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(54) **CMP PROCESS USING SLURRY CONTAINING ABRASIVE OF LOW CONCENTRATION**

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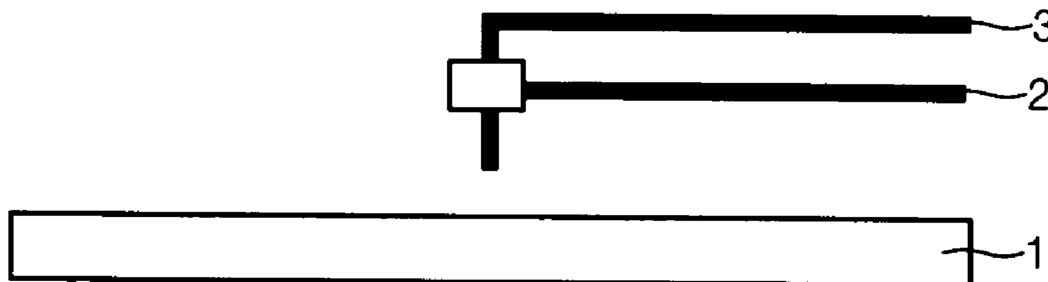
(57) **ABSTRACT**

A CMP process using a slurry containing an abrasive of low concentration is disclosed. More specifically, a planarization process is performed using the slurry containing an abrasive of low concentration of less than 0.1 wt % unlike the conventional CMP slurry, thereby improving uniformity of a CMP process in a manufacture process of a semiconductor device to secure yield and reliability of the device. Particularly, since the disclosed slurry has the more excellent effect of achieving the planarization degree than that of the conventional slurry, the thickness of deposited films before the CMP process can be reduced, and the CMP amount can also be minimized.



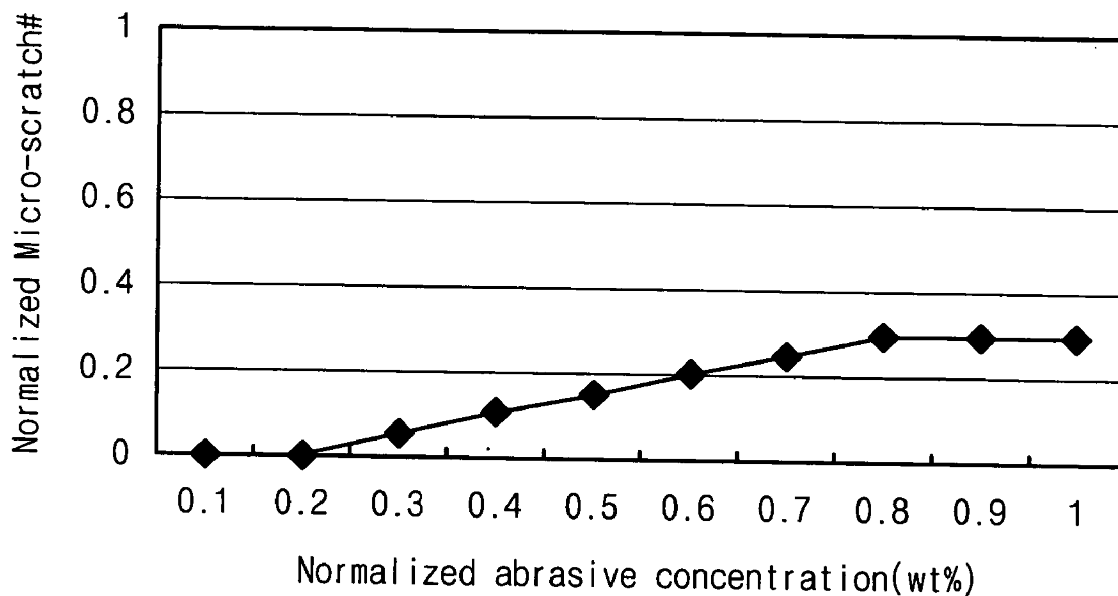


Fig.1

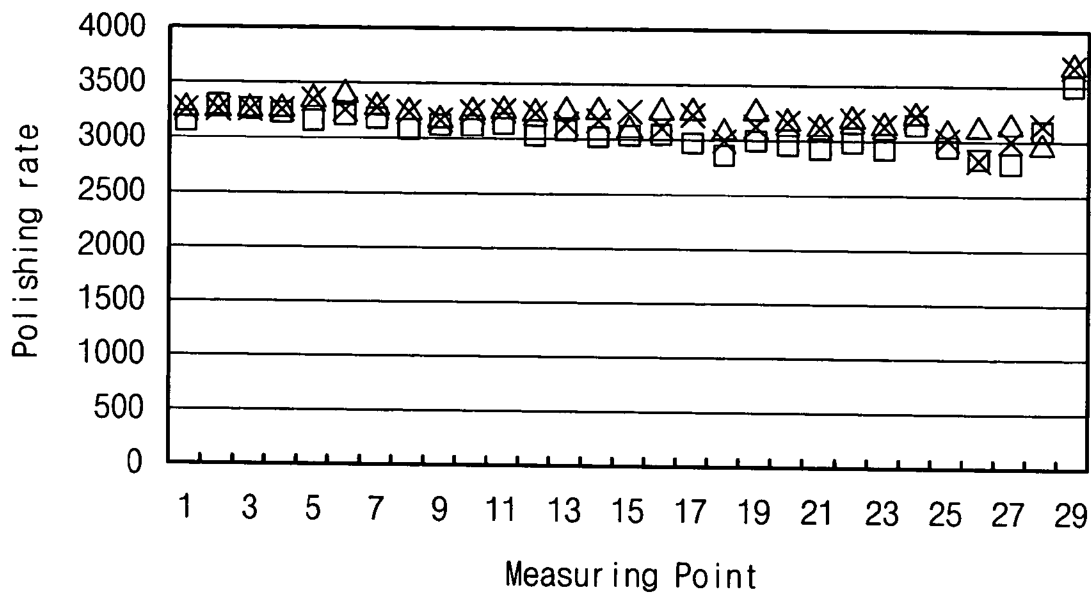


Fig.2

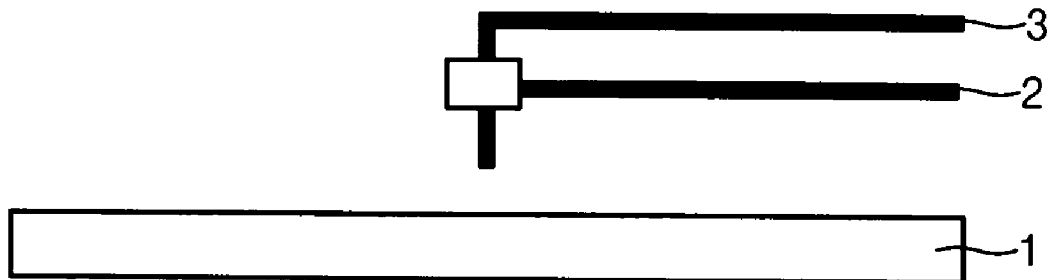


Fig.3

CMP PROCESS USING SLURRY CONTAINING ABRASIVE OF LOW CONCENTRATION

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a CMP process using a CMP (Chemical Mechanical Polishing) slurry containing an abrasive of low concentration. More specifically, the present invention relates to a method for manufacturing a semiconductor device wherein a planarization process is performed using a slurry containing a less than 0.1 wt % abrasive unlike a conventional CMP slurry to improve uniformity of the CMP process in a manufacture process of a semiconductor device, thereby securing yield and reliability of the device.

[0003] 2. Description of the Prior Art

[0004] In general, a CMP process is performed to planarize an interlayer insulating film for insulating a pattern formed in a manufacture process of a semiconductor device, or a film or a pattern formed in a process using a metal. The CMP process which is necessary in the planarization process of the semiconductor device manufacture process is performed using a chemical material having a good reaction property of CMP slurries to remove a material to be chemically removed. At the same time, an ultrafine abrasive mechanically removes the surface of a wafer by injecting liquid slurry between the surface of the wafer and a rotating elastic pad.

[0005] In this slurry process, lots of expendable materials such as a polishing pad, a backing film slurry, a diamond conditioner are used. Particularly, in case of slurry, less than 3% of the slurry is used in the CMP process, and the rest is wasted. As a result, studies have been made on reuse of the wasted slurry but its practicability is still in doubt.

[0006] When an abrasive particle included in the slurry is large or the abrasive is agglomerated, scratch is generated in a semiconductor device. The generation of scratch is more affected as concentration of the abrasive particle becomes higher, which may degrade yield and reliability of a semiconductor device.

[0007] A conventional slurry generally contains 5~15 wt % of silica (SiO_2) and 0.5~5 wt % of ceria (CeO_2) as an abrasive in order to maintain a predetermined polishing speed.

[0008] In the CMP process, since the residual polishing particles causes polishing non-uniformity, expendable materials such as a pad or diamond of a backing film used to overcome the non-uniformity are frequently exchanged. Particularly, when abrasive particles such as ceria (CeO_2), alumina (Al_2O_3) and manganese oxide (MnO_2) are used, a filter is also frequently replaced to remove large particles. The residual abrasive in the CMP slurry may be a scratch source, which causes a fatal defect in a device.

[0009] Therefore, a CMP slurry is required to improve uniformity of a CMP process in a manufacture process of a semiconductor device.

SUMMARY OF THE INVENTION

[0010] Accordingly, it is an object of the present invention to provide a method for manufacturing a semiconductor device which can secure yield and reliability of the device by improving uniformity of a CMP process.

[0011] In an embodiment, there is provided a method for manufacturing a semiconductor device by performing a CMP (Chemical Mechanical Polishing) planarization process using a CMP slurry containing an abrasive having a concentration ranging from 0.01 to 0.1 wt %.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The present invention will become better understood with reference to the accompanying drawings which are given only by way of illustration and thus are not limitative of the present invention, wherein:

[0013] **FIG. 1** is a graph illustrating the degree of scratch of a wafer depending on concentration of an abrasive of a slurry;

[0014] **FIG. 2** is a graph illustrating the polishing speed when a BPSG oxide film is polished using a slurry containing a 0.05 wt % abrasive (■: wafer 1, ▲: wafer 2, x: wafer 3); and

[0015] **FIG. 3** is a diagram illustrating a method for regulating a dilution ratio of a slurry.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0016] The present invention will be described in detail.

[0017] In the above-described method, the concentration of the abrasive included in the CMP slurry ranges from 0.01 to 0.1 wt %.

[0018] If the concentration of the abrasive is less than 0.01 wt %, the content of the abrasive is too low to achieve the mechanical polishing effect. If the concentration of the abrasive is more than 0.1 wt %, the planarization ability is degraded, and micro-scratch is generated according to increase in concentration of polishing particles in the slurry. Accordingly, a slurry containing an abrasive having a concentration ranging from 0.01 to 0.1 wt % is preferably used in order to maintain the proper polishing speed and minimize the micro-scratch.

[0019] Preferably, the concentration of the abrasive included in the CMP slurry ranges from 0.01 to 0.09 wt %, more preferably 0.05 wt %.

[0020] The abrasive is selected from a group consisting of ceria (CeO_2), silica (SiO_2), manganese oxide (MnO_2) and combinations thereof.

[0021] The CMP process is used in an interlayer insulating film planarization process, a STI CMP process, a landing plug poly CMP process, a tungsten CMP process, an aluminum CMP process or a copper CMP process.

[0022] During the interlayer insulating film planarization process, a BPSG oxide film a PSG oxide film, a TEOS oxide film, a P—SiH_4 film, a SiN film or a polysilicon film is polished by regulating the amount of a supplied slurry and flowing water.

[0023] A slurry used in the STI CMP process is a slurry including an anioinic additive, a cationic additive or a non-ionic additive which may be present in an amount ranging from 0.005 to 1 wt %.

[0024] The anioinic additive is selected from a group consisting of carboxylic acid, sulfuric acid ester, sulfonic acid, phosphoric acid ester and salts thereof. The cationic additive is selected from a group consisting of primary amine, secondary amine, tertiary amine, quaternary amine and salts thereof. The non-ionic additive is selected from a group consisting of a polyethyleneglycol-type surfactant and a polyhydroxy alcohol-type surfactant.

[0025] The present invention will be described in detail with reference to the accompanying drawings.

[0026] **FIG. 1** is a graph illustrating the degree of micro-scratch of a wafer depending on concentration of an abrasive of a slurry diluted by deionized water. As shown in **FIG. 1**, it is understood that the concentration of the abrasive decreases as the dilution ratio increases and the micro-scratch also decreases as the concentration of the abrasive decreases.

[0027] **FIG. 2** is a graph illustrating the polishing speed when a BPSG oxide film is polished using a slurry containing a 0.05 wt % abrasive (■: wafer 1, ▲: wafer 2, x: wafer 3). The polishing speed of **FIG. 2** is a result of polishing a BPSG oxide film using a slurry containing a 0.05 wt % abrasive diluted by deionized water 100 times.

[0028] Here, the BPSG oxide film is polished under the following conditions: at a table revolution per minute of 93 rpm, at a head revolution per minute of 87 rpm and at a pressure of 4 psi. As a result, it is shown that the BPSG oxide film has a polishing speed of 3100 Å/min.

[0029] Table 1 shows comparison results of the polishing speed of a HDP oxide, a SiN film and a BPSG oxide film using a slurry containing 5 wt % CeO_2 as an abrasive diluted by deionized water to obtain 1) a slurry including a 0.05 wt % abrasive and 2) a slurry including 0.099 wt %.

TABLE 1

	Polishing speed depending on insulating films (unit: Å/min)				
	0.05 wt % CeO_2			0.099 wt % CeO_2	
Wafer No.	HDP oxide film	SiN film	BPSG oxide film	TEOS oxide film	BPSG oxide film
1	1179	277	3082	2445	6365
2	1170	285	3279		
3	1141	283	3205		

[0030] As shown in Table 1, if the slurry containing 0.05 wt % CeO_2 as an abrasive is used, it is shown that the HDP oxide film has a polishing speed of 1100~1200 Å/min, the BPSG oxide film has a polishing speed of 3000~3300 Å/min, and the SiN film has a polishing speed of 270~290 Å/min. If the slurry containing 0.099 wt % CeO_2 as an abrasive is used, it is shown that the TEOS oxide film has a polishing speed of 2445 Å/min, and the BPSG oxide film has a polishing speed of 6365 Å/min.

[0031] From the above results, the polishing speed is differentiated depending on quality of films to be polished. In order to regulate the proper polishing amount, it is necessary to regulate the concentration of the abrasive with reference to Table 1.

[0032] As shown in Table 1, it is preferable that the HDP oxide film and the TEOS oxide film are polished using a slurry containing a 0.1 wt % of abrasive, and the BPSG oxide film is polished using a slurry containing a 0.05~0.1 wt % of abrasive. When the same concentration of the abrasive is applied regardless of quality of films to be polished, the proper condition can be established by changing other mechanical polishing conditions.

[0033] **FIG. 3** is a diagram illustrating a method for regulating a dilution ratio of a slurry. The polishing amount depending on quality of films such as a HDP oxide film, a TEOS oxide film, a BPSG oxide film and a P—SiH_4 film is regulated by controlling the amount of a first diluted slurry supplied through a slurry input means **2** and deionized water supplied through a water input means **3** on the polishing pad **1** at the same time. The first diluted slurry is obtained by diluting a slurry containing a 5 wt % abrasive by 50 times. In an embodiment of the present invention, since the regulation of the abrasive dilution ratio is important, it is also important to regulate the amount of water supplied to second dilute the first diluted slurry.

[0034] As discussed earlier, in an embodiment of the present invention, a planarization process is performed using a slurry containing an abrasive of low concentration of less than 0.1 wt % unlike the conventional CMP slurry, thereby improving uniformity of a CMP process in a manufacture process of a semiconductor device to secure yield and reliability of the device. Specifically, since the slurry according to the present invention has the more excellent effect of achieving the planarization degree than that of the conventional slurry, the thickness of deposited films for planarization can be reduced, and the polishing amount can also be reduced, thereby providing the advantageous effect in a previous deposition process as well as in a CMP process.

What is claimed is:

1. A method for manufacturing a semiconductor device wherein a CMP (Chemical Mechanical Polishing) planarization process is performed using a CMP slurry, wherein the CMP slurry contains an abrasive having a concentration ranging from 0.01 to 0.1 wt % of the CMP slurry.

2. The method according to claim 1, wherein the concentration of the abrasive ranges from 0.01 to 0.09 wt %.

3. The method according to claim 1, wherein the abrasive is selected from a group consisting of CeO_2, SiO_2, MnO_2 and combinations thereof.

4. The method according to claim 1, wherein the CMP planarization process comprises an interlayer insulating film planarization process, a STI CMP process, a landing plug poly CMP process, a tungsten CMP process, an aluminum CMP process or a copper CMP process.

5. The method according to claim 4, wherein a BPSG oxide film, a PSG oxide film, a TEOS oxide film, a P—SiH_4 film, a SiN film or a polysilicon film is polished in the interlayer insulating film planarization process.

6. The method according to claim 4, wherein the slurry used in the STI CMP process comprises an additive selected from a group consisting of an anionic additive, a cationic additive or a non-ionic additive.

7. The method according to claim 6, wherein the anioinic additive is selected from a group consisting of carboxylic acid, sulfuric acid ester, sulfonic acid, phosphoric acid ester and salts thereof.

the cationic additive is selected from a group consisting of primary amine, secondary amine, tertiary amine, quaternary amine and salts thereof, and

the non-ionic additive is selected from a group consisting of a polyethyleneglycol-type surfactant and a polyhydroxy alcohol-type surfactant.

8. The method according to claim 6, wherein an amount of the additive ranges from 0.005 to 1 wt % of the slurry.

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