

Description

The present invention provides novel colloidal silica slurries having a low sodium and metal content which are particularly useful in the polishing of silicon wafers or substrates. Silicon wafers are basic components of integrated circuits, semiconductor devices, and transistors. During polishing, dilute colloidal silica is continuously injected between the polishing plate and the silicon wafer for fine polishing of the wafer.

The electrical performance of finished semiconductor chips can easily be affected by contaminants acquired by the wafers during processing. Such contamination can be in the form of discrete particles and water soluble or dispersed organic and inorganic impurities. That is, the use of silica sols that are contaminated with trace transition metals, alkali and alkaline earth metals, aluminum, and the like have caused difficulties especially when used in wafer polishing.

These contaminating metals are particularly a nuisance when they include Na, K, alkali and alkaline earth metals such as Ca, Mg, and transition metals such as Fe, Cu, Mn, Ni, Zn, and the like. In general, any transition metal from groups IB, IIB, IIIB, IVB, VB, VIB, and group VIII of the Periodic Table of Elements, if present in high enough concentrations, can cause difficulties in the final products manufactured with silica sols containing these contaminants.

Another metal which can cause difficulties, particularly in the manufacture of certain catalysts, is aluminum. If aluminum is present, and particularly if Fe, Ni, Cu, Mn, or Cr are also present, the silica sols often cannot meet the requirements for the final product, whether those requirements include catalysts, in refractories, in investment casts, or in electronic polishing agents used for electronic wafers.

Alkali metals like lithium, sodium, and potassium demonstrate shifts in electrical properties (threshold and flat-band voltages) when incorporated into semiconductor devices. Heavy metals, such as copper, gold and iron, tend to lower minority carrier lifetime, while increasing dark and leakage currents. Tin, nickel and chromium behave similarly except that they also exhibit a lower oxide breakdown voltage.

Even anions like chloride have a detrimental effect on electrical properties through the process of gettering (concentrating) of the heavy metals and the complexing of the alkali metals.

An additional problem of metal contaminants is that many of these substances have much higher diffusivities in both silicon and silicon dioxide than do the more conventional dopants, such as phosphorus and boron. As a result unpredictable electrical properties can exist.

The effect of metal contaminants on silicon wafers has been widely reported in the following articles: Hiramoto et al., "Degradation of Gate Oxide Integrity by Metal Impurities," Japanese Journal of Applied Physics, Part 2 (Letters), Vol. 28, No. 12, pp. 2109-11 (December 1989); Seibt et al., "TEM Study of Metal Impurity Precipitates in the Surface Regions of Silicon Wafers," Defects in Electronic Materials Symposium, Mater. Res. Soc., Pittsburgh, Pennsylvania, pp. 215-18 (November 30 - December 3, 1987); Hourai, et al., "A Method of Quantitative Contamination with Metallic Impurities of the Surface of a Silicon Wafer," Japanese Journal of Applied Physics, Part 2 (Letters), Vol. 27, No. 12, pp. 2361-3 (December 1988); Corradi et al., "Surface Contamination Detection Below the ppb Range on Silicon Wafers," Journal of Crystal Growth, Vol. 89, No. 1, pp. 39-42 (June 1988); Takizawa et al., "Degradation of Metal-Oxide-Semiconductor Devices Caused by Iron Impurities on the Silicon Wafer Surface", Journal of Applied Physics, Vol. 62, No. 12, pp. 4933-5 (December 15, 1987); Honda et al., "Catastrophic Breakdown in Silicon Oxides: the Effect of Fe Impurities at the SiO₂-Si Interface," Journal of Applied Physics, Vol. 62, No. 5, pp. 1960-3 (September 1, 1987); K. Graff, "Transition Metal Impurities in Silicon and Their Impact on Device Performance," SEMI-CON/EUROPA 1983, Semiconductor Equipment & Material Institute, Mountain View, California, pp. 9-19, (March 8-10, 1983); P.J. Ward, "A Survey of Iron Contamination in Silicon Substrates and its Impact on Circuit Yield," Journal of the Electrochemical Society, Vol. 129, No. 11, pp. 2573-6 (November 1982); and Pearce et al., "Role of Metallic Contamination in the Formation of 'Saucer' Pit Defects in Epitaxial Silicon," Journal of Vacuum Science and Technology, Vol. 14, No. 1, pp. 40-3 (January-February 1977).

It is therefore critical to minimize the possibility of metal contamination in or on the silicon wafer prior to device manufacturing. One concern of semiconductor manufacturers is that colloidal silica containing metals will contaminate the wafer surface. Therefore, it is extremely desirable that colloidal silica products be formed with low sodium and metals content.

The preparation of low sodium, low metals silica is well-known. Various attempts have been made to reduce or eliminate sodium and/or metals from the silica source. A few examples are given in US-A-4,624,800 (Sasaki et al.), issued November 25, 1986; 3,024,089 (Spencer et al.), issued March 6, 1962; JP-A-88/285112 (Watanabe et al.), filed November 22, 1988; Stober and Fink, "Controlled Growth of Monodisperse Silica Spheres in the Micron Size Range", Journal of Colloid and Interface Science, Vol. 26, 1968, pp. 62-69; Wagner and Brunner, "Aerosil, Herstellung, Eigenschaften und Verhalten in Organischen

Flussigkeiten", Angew. Chem., Vol. 72, No. 19/20, 1960, pp. 744-750; and Iler, "Chemistry of Silica", Wiley Interscience, 1979, p. 359.

The Sasaki et al. patent discloses a method for producing an aqueous low alkali-metal, low alumina silica sol by treatment of a powder silica with acid to remove the metals while applying ultrasonic vibrations. Spencer discloses a process for preparing finely divided metallic oxides by hydrolyzing a compound containing the corresponding metal while in contact with a finely divided carbonaceous carrier on which the oxide is deposited and then separating the oxide from the carbon.

The Stober article discloses a system of chemical reactions which permit the controlled growth of spherical silica particles of uniform size by means of hydrolysis of alkyl silicates and subsequent condensation of silicic acid in alcoholic solutions. Ammonia is used as a morphological catalyst.

Low sodium silica sol products, with or without low metal content, can also be prepared by removal of the counterions using ion exchange and then backadding ammonium hydroxide and ammonium carbonate to form stable products according to the Iler article.

Although colloidal silica is normally used in a once through polishing system, the cost of the silica and chemicals admixed therewith have caused an increased interest in the development of commercially acceptable recirculation systems. Recirculation systems provide fast polishing rates without high temperatures, avoid wafer warping, and substantially reduce the chemical cost of the polishing step. Unfortunately, when colloidal silicas, with or without organic accelerators, are placed in service for prolonged periods of time they exhibit increased microorganism and fungi growth. Bacterial contamination causes discoloration, odors, and makes the colloidal silica unacceptable as a polishing aid in wafer production.

Microorganism and fungi growth in colloidal silica are well known. Various attempts have been made to reduce or eliminate bacterial growth in colloidal silica. A few examples are shown in: US-A-3,336,236 (Michalski), issued August 15, 1967; 3,816,330 (Havens), issued June 11, 1974; 3,860,431 (Payne), issued January 14, 1975; 2,823,186 (Nickerson), issued February 11, 1958; 2,801,216 (Yoder et al.), issued July 30, 1957; 3,046,234 (Roman et al.), issued July 24, 1962; 3,377,275 (Michalski et al.), issued April 9, 1968; 3,148,110 (McGahen), issued September 8, 1964; 4,169,337 (Payne), issued October 2, 1979; 4,462,188 (Payne), issued July 31, 1984; 4,588,421 (Payne), issued May 13, 1986; 4,892,612 (Huff), issued January 9, 1990; and 4,664,679 (Kohyama et al.), issued May 12, 1987.

The Michalski '236 patent discloses a method for protecting aqueous colloidal silica sols from bacterial contamination. This patent suggests that colloidal aqueous silica sols can be protected from bacterial contamination by simply adding sodium chlorite in an amount sufficient to inhibit growth and reproduction of the bacteria. Generally from about 10 parts of sodium chlorite per million parts of slurry up to about 1000 parts per million achieve the desired situation of freedom from bacterial contamination.

The Havens patent suggests that colloidal silica aquasols containing about 10-1000 parts per million of hexachlorophene can be protected from contamination by microorganisms. Addition of the hexachlorophene is intended to prevent discoloration, bad odor, and slime formation and increase the shelf life of colloidal silica sols to more than one year.

The Payne '431 and Nickerson patents are concerned with controlling bacterial growth in silica aquasols containing polyhydric alcohols. Payne 431' attempts to control and eliminate the growth of organisms such as aerobacter and pseudomonas bacteria, aspergillus niger mold, and troublesome desulfovibrio and clostridia anaerobic bacteria by addition of a biocide. Typical biocides are glutaraldehyde, ethylenediamine, hydrogen peroxide and methyl p-hydroxybenzoate. Nickerson suggests that the addition of sodium pentachlorophenate will prevent or inhibit the darkening of silica aquasol containing polyhydric alcohol even in those instances where the silica aquasol contains sodium sulfate.

The Yoder and Roman et al. patents disclose the use of dialdehydes, such as glutaraldehyde, to control bacteria. While Michalski et al. '275 and McGahen disclose the use of formaldehyde to protect colloidal silica sols from bacteria growth. McGahen also discloses the use of 3,5-dimethyl tetrahydro 1,3,5,2-H-thiadiazine-2-thione as a microbiocide.

Although each of the aforementioned patents discloses various biocides for inhibiting bacterial growth in colloidal silicas, none of the aforementioned aquasols are satisfactory for use in the polishing of silicon wafers. That is, the aforementioned aquasols have unacceptable polishing rates for use in recirculated polishing systems.

The Payne '337, Payne '188, Payne '421, and Huff '612 disclose the use of various polishing rate accelerator amines added to conventional colloidal silica to form acceptable polishing agents and in particular Payne '188 discloses a water-based composition comprising silica sol, an amine such as triethylene tetramine and a quaternary ammonium salt such as tetramethylammoniumhydroxide, to be used as a polishing agent for polishing silicon wafers, while Payne '421 discloses a similar composition comprising as the amide piperazine. This agent moreover acts as a microbiocidal agent. However, these

patents are not concerned with either a low metals, low sodium colloidal silica or with a polishing agent which can be recirculated without increased microorganism or fungi growth.

Kohyama et al. discloses an aqueous dispersion of silicic anhydride having a silica particle size in the range between about 100 nm to 10,000 nm which is prepared from a dry method. PH controlling agents, such as amines, may be added to the silicic anhydride of Kohyama et al. The silicas prepared according to Kohyama et al. exhibit the following characteristics: (1) the particles are prepared by a dry method which can then be dispersed into a fluid medium, (2) the particles are not discrete but exist as condensed masses or aggregates, and (3) the aggregates settle with time and hence do not fit the historical definition of a silica colloid. Nor is Kohyama et al. concerned with low metals, low sodium colloidal silica or control of microorganism or fungi growth in recirculating systems.

EP-A-0146313 discloses a highly pure aqueous silica sol which is stabilized in the acidic pH range.

The present inventors have found that although no microbiological growths are present in conventional colloidal silica at the outset, increased microbiological growth is observed during recirculation and dilution of the slurry. These microbiological growths are promoted when organic rate accelerators are used.

The present inventors undertook the task of examining the recirculation polishing system and developing a novel group of colloidal silica slurries which eliminate bacterial and fungi growth, maintain and, in some instances, increase the polishing rate of the system, and provide a polishing medium with extremely low values, particularly of Al, Fe, K, Na, and the other transition metals as described above.

Through lengthy experimentation, the present inventors have developed a novel group of low sodium, low metals colloidal silica slurries which are capable of inhibiting bacterial growth and enhancing the polishing rate of silicon wafers. These colloidal silica slurries are formed from a low metal, ammonium-stabilized silica sol that has particle sizes ranging from about 4 to about 130 nanometers. This sol has discrete spherical particles, and finds particular use in high quality investment casting, high technology refractories, catalyst applications, electronic polishing agents, and in high technology coating applications.

Additional advantages of the present invention shall become apparent as described below.

SUMMARY OF THE INVENTION

It is the primary object of the present invention to provide a novel colloidal slurry which is capable of inhibiting bacterial growth and enhancing the rate of polishing silicon wafers, while also providing a polishing slurry which has low sodium and metal content. It may also be desirable to provide a polishing slurry which has a low anion content.

The novel colloidal silica slurry of the present invention comprises: a low metals ammonium-stabilized silica sol having the following characteristics: SiO_2 present in the range between 15 to 50 weight percent; a pH in the range between 8.5 to 11.3; a particle diameter in the range between 3.0 to 130 nm; aluminum, as Al, present in an amount less than about 100 ppm based on SiO_2 ; iron, as Fe, present in an amount less than about 50 ppm based on SiO_2 ; potassium, as K, present in an amount less than about 25 ppm based on SiO_2 ; and sodium, as Na, present in an amount less than about 500 ppm based on SiO_2 ; 0.08 to 5% of an ammonium-containing bactericide; alternatively a polishing rate accelerator in an amount of 0.5 to 5% and in either case optionally up to 1000 ppm of a sodium chlorite or sodium hypochlorite biocide. Optionally, a fungicide may be added to the slurry to inhibit fungi growth. Furthermore the polishing rate accelerator may be present in addition to the bactericide, in which case it is a compound different from the bactericide.

An additional object of the present invention is a process for polishing a silicon wafer which includes the step of recirculating the novel colloidal silica slurry of the present invention between a polishing plate containing a polishing pad and the silicon wafer, the improvement characterized by the use of a colloidal silica slurry defined as above.

The present invention may also include many additional features which shall be further described below.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the polishing of silicon wafers or substrates for use in electronic devices it is preferable to recirculate a colloidal silica slurry having a low sodium and metal content which avoids bacterial and fungi growth, while enhancing the polishing rate of the system. Silicon wafers or substrates are basic components of integrated circuits, semiconductor devices, and transistors.

Low sodium, low metal impurity silica products for recirculated wafer polishing systems can be prepared from low metal silica sources, such as tetramethyl- or tetraethyl-orthosilicate or silicon tetrachlo-

ride. The colloidal silicas can be prepared from these materials by a controlled hydrolysis reaction, although any procedure which yields low metals can be used. After dialysis to remove unwanted sodium and metals, the products can be stabilized with the addition of counterions. The counterions may be selected from ammonium hydroxide, amines, quaternary ammonium hydroxides (tetramethyl- or tetraethyl-ammonium hydroxide), or mixtures thereof. Although it has been found to be highly desirable to stabilize the resultant sol with ammonium hydroxide.

More preferably, however, is the preparation of a low sodium, low metals silica sol as disclosed in our co-pending EP-A-0484289, filed on 31 December 1990.

According to EP-A-0484289, a low metal, ammonium-stabilized silica sol can be made using the following steps:

- (a) diluting a commercial grade sodium silicate solution with water to obtain a dilute sodium silicate solution containing 5.0 to 8.0 weight percent sodium silicate, as SiO_2 ; and then
- (b) exposing the dilute sodium silicate solution to a strong cation exchange resin in the acid form and in sufficient amount and with sufficient capacity to remove essentially all sodium values and other cation values contained in the dilute sodium silicate solution thereby forming a dilute silicic acid solution, now containing 5.0 to 8.0 weight percent silicic acid as SiO_2 ; and then
- (c) adding to the dilute silicic acid solution at least 0.10 weight percent, based on SiO_2 , of oxalic acid crystals and at least 0.25 weight percent, based on total silicic acid solution, of a strong inorganic acid chosen from the group consisting of H_2SO_4 , HCl , HNO_3 , and aqua regia, thereby forming an oxalate-containing, low pH silicic acid solution, which solution has a pH ranging from 0.5 to 2.5; and then
- (d) mixing with or without cooling the oxalate-containing low pH silicic acid solution for 0.5 to 24 hours, recovering the aforesaid silicic acid solution which contains from 5.0 to 8.0 weight percent silicic acid, as SiO_2 ; and then
- (e) exposing the aforesaid silicic acid solution to a strong anion exchange resin in the hydroxide form, and in sufficient amount and with sufficient capacity to replace essentially all negatively charged species contained therein with hydroxide ions, thereby forming an hydroxide-neutralized silicic acid solution having a pH ranging between 2.5 to 4.0; and then
- (f) exposing this hydroxide-neutralized silicic acid solution to a strong cation exchange resin in the acid form and in sufficient amount and with sufficient capacity to replace all positively charged species contained therein with hydrated protons, thereby forming a low-metal silicic acid solution; and then
- (g) chilling the low-metal silicic acid solution to a temperature ranging between 4.5°C (40°F to 50°F), and storing, with or without stirring, for from one minute to fifty (50) hours, thereby forming a chilled low-metal silicic acid solution; and then
- (h) adding from 0 to 50 volume percent of the low-metal silicic acid solution to a preformed ammonium hydroxide solution made by adding concentrated ammonium hydroxide to deionized or softened water in sufficient quantity to achieve the preformed ammonium hydroxide solution having a pH ranging between 8.0 to 11.2, thereby forming an ammonium-neutralized silicic acid heel solution having a pH ranging between 8.0 to 11.2; and then
- (i) heating the heel solution to a temperature ranging between 75°C to 150°C , under sufficient pressure to prevent boiling, and then maintaining this temperature for from 0.5 hours to about twenty-four (24) hours, while slowly adding, either continuously or incrementally with stirring, the remainder of the low-metal silicic acid solution, thereby reacting same with formed or forming silica sol particles, while simultaneously adding, either continuously or incrementally, sufficient ammonium hydroxide solution to maintain a pH ranging from 8.0 to 11.2, and finally forming a dilute ammonium-stabilized low-metal silica sol admixture; and then
- (j) reacting this final admixture, at a temperature from 75°C to 150°C , at pressure sufficient to prevent boiling, for an additional 0.5 to 8.0 hours, thereby forming a dilute, low-metals silica sol solution containing from 2.0 to 6.0 weight percent silica, as SiO_2 ; and then
- (k) concentrating the dilute, low-metals silica sol solution to a concentrated low-metals, ammonium-stabilized silica sol having the following characteristics:
 - SiO_2 ranging from 15 to 50 weight percent,
 - pH 8.5 to 11.3,
 - Particle Diameter of 4.0 to 130 nm,
 - Aluminum, as Al, < 100 ppm, based on SiO_2 ,
 - Iron, as Fe, < 50 ppm, based on SiO_2 ,
 - Potassium, as K, < 25 ppm, based on SiO_2 , and
 - Sodium, as Na, < 500 ppm, based on SiO_2 .

The colloidal silica slurry according to the present invention comprises: a low metals ammonium-stabilized silica sol having the following characteristics: SiO₂ present in the range between 15 to 50 weight percent; a pH in the range between 8.5 to 11.3; a particle diameter in the range between 3.0 to 130 nm; aluminum, as Al, present in an amount less than 100 ppm based on SiO₂; iron, as Fe, present in an amount less than 50 ppm based on SiO₂; potassium, as K, present in an amount less than about 25 ppm based on SiO₂; and sodium, as Na, present in an amount less than 500 ppm based on SiO₂; a bactericide present in an amount between 0.08 to 5%, the bactericide being at least one compound selected from the group consisting of tetramethylammonium chloride, tetraethylammonium chloride, tetrapropylammonium chloride, tetramethylammonium hydroxide, tetraethylammonium hydroxide, tetrapropylammonium hydroxide, alkylbenzyltrimethylammonium chloride, and alkylbenzyltrimethylammonium hydroxide, wherein the alkyl chain ranges from 1 to 20 carbon atoms; and optionally sodium chlorite or sodium hypochlorite present in an amount up to 1000 ppm. Optionally, a polishing rate accelerator which differs from the aforementioned bactericide, and a fungicide can be added to the slurry to increase polishing rate and inhibit fungi growth, respectively.

The polishing rate accelerator, if present, is generally of an amount up to 5%. The bactericide is present in an amount between 0.08-5%, preferably 0.5-0.75%. The biocide is present in an amount up to 1000 ppm, preferably 500 ppm, and more preferably 65-100 ppm. The fungicide is added to the colloidal silica slurry in an amount up to 2.0%, 0.8%, and more preferably in the range 0.1-0.5%.

Alternatively, the colloidal silica slurry may comprise: a low metals ammonium-stabilized silica sol having the following characteristics: SiO₂ present in the range between 15 to 50 weight percent; a pH in the range between 8.5 to 11.3; a particle diameter in the range between 3.0 to 130 nm; aluminum, as Al, present in an amount less than 100 ppm, based on SiO₂; iron, as Fe, present in an amount less than 50 ppm based on SiO₂; potassium, as K, present in an amount less than about 25 ppm based on SiO₂; and sodium, as Na, present in an amount less than about 500 ppm based on SiO₂; and a polishing rate accelerator present in an amount between 0.5 to 5%. In accordance with this embodiment, a sodium chlorite or sodium hypochlorite biocide and/or a fungicide may also be added as required.

COLLOIDAL SILICA

The colloidal silica is preferably prepared in accordance with the aforementioned method disclosed in co-pending EP-A-0464289. The discrete spherical particles formed in that process are different from the chain-like particles that are formed in other processes attempting to achieve very low-metals silica sols. By stabilizing the silica sol with ammonium hydroxide and by using the oxalate complexing agents, a silica sol is formed having characteristics, after concentration, preferably by ultra-filtration, as follows:

Silica, as SiO₂, of 15-50 weight percent,
pH, as adjusted with ammonia, ranging from between about 8.5-11.3, and
Particle Diameter ranging from about 4.0 to 130 nm.

These characteristics are further and primarily enhanced by the fact that this silica sol has less than 100 ppm, Al, less than 50 ppm Fe, less than 25 ppm, less than 500 ppm Na, all based on SiO₂.

This process can be also be optimized to form silica sols which are low-metals, ammonium-stabilized silica sols having the following characteristics.

SiO ₂	25-35 weight percent
pH	8.5 - 9.5
Particle Diameter	3.0 to 100 nm
Aluminum, as Al	< 90 ppm, based on SiO ₂
Iron, as Fe	< 50 ppm, based on SiO ₂
Potassium, as K	< 25 ppm, based on SiO ₂
Sodium, as Na	< 900 ppm, based on SiO ₂

Optionally, another silica sol has the following characteristics:

SiO ₂	30 ± 2.5 weight percent
pH	9.0 ± 0.25
Particle Diameter	5 to 30 nm
Aluminum, as Al	< 30 ppm, based on SiO ₂
Iron, as Fe	< 15 ppm, based on SiO ₂
Potassium, as K	< 10 ppm, based on SiO ₂
Sodium, as Na	< 100 ppm, based on SiO ₂

Still another silica sol has the following characteristics:

SiO ₂	30 ± 2.5 weight percent
pH	9.0 ± 0.25
Particle Diameter	30 to 100 nm
Aluminum, as Al	< 30 ppm, based on SiO ₂
Iron, as Fe	< 15 ppm, based on SiO ₂
Potassium, as K	< 10 ppm, based on SiO ₂
Sodium, as Na	< 100 ppm, based on SiO ₂

Even large particle size silica sols can be made having the characteristics:

SiO ₂	30 ± 5 weight percent
pH	9.0 ± 0.5
Particle Diameter	30 to 130 nm
Aluminum, as Al	< 50 ppm, based on SiO ₂
Iron, as Fe	< 25 ppm, based on SiO ₂
Potassium, as K	< 15 ppm, based on SiO ₂
Sodium, as Na	< 100 ppm, based on SiO ₂

POLISHING RATE ACCELERATOR

The polishing rate accelerator can be any amine/nitrogen compound. However, it is preferable that the polishing rate accelerator be at least one compound selected from the group consisting of: primary amines, secondary amines, tertiary amines, heterocyclic amines, and mixtures thereof. Quaternary amines can be used, but only in combination with one of the other types of amines. It is intended that the above classification include all blends thereof which are known to those skilled in the art. Provided, however, that the polishing rate accelerator cannot be a quaternary amine when used in conjunction with quaternary amine bactericides.

Examples of primary amines are monoethanolamine, isopropylamine, ethylenediamine, and propanediamine. Examples of secondary amines are diethanolamine, dipropylamine, and dibutylamine. An example of a tertiary amine is triethanolamine. Examples of quaternary amines are tetramethylammonium chloride or hydroxide, tetraethylammonium chloride or hydroxide, tetrapropylammonium chloride or hydroxide, alkylbenzyltrimethylammonium chloride or hydroxide, wherein the alkyl chain ranges from 1 to about 20 carbons. Examples of heterocyclic amines are hexamethylenediamine, bis(aminopropyl) piperazine, and piperazine. The polishing rate accelerator may also be one compound selected from the group consisting of diethylenetriamine, triethylenetetramine, tetraethylenepentamine, and aminoethylethanolamine.

BACTERICIDE

The bactericide is at least one compound selected from the group consisting of: tetramethylammonium chloride, tetraethylammonium chloride, tetrapropylammonium chloride, tetramethylammonium hydroxide, tetraethylammonium hydroxide, tetrapropylammonium hydroxide, alkylbenzyltrimethylammonium hydroxide, and alkylbenzyltrimethylammonium chloride, wherein the alkyl chain ranges from 1 to about 20 carbons. Preferred bactericides are those capable of serving a dual function, i.e., being a bactericide and a polishing rate enhancer.

BIOCIDE

The preferred biocide is sodium chlorite or sodium hypochlorite.

FUNGICIDE

The preferred fungicide is sodium OMADINE® (pyrithione).

The novel colloidal silica slurry of the present invention is preferably used in a process for polishing a silicon wafer. The silicon wafer polishing process includes the step of recirculating one of the colloidal silica slurries as previously defined, between a polishing plate containing a polishing pad and the silicon wafer.

The effectiveness of the novel colloidal silica slurries of the present invention can best be shown through the following examples.

EXAMPLE 1

This experiment demonstrates the effect of the bactericide tetramethylammonium hydroxide (TMA-OH) in eliminating aerobic bacteria and mold. Tetramethylammonium chloride may also be used with the same effect. Sample 1 is deionised water, sample 2 is a conventional colloidal silica used in the polishing of silicon wafers, and sample 3 is a low sodium, low metals colloidal silica slurry in accordance with the present invention.

The microbiological test procedures used in generating the following results were as follows: (1) Dilute one part product with 20 parts water (do not make a pH adjustment); (2) Challenge the product with a bacteria/mold inoculum consisting of: (a) *Aspergillus niger*, (b) *Pseudomonas aeruginosa*, and (c) *Aerobacter aerogenes*; (3) Place the inoculated sample on a rotating shaker in a room conditioned at 37°C (rotate at 100 rpm continuously); and (4) Sample at zero time, one week, and two weeks. The organisms are grown under the following conditions: (a) Total count - run at 37°C for 72 hours using TGE agar (tryptone-glucose extract), (b) *Aspergillus* -run at 30°C for 96 hours using potato dextrose, and (c) *Aerobacter* - run at 37°C for 24 hours using EMB agar (eosin methylene blue).

Table 1 below shows the results of the microbiological testing. A 99.0% or greater kill is considered an acceptable colloidal silica slurry.

Table 1

TMA-OH Microbiological Results
Initial Bacteria Cts. = 8.3E08; Initial Mold Cts. = 8E04

Sample	% Amine	Available		%Active Na-Omadine	Incub. Time	%Bact. Killed	%Mold Killed
		Chlorine (ppm)	% Active TMA-OH				
1	None	None	None	None	1 wk	None	None
					2 wk	None	None
2	2%AEEA	100	None	None	1 wk	43	61
					2 wk	98	90
3	4.5%PIP	100	0.68	0.32	1 wk	~100	99.8
					2 wk	~100	~100

AEEA denotes aminoethylethanolamine

PIP denotes piperazine

Table 1 demonstrates the effect of the TMA-OH with and without sodium Omadine® on bacteria and mold. The results indicate that 0.68% active TMA-OH with sodium chlorite and sodium OMADINE® (pyrithione) will inhibit the products after one or two weeks.

EXAMPLE 2

A colloidal silica slurry according to the present invention was prepared and evaluated verses conventional colloidal silicas. Sample 1 is a conventional colloidal silica containing 2%

aminoethylethanolamine (AEEA), sample 2 is a conventional colloidal silica containing 5% piperazine, and sample 3 is a low sodium, low metals colloidal silica slurry according to the present invention.

The field trials set forth below in Table 3 were conducted under the following operating parameters. The polishing machine was a Fujikosi four head 68.6 cm (27") machine having a platen of 68.6 cm (27") diameter with four polishing heads, capable of holding three 10.5 cm (4") wafers. The wafers were P-100 type; boron doped; 10.5 cm (4") diameter; acid etched. Silica level was 3.53% as SiO₂. The polishing pad was a 68.6 cm (27") diameter Suba 600.

The polishing conditions for the field trials were as follows: polishing pressure of 370 g/cm² (5.2 lb/in²), polishing speed of 50 RPM (platen), polishing temperature of 26°-30°, a pH of 10.7-9.7 (start to finish), KOH caustic, a flow rate of 2000 mL/min. (recirculated), and a total removal amount of 15 micrometers.

Table 2 below set forth the compositions of the samples 1-3.

TABLE 2

Component	Sample 1	Sample 2	Sample 3
Base silica	A	A	B
Counter Ion	Na	Na	NH ₄
Polishing Rate Accelerator	2%AEEA	5%PIP	4.5%PIP
Sodium Chlorite	yes	yes	yes
Sodium Omadine®	no	yes	yes
Quaternary	no	yes	yes
Silica A = 50% SiO ₂ , particle size of 50-70 nm (nothing over 90 nm)			
Silica B = 40% SiO ₂ , particle size of > 70 nm (deionized product)			

The field test results were obtained using the following polishing test procedures: (1) Place new polishing pad on machine; (2) Dress the pad by first rinsing with deionized water and then scraping the pad with a razor blade; (3) Load a set of wafers on the machine; (4) Start the slurry flow to purge the lines and soak the pad; (5) Make a service run at the desired pressure and flow rate; (6) After the service run is over, rinse the wafers, remove from the carriers and replace with more wafers; (7) Place in hot (≥170° F) water for a period of 5-10 minutes; and (8) Air dry the wafers.

TABLE 3

(Polishing Results)							
Sample	%Amine	%Active TMA-OH	%Active Na Pyrithione Fungicide	Cation	R _a	Average Pol. Rate	
						Start	Fin
1	2%AEEA	0	0	Na	29±1	0.48	0.48
2	5%PIP	0.75	0.08	Na	31±0	0.66	0.73
3	4.5%PIP	0.68	0.08	NH ₄	28±1	0.70	0.77
R _a denotes surface roughness in microns.							
AEEA denotes aminoethylethanolamine.							
PIP denotes piperazine.							

Table 3 compares the polishing rates of the colloidal silica slurry of the present invention (Sample 3) verses conventional colloidal silicas (Samples 1 and 2) using the same polishing conditions. The present invention was stabilized with ammonia instead of sodium as in samples 1 and 2, and resulted in a polishing rate equivalent to or greater than the conventional colloidal silicas while maintaining reduced sodium levels.

In Table 4 below the polished wafer quality and polishing parameters of the colloidal silica slurry of the present invention (sample 3) are compared with those of conventional colloidal silicas (samples 1 and 2). The colloidal silica slurry of the present invention produced wafers with the same wafer quality as the conventional slurries, while maintaining the same pad characteristics after polishing.

TABLE 4

(Polishing Wafer Quality & Polishing Parameters)					
Sample	Temperature	Scratches per 3 Wafers	Surface Texture	Pad Cleanability	Pad Glazing
1	26-27 °C	0	Acceptable	Good	Acceptable
2	28-29 °C	0	Acceptable	Good	Acceptable
3	29-30 °C	0	Acceptable	Good	Acceptable

EXAMPLE 3

Silicon wafers can be polished using high purity colloidal silicas prepared in accordance with the procedures set forth in EP-A-0464289.

A 30% ammonium-stabilized silica sol having a particle diameter of about 14.4 nm was prepared in accordance with those procedures (Sample 1). Table 5 below lists the metal analyses as done by Ion Coupled Argon Plasma (ICP) of Sample 1. The total metal content based on the average of analyses 1 and analyses 2 is 256 ppm.

TABLE 5

Metal Analyses for Sample 1 (ICP Results)			
Metals	Analyses 1 BOS	Analyses 2 BOS	Average
Na	17.4	21.5	19.4
Ca	13.3	12.3	12.8
Mg	9.5	9.2	9.4
Al	88.6	85.4	87.0
Cr	0.6	0.6	0.6
Cu	5.1	3.5	4.3
Fe	23.7	23.1	23.4
K	4.7	4.7	4.7
Sn	1.9	1.6	1.8
Sr	0.6	0.6	0.6
Ti	72.8	72.8	72.8
Zn	1.6	1.6	1.6
Zr	17.4	17.1	17.2
BOS denotes based on SiO ₂			

Sample 1 was tested on a Siltec 3800 polishing machine against Sample 2 (i.e., a 50% conventional colloidal silica sol having a particle diameter in the range between about 50-70 nm), and Sample 3 (i.e., Sample 1 with an AEEA polishing rate accelerator). The operating conditions for the silicon wafer polishing was as follows:

Number of Polishing Heads	4 x 53 cm (21-inch) diameter
Polishing Speed	65 rpm
Polishing Pressure	3,900 kg/m ² (5.55 lb/in ²)
Polishing Time	20 minutes
Flow Rate	189 ml /minute
Temperature	42 to 45 °C
SiO ₂ Concentration	2.8%
Polishing pH	11.0
Caustic Used	45% KOH

There was no statistical change in polishing rate from the conventional silica sol to the high purity colloidal silicas. The result are set forth in Table 6 below.

TABLE 6

Sample No.	Mean PD (nm)	SiO ₂ to AEEA Ratio	Removal Rate (mils/20 min.) mm/20 min
1	18.2	23.1	(0.846) 0.215
2	62.0	23.2	(0.839) 0.213
3	14.5	23.1	(0.846) 0.215

The silica used in samples 1 and 3 was much smaller in size than that used in sample 2, so it was expected that there might be scratching of the wafer surface during polishing. However, no difference in wafer quality was detected suggesting that samples 1 and 3 are acceptable.

EXAMPLE 4

The various high purity colloidal silicas set forth in Table 7 below each demonstrated acceptable polishing rates.

TABLE 7

(Stock Removal Type Products using High Purity Silica Sols)				
Property	Product A	Product B	Product C	Product D
SiO ₂ Concentration	30.4%	30.0%	22.2%	27.6%
Particle Diameter (nm)	14.4	14.4	14.4	14.4
Type/Amount Amine	PIP/1.3%	AEEA/1.3%	PIP/3.25%	PIP/4.48%
SiO ₂ /Amine Weight Ratio	23.1	23.2	6.85	6.16
TMA-OH Bactericide	None	None	0.19%	0.68%
NaClO ₂ Biocide	None	0.0065%	0.02%	0.01%
Na Omadine® Fungicide	None	None	0.03%	0.08%

While we have shown and described several embodiments in accordance with our invention, it is to be clearly understood that the same are susceptible to numerous changes and modifications apparent to one skilled in the art.

Claims

Claims for the following Contracting States : AT, BE, CH, DE, DK, FR, GB, GR, IT, LI, LU, NL, SE

1. A colloidal silica slurry comprising:

a low metals ammonium-stabilized silica sol having the following characteristics: SiO₂ present in the range between 15 to 50 weight percent; a pH in the range between 8.5 to 11.3; a particle diameter in the range between 3.0 to 130 nm; aluminum, as Al, present in an amount less than 100 ppm, based on SiO₂; iron, as Fe, present in an amount less than 50 ppm, based on SiO₂; potassium, as K, present in an amount less than 25 ppm, based on SiO₂; and sodium, as Na, present in an amount less than 500 ppm, based on SiO₂;

a bactericide present in an amount between 0.08 to 5%, said bactericide being at least one compound selected from the group consisting of tetramethylammonium chloride, tetraethylammonium chloride, tetrapropylammonium chloride, tetramethylammonium hydroxide, tetraethylammonium hydroxide, tetrapropylammonium hydroxide, alkylbenzyl-dimethylammonium chloride, and alkylbenzyl-dimethylammonium hydroxide, wherein the alkyl chain ranges from 1 to 20 carbon atoms; and sodium chlorite or sodium hypochlorite present in an amount between 0 to 1000 ppm.

The colloidal silica slurry according to claim 1, wherein said bactericide is present in an amount between 0.1 to 1.25%.



There was no statistical change in polishing rate from the conventional silica sol to the high purity colloidal silicas. The result are set forth in Table 6 below.

TABLE 6

Sample No.	Mean PD (nm)	SiO ₂ to AEEA Ratio	Removal Rate (mils/20 min.) mm/20 min
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The silica used in samples 1 and 3 was much smaller in size than that used in sample 2, so it was expected that there might be scratching of the wafer surface during polishing. However, no difference in wafer quality was detected suggesting that samples 1 and 3 are acceptable.

EXAMPLE 4

The various high purity colloidal silicas set forth in Table 7 below each demonstrated acceptable polishing rates.

TABLE 7

(Stock Removal Type Products using High Purity Silica Sols)				
Property	Product A	Product B	Product C	Product D
SiO ₂ Concentration	30.4%	30.0%	22.2%	27.6%
Particle Diameter (nm)	14.4	14.4	14.4	14.4
Type/Amount Amine	PIP/1.3%	AEEA/1.3%	PIP/3.25%	PIP/4.48%
SiO ₂ /Amine Weight Ratio	23.1	23.2	6.85	6.16
TMA-OH Bactericide	None	None	0.19%	0.68%
NaClO ₂ Biocide	None	0.0065%	0.02%	0.01%
Na Omadine® Fungicide	None	None	0.03%	0.08%

While we have shown and described several embodiments in accordance with our invention, it is to be clearly understood that the same are susceptible to numerous changes and modifications apparent to one skilled in the art.

Claims

Claims for the following Contracting States : AT, BE, CH, DE, DK, FR, GB, GR, IT, LI, LU, NL, SE

1. A colloidal silica slurry comprising:

a low metals ammonium-stabilized silica sol having the following characteristics: SiO₂ present in the range between 15 to 50 weight percent; a pH in the range between 8.5 to 11.3; a particle diameter in the range between 3.0 to 130 nm; aluminum, as Al, present in an amount less than 100 ppm, based on SiO₂; iron, as Fe, present in an amount less than 50 ppm, based on SiO₂; potassium, as K, present in an amount less than 25 ppm, based on SiO₂; and sodium, as Na, present in an amount less than 500 ppm, based on SiO₂;

a bactericide present in an amount between 0.08 to 5%, said bactericide being at least one compound selected from the group consisting of tetramethylammonium chloride, tetraethylammonium chloride, tetrapropylammonium chloride, tetramethylammonium hydroxide, tetraethylammonium hydroxide, tetrapropylammonium hydroxide, alkylbenzyl-dimethylammonium chloride, and alkylbenzyl-dimethylammonium hydroxide, wherein the alkyl chain ranges from 1 to 20 carbon atoms; and sodium chlorite or sodium hypochlorite present in an amount between 0 to 1000 ppm.

2. The colloidal silica slurry according to claim 1, wherein said bactericide is present in an amount between 0.1 to 1.25%.



3. The colloidal silica slurry according to claim 2, wherein said bactericide is present in an amount between 0.5 to 0.75%.
- 5 4. The colloidal silica slurry according to any one of the preceding claims, wherein said sodium chlorite or sodium hypochlorite is present in an amount between 65 ppm to 100 ppm.
5. The colloidal silica slurry according to any one of the preceding claims, further comprising a fungicide present in an amount of up to about 2.0%.
- 10 6. The colloidal silica slurry according to claim 5, wherein said fungicide is present in an amount between 0.1 to 0.5%.
7. The colloidal silica slurry according to claim 5 or claim 6, wherein said fungicide is sodium pyrithione.
- 15 8. The colloidal silica slurry according to any one of the preceding claims, further comprising a polishing rate accelerator which is present in an amount between 0.5 to 5%, said polishing rate accelerator being at least one of: primary amines, secondary amines, heterocyclic amines, diethylenetriamine, triethylenetetramine, tetraethylenepentamine, and aminoethylethanolamine, and mixtures thereof.
- 20 9. A colloidal silica slurry comprising:
a low metals ammonium-stabilized silica sol having the following characteristics: SiO₂ present in the range between 15 to 50 weight percent; a pH in the range between 8.5 to 11.3; a particle diameter in the range between 3.0 to 130 nm; aluminium, as Al, present in an amount less than 100 ppm, based on SiO₂; iron, as Fe, present in an amount less than about 50 ppm, based on SiO₂; potassium, as K,
25 present in an amount less than 25 ppm, based on SiO₂; and sodium, as Na, present in an amount less than 500 ppm, based on SiO₂; and
a polishing rate accelerator present in an amount between 0.5 to 5%.
- 30 10. The colloidal silica slurry according to claim 9, wherein said polishing rate accelerator is at least one compound selected from the group consisting of: primary amines, secondary amines, tertiary amines, heterocyclic amines, and mixtures thereof.
11. The colloidal silica slurry according to claim 8 or claim 10, wherein said primary amine is monoethanolamine, isopropylamine, ethylenediamine, or propanediamine.
- 35 12. The colloidal silica slurry according to claim 8 or claim 10, wherein said secondary amine is diethanolamine, dipropylamine, or dibutylamine.
- 40 13. The colloidal silica slurry according to claim 8 or claim 10, wherein said heterocyclic amine is hexamethylenediamine, bis(aminopropyl) piperazine, or piperazine.
14. The colloidal silica slurry according to claim 10, wherein said polishing rate accelerator includes at least one quaternary amine.
- 45 15. The colloidal silica slurry according to claim 10, wherein said tertiary amine is triethanolamine.
16. The colloidal silica slurry according to claim 14, wherein said quaternary amine is selected from the group consisting of: tetramethylammonium chloride, tetraethylammonium chloride, tetrapropylammonium chloride, tetramethylammonium hydroxide, tetraethylammonium hydroxide, tetrapropylammonium hydroxide, alkylbenzyltrimethylammonium chloride, and alkylbenzyltrimethylammonium hydroxide, wherein the alkyl chain ranges from 1 to 20 carbon atoms.
- 50 17. The colloidal silica slurry according to claim 9 or claim 10, wherein said polishing rate accelerator is selected from the group consisting of diethylenetriamine, triethylenetetramine, tetraethylenepentamine, and aminoethylethanolamine.
- 55 18. The colloidal silica slurry according to claim 9, claim 10 or claim 17, further comprising either sodium chlorite or sodium hypochlorite in an amount between 1 ppm to 1000 ppm.



19. The colloidal silica slurry according to claim 9, claim 10, claim 17 or claim 18, wherein either the sodium chlorite or sodium hypochlorite are present in an amount between 65 ppm to 100 ppm.
20. The colloidal silica slurry according to claim 9, claim 10, claim 17, claim 18 or claim 19, further comprising a fungicide in an amount up to about 2%.
21. The colloidal silica slurry according to claim 20, wherein said fungicide is present in an amount between 0.1 to 0.5%.
22. The colloidal silica slurry according to claim 20 or claim 21, wherein said fungicide is sodium pyrrithione.
23. A process for polishing a silicon wafer which includes the step of recirculating a colloidal silica slurry according to any one of the preceding claims between a polishing plate containing a polishing pad and said silicon wafer.

Claims for the following Contracting State : ES

1. A method of preparing a colloidal silica slurry comprising admixing:
 - a low metals ammonium-stabilized silica sol having the following characteristics: SiO₂ present in the range between 15 to 50 weight percent; a pH in the range between 8.5 to 11.3; a particle diameter in the range between 3.0 to 130 nm; aluminum, as Al, present in an amount less than 100 ppm, based on SiO₂; iron, as Fe, present in an amount less than 50 ppm, based on SiO₂; potassium, as K, present in an amount less than 25 ppm, based on SiO₂; and sodium, as Na, present in an amount less than 500 ppm, based on SiO₂;
 - a bactericide present in an amount between 0.08 to 5%, said bactericide being at least one compound selected from the group consisting of tetramethylammonium chloride, tetraethylammonium chloride, tetrapropylammonium chloride, tetramethylammonium hydroxide, tetraethylammonium hydroxide, tetrapropylammonium hydroxide, alkylbenzyltrimethylammonium chloride, and alkylbenzyltrimethylammonium hydroxide, wherein the alkyl chain ranges from 1 to 20 carbon atoms; and
 - sodium chlorite or sodium hypochlorite present in an amount between 0 to 1000 ppm.
2. The method according to claim 1, wherein said bactericide is admixed in an amount between 0.1 to 1.25%.
3. The method according to claim 2, wherein said bactericide is admixed in an amount between 0.5 to 0.75%.
4. The method according to any one of the preceding claims, wherein said sodium chlorite or sodium hypochlorite is admixed in an amount between 65 ppm to 100 ppm.
5. The method according to any one of the preceding claims, further comprising admixing a fungicide present in an amount of up to about 2.0%.
6. The method according to claim 5, wherein said fungicide is admixed in an amount between 0.1 to 0.5%.
7. The method according to claim 5 or claim 6, wherein said fungicide is sodium pyrrithione.
8. The method according to any one of the preceding claims, further comprising admixing a polishing rate accelerator in an amount between 0.5 to 5%, said polishing rate accelerator being at least one of: primary amines, secondary amines, heterocyclic amines, diethylenetriamine, triethylenetetramine, tetraethylenepentamine, and aminoethylethanolamine, and mixtures thereof.
9. A method of making a colloidal silica slurry comprising admixing:
 - a low metals ammonium-stabilized silica sol having the following characteristics: SiO₂ present in the range between 15 to 50 weight percent; a pH in the range between 8.5 to 11.3; a particle diameter in the range between 3.0 to 130 nm; aluminium, as Al, present in an amount less than 100 ppm, based



on SiO₂; iron, as Fe, present in an amount less than about 50 ppm, based on SiO₂; potassium, as K, present in an amount less than 25 ppm, based on SiO₂; and sodium, as Na, present in an amount less than 500 ppm, based on SiO₂; and

a polishing rate accelerator present in an amount between 0.5 to 5%.

- 5 10. The method according to claim 9, wherein said polishing rate accelerator is at least one compound selected from the group consisting of: primary amines, secondary amines, tertiary amines, heterocyclic amines, and mixtures thereof.
- 10 11. The method according to claim 8 or claim 10, wherein said primary amine is monoethanolamine, isopropylamine, ethylenediamine, or propanediamine.
12. The method according to claim 8 or claim 10, wherein said secondary amine is diethanolamine, dipropylamine, or dibutylamine.
- 15 13. The method according to claim 8 or claim 10, wherein said heterocyclic amine is hexamethylenediamine, bis(aminopropyl) piperazine, or piperazine.
14. The method according to claim 10, wherein said polishing rate accelerator includes at least one quaternary amine.
- 20 15. The method according to claim 10, wherein said tertiary amine is triethanolamine.
16. The method according to claim 14, wherein said quaternary amine is selected from the group consisting of: tetramethylammonium chloride, tetraethylammonium chloride, tetrapropylammonium chloride, tetramethylammonium hydroxide, tetraethylammonium hydroxide, tetrapropylammonium hydroxide, alkylbenzyltrimethylammonium chloride, and alkylbenzyltrimethylammonium hydroxide, wherein the alkyl chain ranges from 1 to 20 carbon atoms.
- 25 17. The method according to claim 9 or claim 10, wherein said polishing rate accelerator is selected from the group consisting of diethylenetriamine, triethylenetetramine, tetraethylenepentamine, and aminoethylethanolamine.
18. The method according to claim 9, claim 10 or claim 17, further comprising admixing either sodium chlorite or sodium hypochlorite in an amount between 1 ppm to 1000 ppm.
- 35 19. The method according to claim 9, claim 10, claim 17 or claim 18, wherein either the sodium chlorite or sodium hypochlorite are in an amount between 65 ppm to 100 ppm.
20. The method according to claim 9, claim 10, claim 17, claim 18 or claim 19, further comprising admixing a fungicide in an amount up to about 2%.
- 40 21. The method according to claim 20, wherein said fungicide is in an amount between 0.1 to 0.5%
22. The method according to claim 20 or claim 21, wherein said fungicide is sodium pyriithione.
23. A method for polishing a silicon wafer which includes the step of recirculating a colloidal silica slurry according to any one of the preceding claims between a polishing plate containing a polishing pad and said silicon wafer.

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Patentansprüche

Patentansprüche für folgende Vertragsstaaten : AT, BE, CH, DE, DK, FR, GB, GR, IT, LI, LU, NL, SE

1. Kolloidale Silika-Aufschlämmung, umfassend:
 - 55 ein ammonium-stabilisiertes Silikasol mit niedrigem Metallgehalt mit den folgenden Merkmalen: SiO₂, enthalten im Bereich von 15 - 50 Gew.-%; einen pH im Bereich von 8,5 - 11,3; einen Teilchendurchmesser im Bereich von 3,0 - 130 nm; Aluminium, als Al, enthalten in einer Menge von weniger als 100 ppm, bezogen auf SiO₂; Eisen, als Fe, enthalten in einer Menge von weniger als 50



ppm, bezogen auf SiO_2 ; Kalium, als K, enthalten in einer Menge von weniger als 25 ppm, bezogen auf SiO_2 ; und Natrium, als Na, enthalten in einer Menge von weniger als 500 ppm, bezogen auf SiO_2 ;

ein in einer Menge von 0,08 - 5% enthaltenes Bakterizid, das zumindest eine Verbindung, ausgewählt aus der aus Tetramethylammoniumchlorid, Tetraethylammoniumchlorid, Tetrapropylammoniumchlorid, Tetramethylammoniumhydroxid, Tetraethylammoniumhydroxid, Tetrapropylammoniumhydroxid, Alkylbenzyltrimethylammoniumchlorid und Alkylbenzyltrimethylammoniumhydroxid bestehenden Gruppe, ist, worin die Alkylkette im Bereich von 1 - 20 Kohlenstoffatomen liegt; und

Natriumchlorit oder Natriumhypochlorit in einer Menge von 0 - 1000 ppm.

2. Kolloidale Silika-Aufschlammung nach Anspruch 1, worin das Bakterizid in einer Menge von 0,1 - 1,25% enthalten ist.
3. Kolloidale Silika-Aufschlammung nach Anspruch 2, worin das Bakterizid in einer Menge von 0,5 - 0,75% enthalten ist.
4. Kolloidale Silika-Aufschlammung nach irgendeinem der vorangegangenen Ansprüche, worin das Natriumchlorit oder Natriumhypochlorit in einer Menge von 65 - 100 ppm enthalten ist.
5. Kolloidale Silika-Aufschlammung nach irgendeinem der vorangegangenen Ansprüche, die weiters ein Fungizid in einer Menge von bis zu etwa 2,0% umfaßt.
6. Kolloidale Silika-Aufschlammung nach Anspruch 5, worin das Fungizid in einer Menge von 0,1 - 0,5% enthalten ist.
7. Kolloidale Silika-Aufschlammung nach Anspruch 5 oder 6, worin das Fungizid Natriumpyrithion ist.
8. Kolloidale Silika-Aufschlammung nach irgendeinem der vorangegangenen Ansprüche, die weiters einen Polieraten-Beschleuniger umfaßt, der in einer Menge von 0,5 - 5% enthalten ist, wobei der Polieraten-Beschleuniger zumindest einer aus: primären Aminen, sekundären Aminen, heterozyklischen Aminen, Diethylentriamin, Triethylentetramin, Tetraethylenpentamin und Aminoethylethanolamin und Gemischen davon ist.
9. Kolloidale Silika-Aufschlammung, umfassend:
ein ammonium-stabilisiertes Silikagel mit niedrigem Metallgehalt mit den folgenden Merkmalen:
 SiO_2 , enthalten im Bereich von 15 - 50 Gew.-%; einen pH im Bereich von 8,5 - 11,3; einen Teilchendurchmesser im Bereich von 3,0 - 130 nm; Aluminium, als Al, enthalten in einer Menge von weniger als 100 ppm, bezogen auf SiO_2 ; Eisen, als Fe, enthalten in einer Menge von weniger als etwa 50 ppm, bezogen auf SiO_2 ; Kalium, als K, enthalten in einer Menge von weniger als 25 ppm, bezogen auf SiO_2 ; und Natrium, als Na, enthalten in einer Menge von weniger als 500 ppm, bezogen auf SiO_2 ; und
einen Polieraten-Beschleuniger, enthalten in einer Menge von 0,5 - 5%.
10. Kolloidale Silika-Aufschlammung nach Anspruch 9, worin der Polieraten-Beschleuniger zumindest eine Verbindung aus: primären Aminen, sekundären Aminen, tertiären Aminen, heterozyklischen Aminen und Gemischen davon ist.
11. Kolloidale Silika-Aufschlammung nach Anspruch 8 oder 10, worin das primäre Amin Monoethanolamin, Isopropylamin, Ethylendiamin oder Propandiamin ist.
12. Kolloidale Silika-Aufschlammung nach Anspruch 8 oder 10, worin das sekundäre Amin Diethanolamin, Dipropylamin oder Dibutylamin ist.
13. Kolloidale Silika-Aufschlammung nach Anspruch 8 oder 10, worin das heterozyklische Amin Hexamethylendiamin, Bis-(Aminopropyl)piperazin oder Piperazin ist.
14. Kolloidale Silika-Aufschlammung nach Anspruch 10, worin der Polieraten-Beschleuniger zumindest ein quaternäres Amin umfaßt.



15. Kolloidale Silika-Aufschlammung nach Anspruch 10, worin das tertiäre Amin Triethanolamin ist.
- 5 16. Kolloidale Silika-Aufschlammung nach Anspruch 14, worin das quaternäre Amin aus der aus Tetramethylammoniumchlorid, Tetraethylammoniumchlorid, Tetrapropylammoniumchlorid, Tetramethylammoniumhydroxid, Tetraethylammoniumhydroxid, Tetrapropylammoniumhydroxid, Alkylbenzyltrimethylammoniumchlorid und Alkylbenzyltrimethylammoniumhydroxid bestehenden Gruppe ausgewählt wird, worin die Alkylkette im Bereich von 1 - 20 Kohlenstoffatomen liegt.
- 10 17. Kolloidale Silika-Aufschlammung nach Anspruch 9 oder 10, worin der Polieraten-Beschleuniger aus der aus Diethylentriamin, Triethylentetramin, Tetraethylenpentamin und Aminoethylethanolamin bestehenden Gruppe ausgewählt ist.
- 15 18. Kolloidale Silika-Aufschlammung nach Anspruch 9, 10 oder 17, die weiters Natriumchlorit oder Natriumhypochlorit in einer Menge von 1 - 1000 ppm umfaßt.
19. Kolloidale Silika-Aufschlammung nach Anspruch 9, 10, 17 oder 18, worin entweder das Natriumchlorit oder das Natriumhypochlorit in einer Menge von 65 - 100 ppm enthalten ist.
- 20 20. Kolloidale Silika-Aufschlammung nach Anspruch 9, 10, 17, 18 oder 19, die weiters ein Fungizid in einer Menge von bis zu etwa 2,0% umfaßt.
21. Kolloidale Silika-Aufschlammung nach Anspruch 20, worin das Fungizid in einer Menge von 0,1 - 0,5% enthalten ist.
- 25 22. Kolloidale Silika-Aufschlammung nach Anspruch 20 oder 21, worin das Fungizid Natriumpyrithion ist.
23. Verfahren zum Polieren eines Silizium-Wafers, das den Schritt des Rezirkulierens einer kolloidalen Silika-Aufschlammung nach irgendeinem der vorangegangenen Ansprüche zwischen einer Polierplatte umfaßt, die ein Polierkissen und den Silizium-Wafer enthält.

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Patentansprüche für folgenden Vertragsstaat : ES

1. Verfahren zur Herstellung einer kolloidalen Silika-Aufschlammung, umfassend das Vermischen:
 eines ammonium-stabilisierten Silikasols mit niedrigem Metallgehalt mit den folgenden Merkmalen:
 35 SiO_2 , enthalten im Bereich von 15 - 50 Gew.-%; einen pH im Bereich von 8,5 - 11,3; einen Teilchendurchmesser im Bereich von 3,0 - 130 nm; Aluminium, als Al, enthalten in einer Menge von weniger als 100 ppm, bezogen auf SiO_2 ; Eisen, als Fe, enthalten in einer Menge von weniger als 50 ppm, bezogen auf SiO_2 ; Kalium, als K, enthalten in einer Menge von weniger als 25 ppm, bezogen auf SiO_2 ; und Natrium, als Na, enthalten in einer Menge von weniger als 500 ppm, bezogen auf SiO_2 ;
 40 eines in einer Menge von 0,08 - 5% enthaltenen Bakterizids, das zumindest eine Verbindung, ausgewählt aus der aus Tetramethylammoniumchlorid, Tetraethylammoniumchlorid, Tetrapropylammoniumchlorid, Tetramethylammoniumhydroxid, Tetraethylammoniumhydroxid, Tetrapropylammoniumhydroxid, Alkylbenzyltrimethylammoniumchlorid und Alkylbenzyltrimethylammoniumhydroxid bestehenden Gruppe, ist, worin die Alkylkette im Bereich von 1 - 20 Kohlenstoffatomen liegt; und
 45 von Natriumchlorit oder Natriumhypochlorit in einer Menge von 0 - 1000 ppm.
2. Verfahren nach Anspruch 1, worin das Bakterizid in einer Menge von 0,1 - 1,25% zugemischt wird.
3. Verfahren nach Anspruch 2, worin das Bakterizid in einer Menge von 0,5 - 0,75% zugemischt wird.
- 50 4. Verfahren nach irgendeinem der vorangegangenen Ansprüche, worin das Natriumchlorit oder Natriumhypochlorit in einer Menge von 65 - 100 ppm zugemischt wird.
5. Verfahren nach irgendeinem der vorangegangenen Ansprüche, das weiters das Zumischen eines Fungizids in einer Menge von bis zu etwa 2,0% umfaßt.
- 55 6. Verfahren nach Anspruch 5, worin das Fungizid in einer Menge von 0,1 - 0,5% zugemischt wird.



7. Verfahren nach Anspruch 5 oder 6, worin das Fungizid Natriumpyrithion ist.
8. Verfahren nach irgendeinem der vorangegangenen Ansprüche, das weiters das Zumischen eines Polieraten-Beschleunigers in einer Menge von 0,5 - 5% umfaßt, wobei der Polieraten-Beschleuniger
 5 zumindest einer aus: primären Aminen, sekundären Aminen, heterozyklischen Aminen, Diethylentriamin, Triethylentetramin, Tetraethylenpentamin und Aminoethylethanolamin und Gemischen davon ist.
9. Verfahren zur Herstellung einer kolloidalen Silika-Aufschlammung, umfassend das Vermischen:
 10 eines ammonium-stabilisierten Silikasols mit niedrigem Metallgehalt mit den folgenden Merkmalen:
 SiO₂, enthalten im Bereich von 15 - 50 Gew.-%; einen pH im Bereich von 8,5 - 11,3; einen
 Teilchendurchmesser im Bereich von 3,0 - 130 nm; Aluminium, als Al, enthalten in einer Menge von
 weniger als 100 ppm, bezogen auf SiO₂; Eisen, als Fe, enthalten in einer Menge von weniger als etwa
 50 ppm, bezogen auf SiO₂; Kalium, als K, enthalten in einer Menge von weniger als 25 ppm, bezogen
 15 auf SiO₂; und Natrium, als Na, enthalten in einer Menge von weniger als 500 ppm, bezogen auf SiO₂;
 und
 eines Polieraten-Beschleunigers in einer Menge von 0,5 - 5%.
10. Verfahren nach Anspruch 9, worin der Polieraten-Beschleuniger zumindest eine Verbindung aus:
 20 primären Aminen, sekundären Aminen, tertiären Aminen, heterozyklischen Aminen und Gemischen
 davon ist.
11. Verfahren nach Anspruch 8 oder 10, worin das primäre Amin Monoethanolamin, Isopropylamin,
 Ethylendiamin oder Propandiamin ist.
- 25 12. Verfahren nach Anspruch 8 oder 10, worin das sekundäre Amin Diethanolamin, Dipropylamin oder
 Dibutylamin ist.
13. Verfahren nach Anspruch 8 oder 10, worin das heterozyklische Amin Hexamethyldiamin, Bis-
 (Aminopropyl)piperazin oder Piperazin ist.
- 30 14. Verfahren nach Anspruch 10, worin der Polieraten-Beschleuniger zumindest ein quaternäres Amin
 umfaßt.
15. Verfahren nach Anspruch 10, worin das tertiäre Amin Triethanolamin ist.
- 35 16. Verfahren nach Anspruch 14, worin das quaternäre Amin aus der aus Tetramethylammoniumchlorid,
 Tetraethylammoniumchlorid, Tetrapropylammoniumchlorid, Tetramethylammoniumhydroxid, Tetraeth-
 ylammoniumhydroxid, Tetrapropylammoniumhydroxid, Alkylbenzyltrimethylammoniumchlorid und Alkyl-
 benzyltrimethylammoniumhydroxid bestehenden Gruppe ausgewählt wird, worin die Alkylkette im
 40 Bereich von 1 - 20 Kohlenstoffatomen liegt.
17. Verfahren nach Anspruch 9 oder 10, worin der Polieraten-Beschleuniger aus der aus Diethylentriamin,
 Triethylentetramin, Tetraethylenpentamin und Aminoethylethanolamin bestehenden Gruppe ausgewählt
 45 wird.
18. Verfahren nach Anspruch 9, 10 oder 17, das weiters das Zumischen von Natriumchlorit oder Natriumh-
 ypochlorit in einer Menge von 1 - 1000 ppm umfaßt.
19. Verfahren nach Anspruch 9, 10, 17 oder 18, worin entweder das Natriumchlorit oder das Natriumhypo-
 50 chlorit in einer Menge von 65 - 100 ppm zugemischt wird.
20. Verfahren nach Anspruch 9, 10, 17, 18 oder 19, das weiters das Zumischen eines Fungizids in einer
 Menge von bis zu etwa 2,0% umfaßt.
- 55 21. Verfahren nach Anspruch 20, worin das Fungizid in einer Menge von 0,1 - 0,5% zugemischt wird.
22. Verfahren nach Anspruch 20 oder 21, worin das Fungizid Natriumpyrithion ist.



23. Verfahren zum Polieren eines Silizium-Wafers, das den Schritt des Rezirkulierens einer kolloidalen Silika-Aufschlammung nach irgendeinem der vorangegangenen Ansprüche zwischen einer Polierplatte umfaßt, die ein Polierkissen und den Silizium-Wafer enthält.

5 Revendications

Revendications pour les Etats contractants suivants : AT, BE, CH, DE, DK, FR, GB, GR, IT, LI, LU, NL, SE

1. Bouillie de silice colloïdale comprenant :
 - 10 un sol de silice stabilisé à l'ammonium à faible teneur en métaux, ayant les caractéristiques suivantes : SiO_2 présent à raison de 15 à 50 pour cent en poids; un pH compris entre 8,5 et 11,3; un diamètre de particules compris entre 3,0 et 130 nm; de l'aluminium, sous la forme de Al, présent en une quantité inférieure à 100 ppm, en se basant sur SiO_2 ; du fer, sous la forme de Fe, présent en une quantité de moins de 50 ppm, en se basant sur SiO_2 ; du potassium, sous la forme de K, présent en
 - 15 une quantité inférieure à 25 ppm, en se basant sur SiO_2 ; et du sodium, sous la forme de Na, présent en une quantité inférieure à 500 ppm, en se basant sur SiO_2 ;
 - un bactéricide présent en une quantité comprise entre 0,08 et 5%, ledit bactéricide étant au moins un composé choisi dans le groupe consistant en chlorure de tétraméthylammonium, chlorure de tétraéthylammonium, chlorure de tétrapropylammonium, hydroxyde de tétraméthylammonium, hydroxyde de tétraéthylammonium, hydroxyde de tétrapropylammonium, chlorure d'alkylbenzylidiméthylammonium, et hydroxyde d'alkylbenzylidiméthylammonium, où la chaîne alkyle a 1 à 20 atomes de carbone; et
 - 20 du chlorite de sodium ou de l'hypochlorite de sodium présent en une quantité comprise entre 0 et 1000 ppm.
 - 25 2. Bouillie de silice colloïdale selon la revendication 1, où ledit bactéricide est présent en une quantité comprise entre 0,1 et 1,25%.
 3. Bouillie de silice colloïdale selon la revendication 2, où ledit bactéricide est présent en une quantité
 - 30 comprise entre 0,5 et 0,75%.
 4. Bouillie de silice colloïdale selon l'une quelconque des revendications précédentes, où ledit chlorite de sodium ou hypochlorite de sodium est présent en une quantité comprise entre 65 ppm et 100 ppm.
 - 35 5. Bouillie de silice colloïdale selon l'une quelconque des revendications précédentes, contenant de plus un fongicide présent en une quantité pouvant atteindre environ 2,0%.
 6. Bouillie de silice colloïdale selon la revendication 5, où ledit fongicide est présent en une quantité comprise entre 0,1 et 0,5%.
 - 40 7. Bouillie de silice colloïdale selon la revendication 5 ou la revendication 6, où ledit fongicide est sodium pyrithione.
 8. Bouillie de silice colloïdale selon l'une quelconque des revendications précédentes, comprenant de plus un accélérateur de polissage qui est présent en une quantité comprise entre 0,5 et 5%, ledit accélérateur de polissage étant au moins l'un de : amines primaires, amines secondaires, amines hétérocycliques, diéthylènetriamine triéthylènetétramine, tétraéthylènepentamine et aminoéthyléthanolamine, et leurs mélanges.
 - 45 9. Bouillie de silice colloïdale comprenant :
 - un sol de silice stabilisé à l'ammonium à faible teneur en métaux, ayant les caractéristiques suivantes : SiO_2 présent à raison de 15 à 50 pour cent en poids; un pH compris entre 8,5 et 11,3; un diamètre de particules compris entre 3,0 et 130 nm; de l'aluminium, sous la forme de Al, présent en une quantité inférieure à 100 ppm, en se basant sur SiO_2 ; du fer sous la forme de Fe, présent en une
 - 50 quantité inférieure à environ 50 ppm, en se basant sur SiO_2 ; du potassium, sous la forme de K, présent en une quantité inférieure à 25 ppm, en se basant sur SiO_2 ; et du sodium, sous la forme de Na, présent en une quantité inférieure à 500 ppm, en se basant sur SiO_2 ; et
 - 55 un accélérateur de polissage présent en une quantité comprise entre 0,5 et 5%.



10. Bouillie de silice colloïdale selon la revendication 9, où ledit accélérateur de polissage est au moins un composé choisi dans le groupe consistant en : amines primaires, amines secondaires, amines tertiaires, amines hétérocycliques et leurs mélanges.
- 5 11. Bouillie de silice colloïdale selon la revendication 8 ou la revendication 10, où ladite amine primaire est la monoéthanolamine, l'isopropylamine, l'éthylènediamine ou la propanediamine.
12. Bouillie de silice colloïdale selon la revendication 8 ou la revendication 10, où ladite amine secondaire est la diéthanolamine, la dipropylamine ou la dibutylamine.
- 10 13. Bouillie de silice colloïdale selon la revendication 8 ou la revendication 10, où ladite amine hétérocyclique est hexaméthylènediamine, bis(aminopropyl) pipérazine ou pipérazine.
14. Bouillie de silice colloïdale selon la revendication 10, où ledit accélérateur de polissage comprend au moins une amine quaternaire.
- 15 15. Bouillie de silice colloïdale selon la revendication 10, où ladite amine tertiaire est la triéthanolamine.
16. Bouillie de silice colloïdale selon la revendication 14, où ladite amine quaternaire est choisie dans le groupe consistant en : chlorure de tétraméthylammonium, chlorure de tétraéthylammonium, chlorure de tétrapropylammonium, hydroxyde de tétraméthylammonium, hydroxyde de tétraéthylammonium, hydroxyde de tétrapropylammonium, chlorure d'alkylbenzylidiméthylammonium, et hydroxyde d'alkylbenzylidiméthylammonium, où la chaîne alkyle a 1 à 20 atomes de carbone.
- 20 17. Bouillie de silice colloïdale selon la revendication 9 ou la revendication 10, où ledit accélérateur de polissage est choisi dans le groupe consistant en : diéthylènetriamine, triéthylènetétramine, tétraéthylène-pentamine et aminoéthyléthanolamine.
- 25 18. Bouillie de silice colloïdale selon la revendication 9, la revendication 10 ou la revendication 17, contenant de plus soit du chlorite de sodium ou de l'hypochlorite de sodium en une quantité comprise entre 1 ppm et 1000 ppm.
- 30 19. Bouillie de silice colloïdale selon la revendication 9, la revendication 10, la revendication 17 ou la revendication 18, où soit le chlorite de sodium ou l'hypochlorite de sodium sont présents en une quantité comprise entre 65 ppm et 100 ppm.
- 35 20. Bouillie de silice colloïdale selon la revendication 9, la revendication 10, la revendication 17, la revendication 18 ou la revendication 19, contenant de plus un fongicide en une quantité pouvant atteindre environ 20%.
- 40 21. Bouillie de silice colloïdale selon la revendication 20, où ledit fongicide est présent en une quantité comprise entre 0,1 et 0,5%.
- 45 22. Bouillie de silice colloïdale selon la revendication 20 ou la revendication 21, où ledit fongicide est sodium pyrithione.
23. Procédé pour le polissage d'une pastille de silicium qui comprend l'étape de remettre en circulation une bouillie de silice colloïdale selon l'une quelconque des revendications précédentes, entre une plaque de polissage contenant un tampon de polissage et ladite pastille de silicium.
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Revendications pour l'Etat contractant suivant : ES

1. Méthode de préparation d'une bouillie de silice colloïdale, consistant à mélanger :
un sol de silice stabilisé à l'ammonium à faible teneur en métaux, ayant les caractéristiques suivantes : SiO₂ présent à raison de 15 à 50 pour cent en poids; un pH compris entre 8,5 et 11,3; un diamètre de particules compris entre 3,0 et 130 nm; de l'aluminium, sous la forme de Al, présent en une quantité inférieure à 100 ppm, en se basant sur SiO₂; du fer, sous la forme de Fe, présent en une quantité de moins de 50 ppm, en se basant sur SiO₂; du potassium, sous la forme de K, présent en
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- une quantité inférieure à 25 ppm, en se basant sur SiO_2 ; et du sodium, sous la forme de Na, présent en une quantité inférieure à 500 ppm, en se basant sur SiO_2 ;
- un bactéricide présent en une quantité comprise entre 0,08 et 5%, ledit bactéricide étant au moins un composé choisi dans le groupe consistant en chlorure de tétraméthylammonium, chlorure de tétraéthylammonium, chlorure de tétrapropylammonium, hydroxyde de tétraméthylammonium, hydroxyde de tétraéthylammonium, hydroxyde de tétrapropylammonium chlorure d'alkylbenzylidiméthylammonium, et hydroxyde d'alkylbenzylidiméthylammonium, où la chaîne alkyle a 1 à 20 atomes de carbone ; et
- du chlorite de sodium ou de l'hypochlorite de sodium présent en une quantité comprise entre 0 et 1000 ppm.
2. Méthode selon la revendication 1, où ledit bactéricide est mélangé en une quantité comprise entre 0,1 et 1,25%.
 3. Méthode selon la revendication 2, où ledit bactéricide est mélangé en une quantité comprise entre 0,5 et 0,75%.
 4. Méthode selon l'une quelconque des revendications précédentes, où ledit chlorite de sodium ou hypochlorite de sodium est mélangé en une quantité comprise entre 65 ppm et 100 ppm.
 5. Méthode selon l'une quelconque des revendications précédentes, consistant de plus à mélanger un fongicide présent en une quantité pouvant atteindre environ 2,0%.
 6. Méthode selon la revendication 5, où ledit fongicide est mélangé en une quantité comprise entre 0,1 et 0,5%.
 7. Méthode selon la revendication 5 ou 6, où ledit fongicide est sodium pyrithione.
 8. Méthode selon l'une quelconque des revendications précédentes, consistant de plus à mélanger un accélérateur de polissage en une quantité comprise entre 0,5 et 5%, ledit accélérateur de polissage étant au moins l'un de : amines primaires, amines secondaires, amines hétérocycliques, diéthylènetriamine, triéthylènetétramine, tétraéthylènepentamine et aminoéthyléthanolamine, et leurs mélanges.
 9. Méthode de production d'une bouillie de silice colloïdale consistant à mélanger :
 - un sol de silice stabilisé à l'ammonium à faible teneur en métaux, ayant les caractéristiques suivantes : SiO_2 présent à raison de 15 à 50 pour cent en poids, un pH compris entre 8,5 et 11,3; un diamètre de particules compris entre 3,0 et 130 nm; de l'aluminium, sous la forme de Al, présent en une quantité inférieure à 100 ppm, en se basant sur SiO_2 ; du fer, sous la forme de Fe, présent en une quantité inférieure à environ 50 ppm, en se basant sur SiO_2 ; du potassium, sous la forme de K, présent en une quantité inférieure à 25 ppm, en se basant sur SiO_2 ; et du sodium, sous la forme de Na, présent en une quantité inférieure à 500 ppm, en se basant sur SiO_2 ; et
 - un accélérateur de polissage présent en une quantité comprise entre 0,5 et 5%.
 10. Méthode selon la revendication 9, où ledit accélérateur de polissage est au moins un composé choisi dans le groupe consistant en : amines primaires, amines secondaires, amines tertiaires, amines hétérocycliques et leurs mélanges.
 11. Méthode selon la revendication 8 ou la revendication 10, où ladite amine primaire est le monoéthanolamine, l'isopropylamine, l'éthylènediamine ou la propanediamine.
 12. Méthode selon la revendication 8 ou la revendication 10, où ladite amine secondaire est la diéthanolamine, la dipropylamine ou la dibutylamine.
 13. Méthode selon la revendication 8 ou la revendication 10, où ladite amine hétérocyclique est hexaméthylènediamine, bis(aminopropyl)pipérazine ou pipérazine.
 14. Méthode selon la revendication 10, où ledit accélérateur de polissage comprend au moins une amine quaternaire.



15. Méthode selon la revendication 10, où ladite amine tertiaire est la triéthanolamine.
- 5 16. Méthode selon la revendication 14, où ladite amine quaternaire est choisie dans le groupe consistant en : chlorure de tétraméthylammonium, chlorure de tétraéthylammonium, chlorure de tétrapropylammonium, hydroxyde de tétraméthylammonium, hydroxyde de tétraéthylammonium, hydroxyde de tétrapropylammonium, chlorure d'alkylbenzyltriméthylammonium, et hydroxyde d'alkylbenzyltriméthylammonium, où la chaîne alkyle a 1 à 20 atomes de carbone.
- 10 17. Méthode selon la revendication 9 ou la revendication 10, où ledit accélérateur de polissage est choisi dans le groupe consistant en : diéthylènetriamine, triéthylènetétramine, tétraéthylènepentamine, et aminoéthyléthanolamine.
- 15 18. Méthode selon la revendication 9, la revendication 10 ou la revendication 17, consistant de plus à mélanger du chlorite de sodium ou de l'hypochlorite de sodium en une quantité comprise entre 1 ppm et 1000 ppm.
- 20 19. Méthode selon la revendication 9, la revendication 10, la revendication 17 ou la revendication 18, où soit le chlorite de sodium ou l'hypochlorite de sodium sont présents en une quantité comprise entre 65 ppm et 100 ppm.
- 25 20. Méthode selon la revendication 9, la revendication 10, la revendication 17, la revendication 18 ou la revendication 19, consistant de plus à mélanger un fongicide en une quantité pouvant atteindre environ 2%.
- 30 21. Méthode selon la revendication 20, où ledit fongicide est en une quantité comprise entre 0,1 et 0,5%.
- 35 22. Méthode selon la revendication 20 ou la revendication 21, où ledit fongicide est sodium pyrithione.
- 40 23. Méthode pour le polissage d'une pastille de silicium, qui comprend l'étape de remettre en circulation une bouillie de silice colloïdale selon l'une quelconque des revendications précédentes, entre une plaque de polissage contenant un tampon de polissage et ladite pastille de silicium.
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