CLAIMS

1. A polishing composition comprising:

water;

an abrasive;

a polymer selected from the group consisting of poly(acrylic acid), poly(meth-acrylic acid), poly(2-acrylamido-2-methyl-1-propanesulfonic acid, carboxymethyl cellulose, methyl cellulose, hydroxypropyl methyl cellulose, poly-(1-vinylpyrroliddone-co-2-dimethylaminoethyl methacrylate), poly(sodium 4-styrenesulfonate), poly(ethylene oxide), poly(4-sytrenesulfonic acid), polyacrylamide, poly(acrylamide/acrylic acid) copolymers, and combinations thereof, and salts thereof and wherein the polymer has a molecular weight of from 30,000 to 30,000,000 Daltons;

a corrosion inhibitor;

a silicate compound;

an oxidizer; and, optionally,

a surfactant;

a pH-adjusting agent;

a chelating agent,

wherein the polishing composition has a pH of from 7 to 11.5, and wherein the viscosity of the polishing composition is from 1.5 cP to 10 cP.

2. The polishing composition of claim 1, wherein:

(a) the silicate compound is a salt of silicic acid selected from the group consisting of potassium silicate, ammonium silicate, tetramethylammonium silicate, tetrabutylammonium silicate, tetraethylammonium silicate, and combinations thereof; or

(b) the high molecular weight polymer is present in an amount of from 0.01 wt. % to 1.0 wt. %; or

(c) the abrasive is selected from the group consisting of high purity colloidal silica, alumina, ceria, germania, silica, titania, zirconia, alumina dopes colloidal silica in lattices, and mixtures thereof; or

(d) the abrasive is present in an amount of from 3 wt. % to 15 wt. %; or

(e) the corrosion inhibitor is selected from the group consisting of benzotriazole, 3-amino-1, 2, 4-triazole, 3, 5-diamine-1, 2, 4-triazole, and combinations thereof; and the corrosion inhibitor is present in an amount of from 0.01 wt. % to 0.1 wt. %; or

(f) the pH-adjusting agent is present and is selected from the group consisting of nitric acid, sulfuric acid, tartaric acid, succinic acid, citric acid, malic acid, malonic acid, various fatty acids, various polycarboxylic acids and combinations thereof; or

(g) the pH-adjusting agent is present and is selected from the group consisting of potassium hydroxide, sodium hydroxide, ammonia, tetraethylammonium hydroxide, ethylenediamine, piperazine, polyethyleneimine, modified polyethyleneimine, and combinations thereof; or

(h) the pH-adjusting agent is present in an amount ranging from 0.0001 wt. % to 2 wt. %; or

(i) the chelating agent is present and is selected from the group consisting of potassium citrate, benzosulfonic acid, 4-tolyl sulfonic acid, 2,4-diamino-benzosulfonic acid, and malonic acid, itaconic acid, malic acid, tartaric acid, citric acid, oxalic acid, gluconic acid, lactic acid, mandelic acid, amino acids, polycarboxy amino acids, phosphonic acids and combinations thereof and salts thereof; or

(j) the chelating agent is present in an amount ranging from 0.01 wt. % to 3.0 wt. %; or

(k) the surfactant is present and is selected from the group consisting of a non-ionic surfactant, an anionic surfactant, a cationic surfactant, an ampholytic surfactant, and combinations thereof; or

(l) the surfactant is present in an amount of from 0.010 wt. % to 0.1 wt. %; or

(m) the oxidizer is selected from the group consisting of a peroxy compound, an oxidized halide, perboric acid, a perborate, a percarbonate, a permanganate, a cerium compound, a ferricyanide, and combinations thereof.

3. The polishing composition of claim 1, wherein the silicate compound is a salt of silicic acid selected from the group consisting of potassium silicate, ammonium silicate, tetramethylammonium silicate, tetrabutylammonium silicate, tetraethylammonium silicate, and combinations thereof; and

wherein the silicate compound is present in an amount of from 0.2 wt. % to 2 wt. %.

4. The polishing composition of claim 1,
wherein the high molecular weight polymer is present in an amount of from 0.1 wt. % to 0.5 wt. %.

5. The polishing composition of claim 1, wherein the abrasive is present in an amount of from 3 wt. % to 15 wt. %; and
wherein the abrasive is colloidal silica and the colloidal silica has a mean particle size of between 30 nm and 300 nm.

6. The polishing composition of claim 5, wherein the colloidal silica has a mean particle size of between 50 nm and 200 nm.

7. The polishing composition of claim 6, wherein the colloidal silica has a mean particle size of between 60 nm and 150 nm.

8. The polishing composition of claim 5, wherein:
(a) the colloidal silica has a particle size distribution with at least two distinct peaks between 30 nm and 120 nm; or
(b) the colloidal silica has a particle size distribution with at least three distinct peaks between 30 nm and 120 nm.

9. The polishing composition of claim 1, wherein the surfactant is present in an amount of from 0.010 wt. % to 0.1 wt. %; and
wherein the surfactant is selected from the group consisting of an acetylenic diol surfactant, an alcohol ethoxylate surfactant, and a combination thereof.

10. The polishing composition of claim 1, wherein the oxidizer is selected from the group consisting of a peroxy compound, an oxidized halide, perboric acid, a perborate, a percarbonate, a permanganate, a cerium compound, a ferricyanide, and

combinations thereof; and wherein the oxidizer is present in an amount of from 0.5 wt. % to 2.0 wt. %.

11. A polishing method for chemical mechanical planarization of a semiconductor device comprising at least one surface, wherein the at least one surface has (1) a barrier layer selected from the group consisting of tantalum, tantalum nitride, tantalum tungsten silicon carbide, titanium, titanium nitride; (2) an interconnect metal layer selected from the group of copper, tungsten, cobalt, aluminum, ruthenium, or their alloys; and (3) a porous or non-porous dielectric layer, the method comprising the steps of:

a. contacting the at least one surface with a polishing pad;

b. delivering to the at least one surface the polishing composition of claim 1, and

c. polishing the at least one surface with the polishing composition to at least partially remove at least the barrier layer preferably over the dielectric layer.

12. The polishing method of claim 11 wherein:

(a) the porous or non-porous dielectric layer comprises silicon, carbon, oxygen and hydrogen; or

(b) removal rate selectivity between the barrier layer and the dielectric layer ranges between 0.25 to 4; or

(c) removal rate selectivity between the interconnect metal layer and the dielectric layer ranges between 0.25 and 4; or

(d) the barrier layer is tantalum nitride (TaN) and the removal rate of TaN is more than 900 Å/min at 3 psi down force; or

(e) the interconnect metal layer comprises copper and the copper removal rate is more than 400 Å/min at 3 psi down force.

13. The polishing method of claim 11, wherein the porous or non-porous dielectric layer comprises silicon, carbon, oxygen and hydrogen; and
wherein the porous or non-porous dielectric layer is TEOS.

14. The polishing method of claim 11, wherein the porous or non-porous dielectric layer comprises silicon, carbon, oxygen and hydrogen; and
wherein the porous or non-porous dielectric layer further comprises a capping layer of a non-porous material.

15. The polishing method of claim 11,
wherein removal rate selectivity between the barrier layer and the dielectric layer ranges between 0.5 and 2.

16. The polishing method of claim 11,
wherein removal rate selectivity between the interconnect metal layer and the dielectric layer ranges between 0.5 and 2.

17. The polishing method of claim 11, wherein the porous or non-porous dielectric layer comprises silicon, carbon, oxygen and hydrogen;
wherein the porous or non-porous dielectric layer is TEOS; and
wherein removal rate of the TEOS at 3 psi down-force is more than 1500 Å/min.

18. A system for chemical mechanical planarization, comprising:
a semiconductor device comprising at least one surface, wherein the at least one surface has (1) a barrier layer selected from the group consisting of tantalum, tantalum nitride, tantalum tungsten silicon carbide, titanium, titanium nitride; (2) an interconnect metal layer selected from the group of copper, tungsten, cobalt, aluminum, ruthenium, or their alloys; and (3) a porous or non-porous dielectric layer;
a polishing pad; and
a polishing composition according to claim 1, wherein
the at least one surface is in contact with the polishing pad and the polishing composition.