a danger acting as metal contamination sources, which may cause a fatal damage on the wafer. However, the inventive conditioner has no such a danger because it is made from the same material as that of the polishing pad.

The inventive polishing pad is formed not by the conventional foaming or dispersion process causing pores therein but by a pre-polymer process (cf. Korean Patent Application No. 2002-6309) including twice mixing steps.

To prevent excessive abrasion of the polishing pad and prevent defects in the wafer in the course of polishing process, polymer conditioner is proposed. This new conditioner is prepared by using a similar material to the polishing pad, and is fabricated in an integral type where a projection part functioning as the conditioning tip and a tip attaching surface are integrally formed by a mold.
Also, the present invention introduces the aforementioned polishing pad and the conditioner into a CMP process. This CMP process includes the steps of: fixing a polishing pad having a hardness of 50 - 90 shore D and a compression rate of 1 - 8 % without a pore therein and having micro holes and/or grooves for helping introduction and flow of slurry for polishing, to a polishing tool and rotating the polishing pad; polishing a wafer by rotating and shaking the wafer while slurry is supplied on the polishing pad and the polishing pad presses the wafer, wherein in the course of polishing or before and after the polishing, a conditioning in which a conditioner is passed or swept on the surface of the polishing pad to transfer the slurry, is performed to remove sludge on the polishing pad.

Also, although the inventive conditioning process for transferring slurry by a conventional conditioner passing or sweeping the polishing pad is performed at 60% or less pressure of the conventional conditioning pressure, at 60% or less time of the conventional conditioning time, it is possible to remove the sludge on the pad surface.

By introducing the polishing pad without pores therein and having grooves and/or micro holes formed on the surface of the pad to help the flow of slurry, and the conditioner
made of polymer, which is the same material as that of the polishing pad, the invention has the following effects:

1. Abraded amount of the polishing pad is remarkably reduced to increase the lifetime of the pad. In other words, unlike the conventional conditioning process using the conventional conditioner, which excessively abrades the surface of the polishing pad and thus is made in a fresh state, the inventive conditioner made of polymer sweeps away sludge caught in the plurality of micro holes having a diameter of 100 - 250 micrometers and/or the grooves having a width of 100 - 1000 micrometers, using projections formed on a surface of the conditioner, thereby maintaining the surface of the polishing pad at a fresh state. As a result, excessive abrasion of the polishing pad is prevented and abraded amount of the polishing pad is remarkably reduced.

2. The micro holes formed in the pad and having the diameter of 100 - 200 micrometers help flow of slurry. Since the hole sizes allow the pad to form a uniquely designed surface and thus prevent glazing from being generated due to the polished particles, there does not occur an excessive abrasion of the polishing pad unlike the conventional conditioning process. The grooves formed in the pad and having the width of 100 - 1000 micrometers also show the same effects as those of the micro holes.
3. The polishing pad having the aforementioned material and shape has a less necessity of conditioning than the conventional one. Accordingly, the conditioner suitable for the inventive polishing pad, i.e., conditioner made of polymer is used to thereby minimize the abrasion rate and also prevent defects of the wafer due to broken pieces of the conditioner. In actual circumstance, when the CMP process is performed by the inventive polishing pad, although conditioning is not performed, it is confirmed by FIG. 2 that there is no variation in the abrasion efficiency of the polishing pad according to elapse of time.

FIG. 2 shows experimental results of ex-situ conditioning process for 2 - 5 minutes when the polishing of a wafer is performed while rotating a platen supporting the polishing pad at a speed of 20 - 400 RPM, supporting a carrier of the wafer at a pressure of 1 - 10 psi, and rotating the wafer at the same speed of 200 - 400 RPM. In this ex-situ conditioning process, the conditioning is performed not in the course of the polishing but by in a mid term between one polishing process and the next polishing process.

As described previously, the present invention proposes a polishing pad having a surface structure to help flow and spread of slurry without pores therein. The
inventive polishing pad allows free introduction and flow of slurry but prevents glazing of the pad surface so that excessive conditioning process is not further needed. This is due to the development of a polishing pad having new material and surface properties.

Thus, the polishing pad according to the present invention does not cause glazing in its surface, excessive conditioning process is not further needed unlike the conventional polishing pad.

Also, a conditioner made of polymer suitable for the aforementioned polishing pad is introduced to prevent excessive abrasion, which occurs in the conventional diamond conditioner. In addition, metal defects that may be a defect source of a workpiece can be basically prevented.

It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.
What is claimed is:

1. A polishing pad having a hardness of 50 - 90 shore D and a compression rate of 1 - 8 % without a pore therein.

2. The polishing pad according to claim 1, wherein the polishing pad has micro holes and/or grooves for helping introduction and flow of slurry for polishing.

3. The polishing pad according to claim 2, wherein the micro holes have a diameter of 100 - 250 micrometers.

4. The polishing pad according to claim 2, wherein the grooves have a width of 100 - 1000 micrometers.

5. The polishing pad according to claim 1, fabricated from at least one selected from the group consisting of polyurethane, PVC, polyvinyl alcohol, poly acrylic acid, poly acrylic amide, polyethylene oxide, maleic acid copolymer, methyl cellulose and carboxymethyl cellulose.
6. A CMP process conditioner for preventing extra abrasion of a polishing pad and a metal contamination source of a workpiece to be polished, the polishing pad being fabricated from at least one polymer selected from the group consisting of polyurethane, PVC, polyvinyl alcohol, poly acrylic acid, poly acrylic amide, polyethylene oxide, maleic acid copolymer, methyl cellulose and carboxymethyl cellulose.

7. A CMP process comprising the steps of:

fixing a polishing pad having a hardness of 50 - 90 shore D and a compression rate of 1 - 8 % without a pore therein and having micro holes and/or grooves for helping introduction and flow of slurry for polishing, to a polishing tool and rotating the polishing pad;

polishing a wafer by rotating and shaking the wafer while slurry is supplied on the polishing pad and the polishing pad presses the wafer,

wherein in the course of polishing or before and after the polishing, a conditioning in which a conditioner is passed or swept on the surface of the polishing pad to transfer the slurry, is performed to remove sludge on the polishing pad.
8. The CMP process according to claim 7, wherein the conditioner has the same physical properties as the polishing pad.

9. The CMP process according to claim 7 or 8, wherein the micro holes have a diameter of 100 - 250 micrometers.

10. The CMP process according to claim 7 or 8, wherein the grooves have a width of 100 - 1000 micrometers.

11. The CMP process according to claim 7 or 8, wherein the polishing pad is fabricated from at least one selected from the group consisting of polyurethane, PVC, polyvinyl alcohol, poly acrylic acid, poly acrylic amide, polyethylene oxide, maleic acid copolymer, methyl cellulose and carboxymethyl cellulose.

12. The CMP process according to claim 7 or 8, wherein the conditioner is fabricated from at least one selected from the group consisting of polyurethane, PVC, polyvinyl alcohol, poly acrylic acid, poly acrylic amide, polyethylene oxide, maleic acid copolymer, methyl cellulose and carboxymethyl cellulose.
FIG. 1
* RR RATIO = REMOVAL RATIO / AVERAGE REMOVAL RATIO

**FIG. 2**
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
   IPC7 H01L 21/304
   According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
   Minimum documentation searched (classification system followed by classification symbols)
   B24B 11/00, 37/00, B24D 3/28, 13/14, H01L. 21/304

   Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
   KOREAN PATENTS AND APPLICATIONS FOR INVENTION SINCE 1975

   Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
   KIPONET

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tr>
<td>Y</td>
<td>WO 0243921 A(Toyo Boseki Kabushiki Kaisha) 06 JUNE 2002 See the whole document</td>
<td>1-5, 7, 9-11</td>
</tr>
<tr>
<td>Y</td>
<td>JP 2001-246552 A(JSR Corp.) 11 SEPTEMBER 2001 See the whole document</td>
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<td>JP 2001-232554 A(Toyobo Co Ltd) 28 AUGUST 2001 See the abstract</td>
<td>1-5, 7, 9-11</td>
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☐ Further documents are listed in the continuation of Box C. ❌ See patent family annex.

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"&" document member of the same patent family

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Name and mailing address of the ISA/KR

Korean Intellectual Property Office
920 Dusan-dong, Seo-gu, Daejeon 302-701, Republic of Korea
Facsimile No. 82-42-472-7140

Authorized officer

KIM, Kap Byung

Telephone No. 82-42-481-5730

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<td>JP 2001-246552 A</td>
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