METHOD OF CLEANING WAFER SURFACES AFTER POLISHING ALUMINUM WIRINGS IN ULTRA LARGE SCALE INTEGRATED CIRCUITS

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Abstract
A method of cleaning wafer surfaces after polishing aluminum wirings by means of a polishing disc in ultra large scale integrated circuits, the method including: a) mixing and stirring deionized water, between 0.5 and 5 wt. % of a surfactant, between 0.1 and 5 wt. % of an FA/O II chelating agent, and between 0.01 and 5 wt. % of an FA/O II corrosion inhibitor, to yield a neutral aqueous cleaning solution; and b) after a chemical-mechanical polishing treatment for aluminum wirings, directly washing wafer surfaces with the neutral aqueous cleaning solution without lifting the polishing disc.
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CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of International Patent Application No. PCT/CA2010/0080471 with an international filing date of Dec. 30, 2010, designating the United States, now pending, and further claims priority benefits to Chinese Patent Application No. 201010231677.8 filed Jul. 21, 2010. The contents of all of the aforementioned applications, including any intervening amendments thereto, are incorporated herein by reference. Inquiries from the public to applicants or assignees concerning this document or the related applications should be directed to: Matthias Scholl P.C., Attn.: Dr. Matthias Scholl Esq., 14781 Memorial Drive, Suite 1319, Houston, Texas 77079.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention
[0003] The invention relates to a polishing technique, and more particularly to a method of cleaning wafer surfaces after polishing aluminum wirings in ultra large scale integrated circuits.
[0004] 2. Descriptions of Related Art
[0005] Currently, the most applicable integrated circuits are products employing technologies of 90 nm and above, the wiring of which is aluminum. Chemical-mechanical polishing (CMP) technique is a very important process in multilayer wirings of ultra large scale integrated circuit (ULSI) techniques, because the degree of flattening, roughness and dirt of the surface after CMP process directly affect aluminum wiring of next layer, breakdown characteristics of circuits, interface state, and the lifetime of minority carrier, all of which directly relates to properties and yields of wafers of integrated circuits (IC). A large amount of organic matters, grains, and heavy metal ions in particular are introduced during CMP. As aluminum is very active, the newly naked surface of aluminum in CMP tends to be oxidized, and after CMP, it still reacts with residues of the polishing solution. The naked surface in CMP has high surface energy, and thus large grains and metal ions surrounding are easily to be adsorbed. Shortly after CMP, chemical adsorption further occurs between the surface and dirt, and the dirt is difficult to remove, thereby resulting in contamination. Due to uneven distribution of polishing solution residues and barriers of adsorbed large grains, chemical corrosion and oxidation occurs unevenly on the surface, and the performance of the surface is decreased and cannot meet the standard. Conventional treatment after CMP is to lift polishing discs from the polishing solution to deionized water to wash, due to the time delay and cleaning solution only containing deionized water, the effectiveness is not good but often seriously contaminated by organic matters, large grains, and metal ions.

SUMMARY OF THE INVENTION

[0006] In view of the above-described problems, it is one objective of the invention to provide a method of cleaning wafer surfaces after polishing aluminum wirings in ULSIs.
[0007] To achieve the above objective, in accordance with one embodiment of the invention, there is provided a method of cleaning wafer surfaces after polishing aluminum wirings by means of a polishing disc in ultra large scale integrated circuits, the method comprising:

[0008] a) preparing an aqueous cleaning solution comprising steps as follows: collecting deionized water, stirring with between 0.5 and 5 wt. % of a surfactant, between 0.1 and 5 wt. % of an FA/O II chelating agent, and between 0.01 and 5 wt. % of an FA/O II corrosion inhibitor added into the deionized water, continuing stirring to yield a neutral aqueous cleaning solution, the wt. % being based on the total weight of the solution; and

[0009] b) after CMP treatment of the aluminum wirings, without lifting the polishing disc, directly washing wafer surfaces with the neutral aqueous cleaning solution at a large flow rate to make the surface clean.

[0010] In a class of this embodiment, the washing is carried out under following conditions:
[0011] flow rate: between 1000 and 5000 mL/min;
[0012] time: between 0.5 and 2 min; and
[0013] pressure on the wafer surfaces: zero or equivalent to the weight of the polishing disc on the wafer surfaces.

[0014] Advantages of the invention are summarized below: aqueous cleaning is quickly processed after CMP treatment without stopping rotation of the polishing disc; a large flow rate of the neutral aqueous cleaning solution containing surfactant, chelating agent, and corrosion inhibitor can clean wafer surfaces with no corrosion to device, and wash away unevenly distributed polishing solution, organic matters and large grains, thereby obtaining a clean and perfect surface. The surfactant reduces the surface tension of wafers, and the cleaning solution can expand evenly on the wafer surfaces, thus, the effectiveness of the clean is improved. The chelating agent reacts with metal ions forming chemical bonds to yield macromolecular chelates, thereby effectively controlling the adsorption of metal ions on the wafer surfaces, and washing away metal ions using large flow rate of cleaning solution. The corrosion inhibitor forms a single molecular passive film on the surface to prevent residue of polishing solution from continuing reacting with the surface and forming uneven corrosion and oxidation, so that the perfection of the wafer surface is improved.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0015] To further illustrate the invention, experiments detailing a method of cleaning wafer surfaces after polishing aluminum wirings in ULSIs are described below. It should be noted that the following examples are intended to describe and not to limit the invention.

[0016] A method of cleaning wafer surfaces after polishing aluminum wirings by means of a polishing disc in ultra large scale integrated circuits, comprises:

[0017] a) preparing an aqueous cleaning solution comprising steps as follows:
[0018] mixing and stirring deionized water, between 0.5 and 5 wt. % of a surfactant, between 0.1 and 5 wt. % of an FA/O II chelating agent, and between 0.01 and 5 wt. % of an FA/O II corrosion inhibitor, to yield a neutral aqueous cleaning solution, the wt. % being based on the total weight of the solution; and
[0019] b) after CMP treatment of the aluminum wirings, without lifting the polishing disc, directly washing wafer surfaces with the neutral aqueous cleaning solution at a large flow rate to make the surface clean.
The washing is under following conditions:
flow rate: between 1000 and 5000 mL/min;
time: between 0.5 and 2 min; and
pressure on wafer surfaces: zero or equivalent to the weight of the polishing disc on wafer surfaces.

The surfactant is selected from the group consisting of an FA/O 1 surfactant, O₉₋₇ ((C₁₀₋₁₁H₂₁₋₂₅−C₆H₄−O—
CH₂CH₂O)₅−₁₀H), O₁₀−₁₅ ((C₁₀₋₁₁H₂₁−C₆H₄−O—
CH₂CH₂O)₁₀−₁₅H), O₂₀−₂₅ ((C₁₂−₁₈H₂₅−C₆H₄−O—
CH₂CH₂O)₂₀−₃₅H), or JFC.

The FA/O II chelating agent is supplied by Tianjin Jingling Microelectronics Materials Co., Ltd.

The FA/O II corrosion inhibitor has a concentration of between 0.01 and 5 wt. %, and the FA/O II corrosion inhibitor is supplied by Tianjin Jingling Microelectronics Materials Co., Ltd.

EXAMPLE 1

A method of cleaning wafer surfaces after polishing aluminum wirings in ULSIs comprises steps as follows:

To 5000 g of deionized water, 100 g of an FA/O I surfactant and 50 g of an FA/O II chelating agent were added and stirred to yield a mixture. Thereafter, 5 g of a corrosion inhibitor diluted with 200 g of deionized water was added to the mixture and stirred for full dissolution. After CMP treatment, the aluminum wirings were washed with the cleaning solution at a flow rate of 1000 mL/min for 1 min. It was observed that no corrosion circles and oxidations existed on the surface.

EXAMPLE 2

A method of cleaning wafer surfaces after polishing aluminum wirings in ULSIs comprises steps as follows:

To 3400 g of deionized water, 100 g of an FA/O I surfactant and 50 g of an FA/O II chelating agent were added and stirred to yield a mixture. Thereafter, 10 g of a corrosion inhibitor diluted with 200 g of deionized water was added to the mixture and stirred for full dissolution. After CMP treatment, the aluminum wirings were washed with the cleaning solution at a flow rate of 4000 mL/min for 0.6 min. It was observed that no corrosion circles and oxidations existed on the surface.

Effects of the invention are summarized below:

Aluminum wirings in ULSIs after polishing have high surface energy, large surface tension, uneven distribution of polishing solution residues, adsorption of organic matters, grains, and metal ions. Once alkaline polishing is accomplished, cleaning method of the invention is processed before polishing disc stops rotation, in which most of grains can be removed; the large flow rate of cleaning solution washes away polishing solution residues; the surfactant, chelating agent, and corrosion inhibitor in the cleaning solution quickly reduce the surface tension, and react with metal ions to form soluble chelates and a single molecular passive film, therefore, uneven corrosion and oxidation on the surface can be prevented, and a clean and perfect surface is obtained.

While particular embodiments of the invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects, and therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of the invention.

The invention claimed is:

1. A method of cleaning wafer surfaces after polishing aluminum wirings by means of a polishing disc in ultra large scale integrated circuits, the method comprising:
ad) mixing the following: deionized water, between 0.5 and 5 wt. % of a surfactant, between 0.1 and 5 wt. % of an FA/O II chelating agent, and between 0.01 and 5 wt. % of an FA/O II corrosion inhibitor, to yield a neutral aqueous cleaning solution, the wt. % being based on the total weight of the solution; and
bb) after a chemical-mechanical polishing treatment of the aluminum wirings, directly washing the wafer surfaces with the neutral aqueous cleaning solution obtained in step a), without lifting the polishing disc.

2. The method of claim 1, wherein the washing in step b) is carried out under following conditions:
flow rate: between 1000 and 5000 mL/min;
time: between 0.5 and 2 min; and
pressure on the wafer surfaces: zero or equivalent to a weight of the polishing disc on the wafer surfaces.