Patent Literature 2: Japanese Patent Laid-Open No. 2002-246378

Patent Literature 3: Japanese Patent Laid-Open No. 2008-71801

Summary ~~of Invention~~

Technical Problem

[0005]

In accordance with a narrower line width of a semiconductor substrate, however, even fine etching is supposed to have a large impact to form a structure having a thinner thickness of a SiO_2 film and a narrower line width than a conventional one. In view of such a circumstance, SiN etching that has high selectivity while the cleaning effect on SiN is sufficiently ensured is increasingly demanded.

[0006]

The present invention has been made in view of the above circumstance, and an object thereof is to provide a substrate cleaning liquid and a substrate cleaning method that impart a good etching rate of silicon nitride and that also impart a high selection ratio while etching of silicon oxide is suppressed.

~~Solution to Problem~~

[0007]

That is, with respect to the substrate cleaning liquid of the present invention, a first aspect of the present

invention provides a cleaning liquid for use in cleaning of a substrate having silicon nitride and silicon oxide on the same substrate, at least a portion of one or both of the silicon nitride and the silicon oxide being exposed on the substrate, wherein the cleaning liquid includes phosphoric acid, electrolytic sulfuric acid including persulfuric acid produced by electrolysis of sulfuric acid, and water, and is warmed to 165°C or higher and lower than a boiling point for use in the cleaning.

[0008]

~~A second aspect of the present invention~~An embodiment provides a substrate cleaning method according to the first aspect, wherein a concentration of the persulfuric acid produced by electrolysis in an entire cleaning liquid is 1.0 to 8.0 g/L.

[0009]

~~A third aspect of the present invention~~An embodiment provides the substrate cleaning liquid according to any of the first and second aspects, wherein a concentration of the phosphoric acid is 15 to 40% by mass and a concentration of the sulfuric acid is 30 to 85% by mass in the entire cleaning liquid.

[0010]

~~A fourth aspect of the present invention~~An embodiment provides the substrate cleaning liquid according to any of the first to third aspects, wherein a ratio of a concentration (% by mass) of the phosphoric acid to a concentration (% by mass) of the sulfuric acid ranges from 1:1.5 to 1:4 in the entire

cleaning liquid.

[0011]

~~A fifth aspect of the present invention~~An embodiment provides the substrate cleaning liquid according to any of the first to fourth aspects, having a water content of 15 to 25% by mass.

[0012]

~~A sixth aspect of the present invention~~An embodiment provides the substrate cleaning liquid according to any of the first to fifth aspects, for use in sheet-type cleaning of the substrate.

[0013]

~~A seventh aspect of the present invention~~An aspect provides a substrate cleaning method that is a method for cleaning a substrate having silicon nitride and silicon oxide on the same substrate, at least a portion of one or both of the silicon nitride and the silicon oxide being exposed on the substrate, the method including bringing the substrate into contact with the substrate cleaning liquid according to the ~~first to sixth aspects of the present invention~~one of the above substrate cleaning liquid to selectively etch the silicon nitride on the substrate.

[0014]

An ~~eighth aspect of the present invention~~embodiment provides the substrate cleaning method according to the seventh aspect, wherein the silicon nitride is stacked on the silicon oxide on the substrate.

[0015]

~~A ninth aspect of the present invention~~An embodiment provides the

substrate cleaning method according to the seventh or eighth aspect, wherein the substrate has a pattern line width of 32 nm or less.

[0016]

~~A tenth aspect of the present invention~~An embodiment provides the substrate cleaning method according to any of the seventh to ninth aspects, including cleaning the substrate by the cleaning liquid in a sheet-type manner.

[0017]

An ~~eleventh aspect of the present invention~~embodiment provides the substrate cleaning method according to any of the seventh to tenth aspects, including recovering a cleaning liquid used for cleaning, subjecting the cleaning liquid to electrolysis to increase a concentration of persulfuric acid, and thereafter further subjecting the resulting cleaning liquid to the cleaning as a cleaning liquid.

[0018]

Hereinafter, configurations defined in ~~the present invention~~various embodiment are described.

In the ~~present invention~~embodiments, persulfuric acid produced by electrolyzing sulfuric acid is included, and a persulfuric acid salt is not included.

In the ~~present invention~~embodiments, etchability of silicon nitride by phosphoric acid is favorably achieved. Phosphoric acid, however, has a function of etching silicon oxide, and therefore etching of silicon oxide by phosphoric acid is suppressed by sulfuric acid and persulfuric acid. Such functions enable silicon nitride to be selectively