METHOD FOR ETCHING SILICON WAFER

Background of the Invention

The present invention relates to a method for etching a silicon wafer. More specifically, the present invention relates to a method for etching a silicon wafer, which can give a stable surface of a silicon wafer.

In silicon-wafer producing processes, particularly, an etching step has come to be an important step in a point of removing damages on a surface of a silicon wafer with simultaneously maintaining a flat shape of the surface of a silicon wafer. The etching step comes after a lapping step and before a polishing step. Especially, as minuteness of a semiconductor device improves, a requirement for flatness of a silicon wafer becomes severer. It is difficult to improve flatness of a silicon wafer by merely controlling in a polishing step, and a precise treatment in an etching step, which has an influence upon a surface shape of a silicon wafer, is required. In order to satisfy such a requirement, not only a composition of an etching liquid but also an etching apparatus itself has recently been improved.

However, since an etching step aims to corrode a surface of a silicon wafer, an oxidation film is not sufficiently formed on a surface of a silicon wafer obtained right after etching in view of properties of silicon, and the surface of the silicon wafer exhibits hydrophobicity.

Just after etching, the silicon wafer is subjected to a rinsing treatment so as to restrain a progress of etching. For the rinsing treatment, there has conventionally been used deionized water. Since deionized water does not have an oxidizing ability, hydrophobicity of the surface of the silicon wafer is maintained. In such a condition, the surface of the silicon wafer is activated, and therefore, a foreign matter is liable to adhere to the

surface of the silicon wafer. Moreover, once a foreign matter adheres, the foreign matter directly contacts with the silicon wafer, thereby having a difficulty in removing the foreign matter in the following washing step, or the like. Further, when a rinsing is insufficient or when a following drying is insufficient, a rinse adheres to the hydrophobic surface of the silicon wafer in the form of a waterdrop. If the condition is maintained, a trace of the waterdrop remains as a water mark after the silicon wafer is naturally dried.

The water mark is not a mere trace of a deionized water. The waterdrop absorbs an oxygen in the air and is partially and abnormally oxidized, and the water mark cannot be removed in a following washing step using APM liquid (i.e., a washing liquid prepared by diluting ammonia and hydrogen peroxide with superdeionized water). Such a defect is often caused not only in a process of producing a silicon wafer but also in a semiconductor device process.

Summary of the Invention

In consideration of such conventional problems, the present invention aims to provide a method for etching a silicon wafer, the method being able to avoid an occurrence of a defect in advance during an etching treatment.

According to the present invention, there is provided a method for etching a silicon wafer, comprising the steps of:

lapping a silicon wafer;

etching the silicon wafer; and

polishing the silicon wafer;

wherein the etching step includes an etching treatment and a rinsing treatment, and at least an oxidizing agent is added to a rinse to be used for the rinsing treatment, thereby forming an oxidation film on a surface of the silicon wafer.

Since an oxidizing agent such as ozone, a neutralizing agent, and a surface-active agent or a wetting agent are added to a rinse to be used for restraining etching, the surface of the silicon wafer is oxidized during the rinsing treatment, thereby protecting the surface of the silicon wafer by a stable oxidation film so as to avoid generation of a defect.

Brief Description of the Drawings

Fig. 1 is a schematic view showing conditions of adhesion of foreign matters in a method for etching a silicon wafer of the present invention and a conventional method for etching a silicon wafer.

Fig. 2 is a graph showing an effect of adding ozone in a rinse used for a rinsing treatment.

Detailed Description of the Preferred Embodiment

The present invention is hereinbelow described in detail.

First, a process of producing a silicon wafer is generally described. A silicon ingot consisting of silicon single crystals is subjected to slicing, lapping, etching, polishing, and washing in this order so as to obtain a silicon wafer as a product. After this, a silicon wafer is transferred to a process for producing a semiconductor device.

An etching step is constituted of an etching treatment and a rinsing treatment which restrains etching. After lapping a silicon wafer, damages given by a slurry, or the like, remain on the surface of the silicon wafer. Etching the silicon wafer is to remove the damages on the surface. Specifically, in the etching step is used a mixed acid containing hydrogen fluoride (HF), nitric acid (HNO_3), acetic acid (CH_3COOH) and water so as to remove a damaged layer of the surface of the silicon wafer.

A rinsing treatment comes after the etching treatment. To the rinsing treatment is usually applied a quick damp rinse, an overflow rinse, or the like. In a quick damp rinse, a cycle of supplying and discharging deionized water is repeated several times. In an overflow rinse, a deionized water is supplied for a predetermined period of time to a vessel containing a silicon wafer from the bottom of the vessel so that the deionized water overflows, and simultaneously acid on the silicon wafer is removed.

In the present invention, at least an oxidizing agent such as ozone is added to a rinse used for restraining etching in the aforementioned rinsing treatment so as to form an oxidation film on the surface of the silicon wafer. Additionally, a neutralizing agent is preferably added to the rinse to stop an etching reaction, and a surface-active agent or a wetting agent is preferably added so as to decrease stains on a surface of a silicon wafer as much as possible.

An oxidizing agent used for the rinsing treatment in the etching step is not limited, and ozone, hydrogen peroxide, a mixture of ammonium hydroxide and hydrogen peroxide, nitric acid, and sulfuric acid, or the like can be used.

Though an oxidizing agent such as ozone dissolved at a rate ranging from 0.5 to 40 ppm in deionized water is effective, the rate is preferably within the range from 2 to 20 ppm from the economical view point. There are various known methods for generating ozone, and any of the methods can be employed. A temperature for the rinsing treatment has no limitation, either.

Incidentally, a neutralizing agent, a surface-active agent, and a wetting agent to be added to the rinse are not particularly limited, and known agents can be employed for the agents.

The present invention is hereinbelow described in more detail on the basis of embodiments shown in Figures.

Fig. 1 is a schematic view showing conditions of adhesion of foreign matters in a method for etching a silicon wafer of the present invention and a conventional method for etching a silicon wafer. Reference numeral 1 denotes a silicon wafer. (a) of Fig. 1 shows a silicon wafer in a condition just after being cut off a silicon ingot. (b) of Fig. 1 shows a silicon wafer in a condition after damages on the surface of the silicon wafer 1 shown in (a) of Fig. 1 are removed.

(c) of Fig. 1 shows surface conditions of silicon wafers 1 obtained after a rinsing treatment. One of them shows no oxidation film after a rinsing treatment using a mere deionized water. The other shows presence of an oxidation film 2 formed on the surface of the silicon wafer after a rinsing treatment using a deionized water 1 with an oxidizing agent such as ozone therein.

(d) of Fig. 1 shows conditions of adhesion of pollutants 3 such as foreign matters which adhered to the silicon wafers 1 during storage. In case of rinsing with a mere deionizing water, pollutants 3 and the like directly adhere to the silicon wafer 1.

Fig. 2 shows effect of rinsing treatments in which ozone was added to a rinse.

As obvious from the results shown in Fig. 2, rinsing treatments using ozone in a rinse decreases the generation of defects in silicon wafers in comparison with a rinsing treatment with mere deionized water.

Incidentally, rates of defects were obtained by visually inspecting surfaces of the silicon wafers under a light-condensed condition.

As described above, according to the present invention, the generation of a defect on a surface of a silicon wafer is restricted because an oxidation film is formed on the surface of the silicon wafer by adding an

oxidizing agent such as ozone to a rinse to be used in a rinsing treatment; thereby showing remarkable effect of improving properties of a semiconductor device, yield, or the like.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above method without departing from the scope of the invention, it is intended that all matter contained in the above description and shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

WHAT IS CLAIMED IS:

1. A method for etching a silicon wafer, comprising the steps of:

lapping a silicon wafer;

etching the silicon wafer; and

polishing the silicon wafer;

wherein the etching step includes an etching treatment and a rinsing treatment, and at least an oxidizing agent is added to a rinse to be used for the rinsing treatment, thereby forming an oxidation film on a surface of the silicon wafer.

2. A method for etching a silicon wafer according to claim 1, wherein the oxidizing agent is one of ozone, hydrogen peroxide, a mixture of ammonium hydroxide and hydrogen peroxide, nitric acid, and sulfuric acid.

3. A method for etching a silicon wafer according to claim 2, wherein a surface-active agent or a wetting agent is further added to the rinse.

4. A method for etching a silicon wafer according to claim 2, wherein a neutralizing agent is further added to the rinse.

5. A method for etching a silicon wafer according to claim 4, wherein a surface-active agent or a wetting agent is further added to the rinse.

6. A method for etching a silicon wafer according to claim 1, wherein a neutralizing agent is further added to the rinse.

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7. A method for etching a silicon wafer according to claim 6, wherein a surface-active agent or a wetting agent is further added to the rinse.

8. A method for etching a silicon wafer according to claim 1, wherein a surface active agent or a wetting agent is further added to the rinse.

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