Claims

1. A barrier chemical mechanical planarization (CMP) polishing composition comprising:

≥ 2.0 wt.% of an abrasive selected from the group consisting of silica, alumina, ceria, germania, titania, zirconia, colloidal silica, alumina doped colloidal silica, and mixtures thereof;

from 0.005 wt.% to 2.0 wt.% of a planarization agent, wherein the planarization agent is selected from the group consisting of ethanol, 2-[(1-dodecylcyclohexyl)oxy]-; cyclic oligosaccharides; poly(oxy-1,2-ethanediyl), α-(1-nonyldecyl)-ω-hydroxy-; poly(oxy-1,2-ethanediyl), α-(1-decylcyl~~l~~clohexyl)-ω-hydroxy-; ethanol, 2-(cyclotridecyloxy)-; polyethylene oxide having a molecular weight ranging from 50 Dalton to 1 million Dalton; polypropylene oxide having a molecular weight ranging from 50 Dalton to 1 million Dalton; and combinations thereof;

corrosion inhibitor;

water soluble solvent, wherein the water soluble solvent is selected from the group consisting of DI water, a polar solvent and a mixture of DI water and polar solvent; wherein the polar solvent is selected from the group consisting of alcohol, ether, and ketone;

~~optionally~~

from 0.005 wt.% to 2.0 wt.% of a wetting agent, wherein the wetting agent ~~is selected from the group consisting of a non-ionic surfactant, an anionic surfactant, a cationic surfactant, an ampholytic surfactant~~comprises an acetylenic diol surfactant~~, and combinations thereof~~;

optionally;

rate boosting agent;

pH adjusting agent;

oxidizing agent; and

chelator;

wherein

the polishing composition has a pH from 7 to 12~~;~~

~~the polishing composition is free of a water soluble aluminum compound~~.

2. The barrier chemical mechanical planarization polishing composition of Claim 1, wherein the abrasive~~s~~ is colloidal silica and the colloidal silica has a mean particle size of 20 nm and 200 nm.

3. The barrier chemical mechanical planarization polishing composition of Claim 1, wherein the planarization agent is the polyethylene oxide or the polypropylene oxide.

4. The barrier chemical mechanical planarization polishing composition of Claim 1, wherein 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 0.0005 wt.% to 1.0 wt.%.

~~5. The barrier chemical mechanical planarization polishing composition of Claim 1, wherein the wetting agent is present in the polishing composition.~~

~~6. The barrier chemical mechanical planarization polishing composition of Claim 1, wherein the wetting agent is selected from the group consisting of an acetylenic diol surfactant, an alcohol ethoxylate surfactant, and combinations thereof; and the surfactant is present in an amount of from 0.005 wt.% to 2.0 wt.%.~~

~~7.~~5. The barrier chemical mechanical planarization polishing composition of Claim 1, wherein the rate boosting agent is selected from the group consisting of potassium silicate, sodium silicate, ammonium silicate, tetramethylammonium silicate, tetrabutylammonium silicate, tetraethylammonium silicate, and combinations thereof; and the rate boosting agent is used in an amount ranging from 0.01 wt.% to 15~~.~~0 wt.%.

8.6. The barrier chemical mechanical planarization polishing composition of Claim 1, wherein the pH adjusting agent is selected from the group consisting of a) nitric acid, sulfuric acid, tartaric acid, succinic acid, citric acid, malic acid, malonic acid, various fatty acids, various polycarboxylic acids and combinations thereof to lower pH of the polishing composition; and (b) potassium hydroxide, sodium hydroxide, ammonia, tetraethylammonium hydroxide, ethylenediamine, piperazine, polyethyleneimine, modified polyethyleneimine, and combinations thereof to raise pH of the polishing composition; and the pH adjusting agent is used in an amount ranging from 0.001 wt.% to 3.0 wt.%.

9.7. The barrier chemical mechanical planarization polishing composition of Claim 1, wherein the oxidizing agent is selected from the group consisting of hydrogen peroxide, periodic acid, potassium iodate, potassium permanganate, ammonium persulfate, ammonium molybdate, ferric nitrate, nitric acid, potassium nitrate, ammonia, amine compounds, and combinations thereof; and the oxidizing agent is used in an amount ranging from 0.2 wt.% to 2.0 wt.%.

10.8. The barrier chemical mechanical planarization polishing composition of Claim 1, wherein the chelator is selected from the group consisting of potassium citrate, benzosulfonic acid, 4-tolyl sulfonic acid, 2,4-diamino-benzosulfonic acid, 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 salts thereof, and combinations thereof; and the chelator is used in an amount ranging from 0.05 wt.% to 5.0 wt.%.

11.9. The barrier chemical mechanical planarization polishing composition of Claim 1, wherein the barrier chemical mechanical planarization polishing composition comprising comprises ≥ 2.0 wt.% colloidal silica; benzotriazole; the planarization agent comprising chemical selected from the group consisting of secondary alcohol ethoxylate, and polyethylene oxide, and combinations thereof; wherein the barrier chemical mechanical planarization polishing composition has a pH of 8 to 12.

~~12.~~10. The barrier chemical mechanical planarization polishing composition of Claim 1, wherein the barrier chemical mechanical planarization polishing composition ~~comprising~~ comprises ≥ 2.0 wt.% colloidal silica; benzotriazole; ~~the planarization agent comprising chemical selected from the group consisting of secondary alcohol ethoxylate,~~ polyethylene oxide~~, and combinations thereof~~; potassium silicate; and nitric acid or potassium hydroxide; wherein the barrier chemical mechanical planarization polishing composition has a pH of 8 to 12.

~~13.~~11. The barrier chemical mechanical planarization polishing composition of Claim 1, wherein the barrier chemical mechanical planarization polishing composition ~~comprising~~ comprises ≥ 2.0 wt.% colloidal silica; ~~the planarization agent comprising chemical selected from the group consisting of secondary alcohol ethoxylate,~~ polyethylene oxide~~, and combinations thereof; a wetting agent selected from the group consisting of an acetylenic diol surfactant, an alcohol ethoxylate surfactant, and combinations thereof,~~ and nitric acid or ~~-~~potassium hydroxide; ~~-~~wherein the barrier chemical mechanical planarization polishing composition has a pH of 8 to 12.

~~14.~~12. A polishing method for chemical mechanical planarization of a semiconductor device comprising at least one surface having at least ~~-~~a barrier layer and a dielectric layer; the method comprising the steps of:

a. delivering to the at least one surface the polishing composition in any one of Claim 1 to ~~13~~11;

b. polishing the at least one surface with the polishing composition by using a polishing pad;

wherein the barrier layer comprises tantalum or titanium containing films selected from the group consisting of tantalum, tantalum nitride, tantalum tungsten silicon carbide, titanium, titanium nitride, ~~-~~titanium-tungsten, titanium tungsten nitride, and combinations thereof; and the dielectric layer selected from the group consisting of oxide film, low-K material, and combinations thereof.

~~15.~~13. A system for chemical mechanical planarization, comprising:

a semiconductor device comprising at least one surface having at least ~~-~~a barrier layer and a dielectric layer;

a polishing pad; and

a polishing composition in any one of Claims 1 to ~~13~~11;

wherein the barrier layer comprises tantalum or titanium containing films selected from the group consisting of tantalum, tantalum nitride, tantalum tungsten silicon carbide, titanium, titanium nitride, ~~-~~titanium-tungsten, titanium tungsten nitride, and combinations thereof; and the dielectric layer selected from the group consisting of oxide film, low-K material, and combinations thereof; and

the at least one surface is in contact with the polishing pad and the polishing composition.