1. The Title of the Invention

RESIN COATED MEMBER FOR USE IN SEMICONDUCTOR DEVICE TREATMENT AND METHOD FOR MANUFACTURING THE SAME

2. Field of the Invention

The present invention relates to a member for use in semiconductor device treatment and a method for manufacturing the same, in particular, to a resin coated member for use in semiconductor device treatment, which is coated with a fluorine-contained resin or engineering plastic, and a method for manufacturing the same.

3. Prior Art

In the semiconductor device manufacturing process, treatments such as plasma etching and cleaning are employed, and as the materials for containers and parts, such as chamber and etching cover material, or jigs such as carrier boat (hereinafter all of these shall be referred to as members) used in such treatments, quartz glass, alumina, alumite, ceramics, etc. have been used. In plasma etching, a thin film on the surface of a semiconductor device is anisotropically etched with ions or radicals developed in plasma by a chemical or physical etching mechanism, and in addition, by electrically accelerating the speed of ions to draw the same up to the silicon wafer surface. During the above etching treatment, however, the surface of the member is also etched, which causes development of particles, leading to contamination of the semiconductor device; thus, as measures to prevent such

particles and contamination, fluorine-contained resin tape or engineering plastic tape, or a fluorine-contained resin coating or an engineering plastic coating has been applied to the surface of the member. However, applying resin tape to the surface of a member has problems in that the tape does not have sufficient thickness to be fully effective in etching resistance, in addition, seams are formed in strips of the applied tape and ions in plasma seep into the gaps at the seamed portions of the tape, causing the surface of the member to be partially etched. Furthermore, it is difficult to apply resin tape evenly to the surface of a member; consequently, clearances are partially formed between the surface of the member and the resin tape, whereby a rough surface is formed and the electric properties become non-uniform on the surface. This in turn causes dielectric breakdown partially on the surface, and consequently defects such as pinholes. Further, there has been caused another problem in that the adhesive material of the tape releases contaminates which degrade the properties of the semiconductor device. On the other hand, the member coated with a resin also has disadvantages in that its coated surface becomes rough and thereby plasma is not sufficiently developed and pinholes appear on its coating.

In the cleaning treatment, a semiconductor device is placed in a member and immersed in a cleaning fluid, and the member is provided with grooves so as to make it easier to place the semiconductor device thereon. These grooves are cut by machining process using a grinding jig with abrasive grains such as of diamond deposited on its surface. Therefore,

when the member is made of quartz glass, micro cracks are developed on the surface of the member during the machining process and a sharp unevenness is formed on the same, which may in turn give rise to problems of scoring the semiconductor device when taking the same in and out of the member and of chipping the projected portions off the surface, leading to development of particles and contamination of the semiconductor device. Further, impurities are left remaining in the micro-cracks and gradually volatilize, causing contamination of the semiconductor device.

4.Diclosure of the Invention

In light of the above described situation, the present inventors concentrated their energy on the investigation and finally found that a member which has excellent resistance to etching, causes no abnormal etching due to partial change in electrical properties, is stable against cleaning fluids such as hydrofluoric acid, is free from peeling of resin coating and contamination by impurities, and is usable for a long period of time can be obtained by: coating the entire surface of the member with a fluorine-contained resin coating or an engineering plastic in such a manner as to prevent pinholing; preferably applying the coating to the thickness of 50 μm or more; and further preferably restricting the surface roughness Ra of the coating to 1 μm or less. Thus the invention has been completed.

Accordingly, an object of the invention is to provide a resin coated member for use in semiconductor device

treatment which has excellent resistance to plasma etching, causes no abnormal etching, and is usable for a long period of time.

Another object of the invention is to provide a resin coated member for use in semiconductor device treatment which does not score the semiconductor device and is free from peeling of resin coat or contamination by particles during the cleaning of the semiconductor device.

Still another object of the invention is to provide a method for manufacturing the above-described resin coated member for use in semiconductor device treatment.

5. The Preferred Embodiments to Work the Invention

The invention to achieve the above objects relates to a member for use in plasma etching or cleaning of a semiconductor device, characterized in that its entire surface is coated with a fluorine-contained resin or an engineering plastic in such a manner as to prevent pinholing, preferably the thickness of the fluorine-contained resin coating or the engineering plastic coating is 50 μm or more and the surface roughness Ra of the coating is 1 μm or less and to a method for manufacturing the same.

The term "member" herein used means containers and parts, such as chamber and cover, or jigs, such as carrier boat on which a semiconductor device is placed, used in plasma etching. As a base material for the member, quartz glass, aluminum, alumite, ceramics or a combination thereof is used, and as for the member of the present invention, it is coated with

a fluorine-contained resin or an engineering plastic in such a manner as to prevent pinholing. Preferably the coating of the fluorine-contained resin or the engineering plastic is 50 μm thick or more and the surface roughness Ra of the same is 1 μm or less. The fluorine-contained resin used is at least one selected from tetrafluoroethylene resin, tetrafluoroethylene-perfluoroalkylvinylether resin, perfluoroethylenepropylene resin, ethylenetetrafluoro-ethylene resin, chlorotrifluoroethylene resin, ethylene-chlorotrifluoroethylene resin, vinylidene difluoride resin, vinyl fluoride resin, and tetrafluoroethylene-perfluorodioxol resin. Particularly preferred among them is tetrafluoroethylene resin, because it has superior heat resistance, chemical resistance, corrosion resistance and abrasion resistance. The engineering plastic used is at least one selected from polyamide, polycarbonate, polyacetal, polyethylene terephthalate, polybutylene terephthalate, polyphenylene oxide, polyphenylene sulfide, polysulfone, polyethersulfone, polyallylsulfone, polyphenylsulfone, polyallylate, polyether ether ketone, polyoxybenzilene, polyimide, polyaminobismaleimide, BT polymer, polyetherimide, polyamideimide, polymethylpentene and liquid crystal polymer. When coating the member surface with the above fluorine-contained resin or engineering plastic, the resin is dissolved in a solvent by the known method to prepare a coating fluid and the coating fluid is applied by spray coating, electrostatic coating, roll coating or dip coating; however,

of the above coating methods, spray coating and electrostatic coating are preferable. In the above coating, the coating fluid of the fluorine-contained resin or the engineering plastic is applied more than one time so as to prevent pinholing. Preferably, the fluorine-contained resin or the engineering plastic is applied to give a coating with thickness of 50 μm or more and surface roughness Ra of 1m or less. More preferably, the variation in the thickness is 10% or less. If the thickness of the coating is less than 50 μm thick, pinholes are likely to appear in the coating during etching, in addition, the edge portions of the member become extremely thin and crack. As a result, the exposed portion of the member and the thin portion of the coating are etched or permeated with hydrofluoric acid solution, and corrosion occurs there. If the surface roughness Ra of the coating is more than 1 μm, the electrical properties on the coating surface partially change, causing abnormal etching. And if the variation in the thickness is more than 10%, large waviness is generated even if the surface roughness Ra is 1 μm or less, causing degradation of the electrical properties of the coating and causing pinholing by plasma easier. After applying the above fluorine-contained resin or engineering plastic, desirably the member coated with a fluorine-contained resin undergoes baking and the member coated with a thermosetting resin such as polyimide undergoes thermosetting treatment so as to smooth the coat surface. In the above baking or thermosetting treatment, the temperatures are adopted in accordance with the known method. When coating the member surface with a fluorine-contained resin,

it is important to restrict the surface roughness Ra of the coating before baking to 1 μm or less, since the surface roughness after baking is influenced by that before baking.

For the member of the present invention, in addition to the above, desirably its edges are subjected to rounding to provide curved portions each having a curvature R of 0.5 mm or more before coating. This prevents the coating at the edge portions of the member from becoming thin and reduces the occurrence of crack. The rounding methods used for the member made of quartz glass can be carried out by a method comprising heating the edge portions with an oxyhydrogen flame, mechanically grinding the same with a grinder etc., or blowing crystalline silicon dioxide powder, silicon carbide powder, etc. onto the surface of the quartz glass. And for the member made of aluminum, alumite, ceramics, the methods of mechanically grinding the edge portions with a grinder etc. and blowing crystalline silicon dioxide powder, silicon carbide powder, etc. onto the surface thereof can be used.

When the member of the invention is made of quartz glass, in order to further improve the adhesiveness of the fluorine-contained resin coating or an engineering plastic coating, preferred is to apply the fluorine-contained resin solution after subjecting the quartz glass surface to frost treatment. By applying frost treatment, unevenness are formed on the surface of the quartz glass, and the anchoring effect provided by unevenness decrease the peeling of the resin coating on the quartz glass surface, and the member can be used for a much longer period of time. The term "frost

treatment" means to provide unevenness on the surface of quartz glass by physical or chemical means; and, the physical means include, for example, means of blowing crystalline silicon dioxide powder, silicon carbide powder, etc. onto the surface thereof with the aid of pressurized air, known as sandblasting, and of brushing the surface with a brush having crystalline silicon dioxide powder, silicon carbide powder, etc. attached thereto and wetted with water. The chemical means include, for example, chemical treating in which the member is immersed in a mixed reagent containing hydrogen fluoride and ammonium fluoride or in the mixed reagent further containing acetic acid, which is described in Japanese Patent Laid-Open No. 7-267679 and Japanese Patent Laid-Open No. 10-36140. The chemical means is particularly suitable because it does not cause micro-cracks to occur on the surface of the member, and hence the deterioration of the mechanical strength of quartz glass. The surface roughness Ra formed by the above frost treatment falls within in the range of 0.1 to 10 μm. The deviation of the surface roughness from the above range is not preferably because it prevents the adhesion between the member surface and a fluorine-contained resin coat or an engineering plastic coat from being fully improved.

The solvents used for the preparation of the above coating fluid include, for example, alkylene glycols such as propylene glycol, esters such as methylethyl acetate and methylbutyl acetate, ketones such as acetone and methyl isobutyl ketone, alcohols such as ethylene alcohol and butyl alcohol, toluene,

xylene, dimethylformamide, dimethylacetoamide, pyrrolidones and caprolactones.

Example 1

A chamber for 8-inch silicon wafer dry etching system was made of quartz glass. The inside surface of the quartz glass chamber was subjected to rounding by blasting the surface thereof with crystalline silicon dioxide powder to obtain a chamber with edges having an R -value of 2 mm. Further, the entire inside surface of the chamber was also blasted with crystalline silicon dioxide powder (with particle diameter of 100 to 300 μm) to form an uneven surface with surface roughness Ra of 2.5 μm, Rmax of 20 μm. The inside surface of the quartz glass chamber obtained as above was coated with tetrafluoroethylene resin by means of electrostatic coating to form a coating with surface roughness Ra of 0.2 μm and thickness of 400 μm, and baked. The surface roughness Ra of the tetrafluoroethylene resin coating was 0.2 μm. And the variation in the coating thickness was 5%.

In the above quartz glass chamber, CF_4+O_2 gas was brought to the plasma state and thereby the oxide of the 8-inch wafer was etched. Even after 2-week use of the quartz glass chamber, the quartz glass was not exposed and there developed no abnormal particles on the silicon wafer surface, either. After 2 weeks, the tetrafluoroethylene resin coating was peeled and the inside surface of the quartz glass chamber was coated again with tetrafluoroethylene resin to 400 μm thick, and then the chamber was set in the etching system. The chamber could be used without causing any problems.

Example 2

A chamber for 8-inch silicon wafer dry etching system was made of quartz glass, and the edges of the chamber were subjected to rounding to an R-value of 1 mm by applying oxyhydrogen flame heating to the edges. The quartz glass chamber was immersed into a chemical solution containing hydrogen fluoride and ammonium fluoride to form an uneven surface with surface roughness Ra of 1.5 μm and Rmax of 13 μm. Then, the inside of the chamber was coated with a polyimide coating fluid by the spray coating, and the coating fluid was thermoset to form a polyimide coating of 200 μm thick. The surface roughness Ra of the inside surface of the chamber was 0.5 μm and the variation in the coating thickness was 8%.

In the above quartz glass chamber, CF_4+O_2 gas was brought to the plasma state and thereby the oxide of the 8-inch wafer was etched. Even after 2-week use of the quartz glass chamber, the quartz glass was not exposed and there developed no abnormal particles on the silicon wafer surface, either. After 2 weeks, the polyimide coating was peeled and the inside surface of the quartz glass chamber was coated again with polyimide to 200 μm thick, and then the chamber was set in the etching system. The chamber could be used without causing any problems.

Example 3

A cover for 8-inch silicon wafer dry etching system was made of aluminum, and anodized. The aluminum cover was subjected to rounding to R-value of 1 mm by applying the sandblast treatment, and the outside surface of the same was coated with polyimide coating fluid by the roll coating, and

the coating fluid was thermoset to form a polyimide coating having a thickness of 300 μm. The surface roughness Ra was 0.1 μm and the variation in the coating thickness was 3%.

In the etching system equipped with the above aluminum cover, CF_4+O_2 gas was brought to the plasma state and thereby the oxide of the 8-inch wafer was etched. Even after 2-week use of the aluminum cover, the aluminum was not exposed and there developed no abnormal particles on the silicon wafer surface, either. After 8 weeks, the polyimide coating was peeled, and the aluminum cover was coated again with polyimide to 200 μm thick and set in the etching system. The cover could be used without causing any problems.

Example 4

A cover for 8-inch silicon wafer dry etching system was made of alumina, and the alumina cover was subjected to rounding to R-value of 1 mm by applying the sandblast treatment. The outside surface of the same was coated with polyimide coating fluid at a thickness of 150μm by means of roll coating. The surface roughness Ra was 0.6 μm and the variation in the coating thickness was 7%.

In the etching system with the above alumina cover, CF_4+O_2 gas was brought to the plasma state and thereby the oxide of the 8-inch wafer was etched. Even after 2-week use of the alumina cover, the alumina was not exposed and there developed no abnormal particles on the silicon wafer surface, either. After 3 weeks, the polyimide coating was peeled, and the alumina cover was coated again with polyimide to 150 μm thick and set

in the etching system. The cover could be used without causing any problems.

Example 5

A 6-inch carrier boat (with 4 groove bars) was made of quartz glass. The surface of the carrier boat was subjected to rounding by blasting the surface thereof with crystalline silicon dioxide powder to obtain edges having an R-value of 2 mm. Then, the entire quartz glass carrier boat was blasted with crystalline silicon dioxide powder of 100 to 300 μm in particle size to thereby form an uneven surface having a surface roughness Ra of 2.5 μm, Rmax of 20 μm. The surface of the quartz glass carrier boat was further coated with a tetrafluoroethylene resin at dry thickness of 400 μm by means of electrostatic coating. Then, 25 pieces of 6-inch silicon wafers were mounted on the thus obtained fluorine-contained resin coated quartz glass carrier boat to perform RCA cleaning (JIS D9111), and were subjected to hydrofluoric acid pickling, rinsing with pure water, and to final drying using an IPA vapor drier. The particles remaining on the surface of the silicon wafer were counted by using a laser particle counter to find only about 50 particles residing on the peripheral portion of the silicon wafer.

Example 6

A 6-inch quartz glass carrier boat (having provided with 4 groove bars) similar to that used in Example 5 was made, and was subjected to rounding to R-value of 1 mm by applying with oxyhydrogen flame heating to the edges. Then, the quartz glass carrier boat was immersed into a chemical solution

containing hydrogen fluoride and ammonium fluoride to form an unevenness surface with Ra of 1.5 μm and Rmax of 13 μm. The surface of the quartz glass carrier boat was coated with tetrafluoroethylene resin by the electrostatic coating to form a coating with a thickness of 200 μm. Then, 25 pieces of 6-inch silicon wafers were mounted on the thus obtained fluorine-contained resin coated quartz glass carrier boat to perform RCA cleaning, and were subjected to hydrofluoric acid pickling, rinsing with pure water, and to final drying using an IPA vapor drier. The particles remaining on the surface of the silicon wafer were counted by using a laser particle counter to find only about 50 particles residing on the peripheral portion of the silicon wafer.

Comparative Example 1

A chamber for 8-inch silicon wafer dry etching system was made of quartz glass similar to that used in Example 1, and in the above quartz glass chamber, CF_4+O_2 gas was brought to the plasma state and thereby the oxide of the 8-inch wafer was etched. Even after 2-week use of the quartz glass chamber, the quartz glass was not exposed and there developed no abnormal particles on the silicon wafer surface, either. After 2 weeks, when using the chamber, abnormal particles were developed on the silicon wafer surface, and the use of the same was stopped.

Comparative Example 2

A cover for 8-inch silicon wafer dry etching system was made of aluminum, and the surface of the cover was anodized. After applying a polyimide tape 125 μm thick to the outside surface of the aluminum cover, the cover was fitted to the

etching system, and the oxide of the 8-inch wafer was etched with CF_4+O_2 gas. After 2-week use of the aluminum cover, the gaps between the strips of the polyimide tape was etched abnormally and the aluminum was exposed, and moreover, unevenness was formed on the surface, etching was accelerated partially, and pinholes appeared in the polyimide tape. After 2 weeks, the polyimide tape was peeled off, and new polyimide tape was applied again to the cover and the cover was set in the etching system. Abnormal contamination was observed on the wafer and the use of the cover was stopped.

Comparative Example 3

A cover for 8-inch silicon wafer dry etching system was made of aluminum, and the surface of the cover was anodized. The oxide of the 8-inch wafer was etched with CF_4+O_2 gas, which had been brought to the plasma state, using the etching system with the aluminum cover. When using the aluminum cover for 2 weeks, the alumite started to peel off the cover surface and abnormal contamination was observed on the wafer, thus the use of the cover was stopped.

Comparative Example 4

A cover for 8-inch silicon wafer dry etching system was made of alumina. The alumina cover was fitted to the etching system, and the oxide of the 8-inch wafer was etched with CF_4+O_2 gas, which had been brought to the plasma state, using the etching system. From the very beginning of its use, abnormal contamination was observed on the wafer; thus, the use of the cover was stopped.

Comparative Example 5

A chamber for 8-inch silicon wafer dry etching system was made of quartz glass. The inside surface of the quartz glass chamber was blasted with silicon carbide (GC powder) to thereby form an uneven surface with surface roughness Ra of 4 μm, Rmax of 35 μm. On the inside surface of the quartz glass chamber obtained as above, a coating with thickness 30 μm was formed with tetrafluoroethylene resin by the electrostatic coating, and baked. The surface roughness Ra of the tetrafluoroethylene resin coating was 2.5 μm after baking. And the variation in the coating thickness was 20%.

In the above quartz glass chamber, CF_4+O_2 gas was brought to the plasma state and thereby the oxide of the 8-inch wafer was etched. The tetrafluoroethylene resin coating was partially peeled off the surface of the quartz glass chamber since there appeared a large number of pinholes, and the chamber could not be used.

Comparative Example 6

A 6-inch quartz glass carrier boat similar to that used In Example 5 was made. When using the carrier boat for cleaning silicon wafers similar to that described in Example 5, except for forming the fluororesin coating. As a result, 700 particles were counted on the surface of the silicon wafer. The particles were found to generate on the central portion of the silicon wafer, and the production yield of the silicon wafer was decreased.

Comparative Example 7

A 6-inch quartz glass carrier boat similar to that used in Example 5 was made, and the edges of the groove portions

were subjected to rounding to an R-value of 1mm by applying oxyhydrogen flame heating to the edges. Then, the carrier boat was blasted with crystalline silicon dioxide powder of 100 to 300 μm in particle size to thereby form an uneven surface having a surface roughness Ra of 2.5 μm and Rmax of 20 μm. The surface of the quartz glass carrier boat grooves alone was coated with tetrafluoroethylene resin at a dry thickness of 400 μm by means of electrostatic coating. When cleaning the silicon wafers similar to that described in Example 5, about 20 particles remaining on the peripheral portions of the silicon wafers were observed. However, with repeated cleaning, the hydrofluoric acid solution was found to penetrate the edge portion of the tetrafluoroethylene resin coating as to cause peeling off of the coating on carrying out the tenth cleaning.

5. Effect of the Invention

The resin-coated member for use in semiconductor device treatment of the invention has excellent resistance to plasma etching and causes no abnormal etching. Further, there appear no pinholes in the coating and, even at the time of cleaning semiconductor devices, there is caused no contamination of the device due to peeling of the coating and development of particles, whereby it enables satisfactory and long-time treatment of the semiconductor device. In addition, the method of manufacturing the above member is such a simple one that it includes only the steps of: rounding all the edge portions of the member; and applying a coating on the entire

surface of the member by coating the surface with a fluorine-contained resin coating fluid or an engineering plastic coating fluid. Thus the method is industrially valuable.

Claims

1. A resin coated member for use in a semiconductor device treatment, used in plasma etching or cleaning of a semiconductor device treatment, wherein an entire surface of the member is covered with a pinhole-free fluorine-contained resin or engineering plastic coating having a film thickness of 50 μm or more and a surface roughness Ra of 1 μm or less.

2. The resin coated member for use in a semiconductor device treatment as claimed in claim 1, wherein a variation in film thickness of the fluorinated resin or engineering plastic coating is 10% or less.

3. The resin coated member for use in a semiconductor device treatment as claimed in claim 1 or 2, wherein the member is made of quartz glass, ceramics, aluminum, alumite, or a combination thereof.

4. The resin coated member for use in a semiconductor device treatment as claimed in claim 3, wherein the member is made of quartz glass.

5. The resin coated member for use in a semiconductor device treatment as claimed in any one of claims 1 to 4, wherein the edges of the member are subjected to rounding.

6. The resin coated member for use in a semiconductor

device treatment as claimed in claim 5, wherein the edges of the member are subjected to rounding into curved portions each having a curvature R of 0.5 mm or more.

7. The resin coated member for use in a semiconductor device treatment as claimed in claim 1 or 2, wherein the fluorine-contained resin is at least one selected from tetrafluoroethylene resin, tetrafluoroethylene-perfluoroalkylvinylether resin, perfluoroethylene propylene resin, ethylene tetrafluoroethylene resin, chlorotrifluoroethylene resin, ethylene chlorotrifluoro-ethylene resin, vinylidenedifluoride resin, vinyl fluoride resin, and tetrafluoroethylene perfluorodioxol resin.

8. The resin coated member for use in a semiconductor device treatment as claimed in claim 7, wherein the fluorine-contained resin is tetrafluoroethylene resin.

9. The resin coated member for use in a semiconductor device treatment as claimed in claim 1 or 2, wherein the engineering plastic is at least one selected from polyamide, polycarbonate, polyacetal, polyethylene terephthalate, polybutylene terephthalate, polyphenylene oxide, polyphenylene sulfide, polysulfone, polyethersulfone, polyallylsulfone, polyphenylenesulfone, polyallylate, polyether ether ketone, polyoxybenzilene, polyimide, polyamino bismaleimide, BT polymer, polyetherimide, polyamideimide, polymethylpentene, and liquid crystal polymer.

10. A method of manufacturing a resin coated member for use in a semiconductor device treatment comprising the steps of:

rounding all edges of the member, and then,

forming a fluorine-contained resin coating or

engineering plastic coating which is free from pinholes on a surface of the member by treating the resulting member with a fluorine-contained resin coating fluid or an engineering plastic coating fluid, thereby obtaining a pinhole-free fluorine-contained resin or engineering plastic coating film having a thickness of 50 μm or more and a surface roughness Ra of 1 μm or less.

11. The method of manufacturing a resin coated member for use in a semiconductor device treatment as claimed in claim 10, wherein a variation in film thickness of the fluorine-contained resin or engineering plastic coating is 10% or less.

12. The method of manufacturing a resin coated member for use in a semiconductor device treatment as claimed in claim 10 or 11, wherein the member is made of quartz glass.

13. The method of manufacturing a resin coated member for use in a semiconductor device treatment as claimed in claim 12, wherein a frost treatment is applied to the member formed of quartz glass and then a fluorine-contained resin coating fluid or an engineering plastic coating fluid is applied to the member.

14. The method of manufacturing a resin coated member for use in a semiconductor device treatment as claimed in claim 13, wherein the frost treatment is a surface treatment using a chemical agent.

15. The method of manufacturing a resin coated member for use in a semiconductor device treatment as claimed in claim 13 or 14, wherein all edges of the quartz glass member are subjected to rounding to a curvature R of 0.5 mm or more before the frost treatment.