

CHEMICAL SOLUTION AND METHOD FOR TREATING SUBSTRATE

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a chemical solution and a method for treating a substrate.

2. Description of the Related Art

[0002] As the miniaturization of semiconductor products progresses, there is an increasing demand for performing a step of removing unnecessary transition metal-containing substances on a substrate in a semiconductor product manufacturing process with high efficiency and high accuracy.

[0003] JP2016-092101A describes “method for treating a substrate on which a ruthenium-containing film is formed, including a step of removing ruthenium deposits attached to the outer edge portion of a surface of the substrate on which the ruthenium-containing film is formed and/or ruthenium deposits attached to a back surface of the substrate by using a remover solution, wherein a content of orthoperiodic acid in the remover solution with respect to a total mass of the remover solution is 0.05% to 8% by mass, and a pH of the remover solution is equal to or lower than 3.5 (claim 1)”.

SUMMARY OF THE INVENTION

[0005] In recent years, it has been also required to reduce the roughness (surface roughness) of a portion to be treated at the time of removing unnecessary transition metal-containing substances on a substrate. In a case where the roughness of the portion to be treated is high, sometimes the lamination properties of substances to be laminated on the portion to be treated deteriorate, which leads to the deterioration of the performance of semiconductor products.

The inventors of the present invention examined the removability of transition metal-containing substances by using the method disclosed in JP2016-092101A. As a result, the inventors have found that the dissolving ability for the transition metal-containing substances and the smoothness of the portion to be treated are not necessarily simultaneously achieved to a sufficient degree and need to be further improved.

[0006] Therefore, embodiments of the present invention provide a chemical solution, which has

an excellent dissolving ability for a transition metal-containing substance and can realize excellent smoothness of a portion to be treated, and a method for treating a substrate by using the chemical solution.

[0007] In light of the above, the inventors of the present invention conducted intensive examinations. As a result, the inventors have found that by a chemical solution including periodic acids and a predetermined amount of a compound, embodiments of the invention can be achieved, and have accomplished the present invention.

That is, the inventors have disclosed the following embodiments.

[0008] According to a first aspect of the present invention, there is provided a chemical solution used for removing a transition metal-containing substance on a substrate, including

one or more kinds of periodic acids selected from the group consisting of a periodic acid and a salt thereof, and

a compound including one or more kinds of anions selected from the group consisting of IO_3^- , I^- , and I_3^- ,

in which a content of the compound including anions with respect to a total mass of the chemical solution is 5 ppb by mass to 1% by mass.

In an embodiment, the periodic acids include at least one kind of compound selected from the group consisting of orthoperiodic acid, a salt of orthoperiodic acid, metaperiodic acid, and a salt of metaperiodic acid.

In an embodiment, a content of the periodic acids with respect to the total mass of the chemical solution is equal to or smaller than 37.0% by mass.

In an embodiment, a content of the periodic acids with respect to the total mass of the chemical solution is 2.0% to 8.0% by mass.

In an embodiment, a ratio of a content of the periodic acids to the content of the compound including anions is 1×10^0 to 1×10^8 .

In an embodiment, the compound including anions includes at least one kind of compound selected from the group consisting of iodic acid, tetramethylammonium iodate, tetraethylammonium iodate, tetrabutylammonium iodate, ammonium iodate, hydrogen iodide, tetramethylammonium iodide, tetraethylammonium iodide, tetrabutylammonium iodide, ammonium iodide, and nitrogen triiodide.

In an embodiment, the compound including anions includes a cation selected from the group consisting of a hydrogen cation, a tetramethylammonium cation, a tetraethylammonium cation, and a tetrabutylammonium cation.

In an embodiment, the transition metal-containing substance includes at least one kind of metal selected from the group consisting of Ru, Ti, Ta, Co, Cr, Hf, Os, Pt, Ni, Mn, Cu, Zr, Mo, La, W, and Ir.

In an embodiment, the transition metal-containing substance includes a Ru-containing substance.

In an embodiment, the chemical solution further includes a pH adjuster.

In an embodiment, the pH adjuster includes at least one kind of compound selected from the group consisting of tetramethylammonium hydroxide, tetraethylammonium hydroxide, tetrabutylammonium hydroxide, aqueous ammonia, a water-soluble amine, sulfuric acid, hydrochloric acid, acetic acid, nitric acid, hydrofluoric acid, perchloric acid, and hypochlorous acid.

In an embodiment, the pH adjuster includes at least one kind of compound selected from the group consisting of tetramethylammonium hydroxide, tetraethylammonium hydroxide, tetrabutylammonium hydroxide, aqueous ammonia, and a water-soluble amine.

In an embodiment, the chemical solution has a pH lower than 8.0.

In an embodiment, the chemical solution has a pH of 2.5 to 5.0.

According to a second aspect of the present invention, there is provided a method for treating a substrate, having a step A of removing a transition metal-containing substance on a substrate by using the above chemical solution.

In an embodiment, the transition metal-containing substance includes a Ru-containing substance.

In an embodiment, the step A is a step A1 of performing a recess etching treatment on transition metal-containing wiring disposed on a substrate by using the chemical solution, a step A2 of removing a transition metal-containing film at an outer edge portion of a substrate, on which the transition metal-containing film is disposed, by using the chemical solution, a step A3 of removing a transition metal-containing substance attached to a back surface of a substrate, on which a transition metal-containing film is disposed, by using the chemical solution, a step A4 of

removing a transition metal-containing substance on a substrate, which has undergone dry etching, by using the chemical solution, or a step A5 of removing a transition metal-containing substance on a substrate, which has undergone a chemical mechanical polishing treatment, by using the chemical solution.

In an embodiment, the above method has the step A1 as the step A, further having a step B of treating the substrate obtained by the step A1 by using a solution selected from the group consisting of a mixed solution of hydrofluoric acid and aqueous hydrogen peroxide, a mixed solution of sulfuric acid and aqueous hydrogen peroxide, a mixed solution of aqueous ammonia and aqueous hydrogen peroxide, and a mixed solution of hydrochloric acid and aqueous hydrogen peroxide after the step A1.

In an embodiment of the above method, the step A1 and the step B are alternately repeated.

In an embodiment, the above method further has a step C of performing a rinsing treatment on the substrate obtained by the step A by using a rinsing solution after the step A.

In an embodiment, the rinsing solution is a solution selected from the group consisting of hydrofluoric acid, hydrochloric acid, aqueous hydrogen peroxide, a mixed solution of hydrofluoric acid and aqueous hydrogen peroxide, a mixed solution of sulfuric acid and aqueous hydrogen peroxide, a mixed solution of aqueous ammonia and aqueous hydrogen peroxide, a mixed solution of hydrochloric acid and aqueous hydrogen peroxide, aqueous carbon dioxide, aqueous ozone, aqueous hydrogen, an aqueous citric acid solution, sulfuric acid, aqueous ammonia, isopropyl alcohol, an aqueous hypochlorous acid solution, aqua regia, ultrapure water, nitric acid, perchloric acid, an aqueous oxalic acid solution, and an aqueous orthoperiodic acid solution.

In an embodiment, a temperature of the chemical solution is 20°C to 75°C.

[0009] According to embodiments of the present invention, it is possible to provide a chemical solution, which has an excellent dissolving ability for a transition metal-containing substance and can realize excellent smoothness of a portion to be treated, and a treatment method using the chemical solution.

BRIEF DESCRIPTION OF THE DRAWINGS