

CLAIMS

1. A polishing composition comprising:
- 0.01 wt % to 20 wt% of an abrasive selected from the group consisting of high purity colloidal silica particles, alumina, ceria, germania, silica, titania, zirconia, alumina dopes colloidal silica in lattices, and mixtures thereof;
- 0.01 % to 10 wt % of a water soluble aluminium compound selected from the group consisting of sodium aluminate, potassium aluminate, aluminium acetate, aluminium chloride, aluminium hydroxide, and combinations thereof;
- at least one of:
- 0.0001 wt % to 5 wt % of a pH adjusting agent;
- 0.0001 wt% to 10 wt % of a surfactant selected from the group consisting of a). non-ionic surface wetting agents; b). anionic surface wetting agents; c). cationic surface wetting agents; d). ampholytic surface wetting agents; and mixtures thereof;
- 0.0005wt % to 0.5wt % of a corrosion inhibitor;
- 0.01 wt % to 10 wt % of an oxidizing agent selected from the group consisting of peroxy-compound comprising at least one peroxy group (O-O), oxidized halide, perboric acid, perborate, percarbonate, peroxyacid, permanganate, chromate, cerium compound, ferricyanide, and mixtures thereof; and
- 0.1 wt % to 5 wt % of an organic acid;
- and
- water;
- wherein the polishing composition has a pH above 7.
2. The polishing composition of Claim 1, wherein
- the corrosion inhibitor is a chemical additive containing nitrogen atoms in the molecules selected from the group consisting of benzotriazole (BTA) and its derivatives, triazole and its derivatives; imidazole and its derivatives, pyrazole and its derivatives, benzimidazole and its derivatives, and combinations thereof;
- the pH-adjusting agent is selected from the group consisting of hydrochloric acid, nitric acid, sulfuric acid, chloroacetic acid, tartaric acid, succinic acid, citric acid, malic acid, malonic acid, sulfonic acid, phosphoric acid, fatty acid, polycarboxylic acid, hydrogen chloride, and mixtures thereof; or is selected from the group consisting of potassium hydroxide, sodium hydroxide, ammonia, quaternary

organic ammonium hydroxide, ethylenediamine, piperazine, polyethyleneimine, modified polyethyleneimine, and mixtures thereof;

and

the organic acid is selected from the group consisting of aromatic organic acid, amino acid or salt thereof, and combinations thereof.

3. The polishing composition of Claim 1, wherein
- the non-ionic surface wetting agent is selected from the group consisting of ethoxylated alcohol, ethoxylated acetylenic diol surfactant, polyethylene glycol alkyl ether, propylene glycol alkyl ether, glucoside alkyl ether, polyethylene glycol octylphenyl ether, polyethylene glycol alkylphenyl ether, glycerol alkyl ester, polyoxyethylene glycol sorbiton alkyl ester, sorbiton alkyl ester, cocamide monoethanol amine, cocamide diethanol amine, dodecyl dimethylamine oxide, block copolymers of polyethylene glycol and polypropylene glycol, polyethoxylated tallow amines, fluorosurfactant, and combinations thereof;
- the anionic surface wetting agent is selected from the group consisting of alkyl carboxylate, alkyl polyacrylic salt, alkyl sulfate, alkyl phosphate, alkyl bicarboxylate, alkyl bisulfate, alkyl biphosphate, alkoxy carboxylate, alkoxy sulfate, alkoxy phosphate, alkoxy bicarboxylate, alkoxy bisulfate, alkoxy biphosphate, substituted aryl carboxylate, substituted aryl sulfate, substituted aryl phosphate, substituted aryl bicarboxylate, substituted aryl bisulfate, substituted aryl biphosphate, and combinations thereof;
- the cationic surface wetting agent is a halide of molecules comprising hydrophobic chain and cationic charge center selected from the group consisting of amine, quaternary ammonium, benzyalkonium and alkylpyridinium ion;
- and
- the ampholytic surface wetting agent possess both positive (cationic) and negative (anionic) charges on the main molecular chains and with their relative counter ions.
4. The polishing composition of Claim 1 comprises high purity colloidal silica particles; water soluble aluminium compound selected from the group consisting of sodium aluminate, potassium aluminate, aluminium acetate, aluminium

hydroxide, and combinations thereof; and the polishing composition has a pH of 8 to 12.

- 5 5. The polishing composition of Claim 4 further comprising corrosion inhibitor selected from the group consisting of benzotriazole (BTA) and its derivatives, triazole and its derivatives, and combinations thereof; potassium hydroxide; benzenesulfonic acid; optionally a peroxy-compound comprising at least one peroxy group; and the polishing composition has a pH of 10 to 12.
- 10 6. A polishing method for chemical mechanical planarization of a semiconductor device comprising at least one surface having a first material and a second material, comprising the steps of:
- a) contacting the at least one surface with a polishing pad;
- b) delivering a polishing composition to the at least one surface, the polishing
15 composition comprising:
- 0.01 wt % to 20 wt% of an abrasive selected from the group consisting of high purity colloidal silica particles, alumina, ceria, germania, silica, titania, zirconia, alumina dopes colloidal silica in lattices, and mixtures thereof;
- 0.01 % to 10 wt % of a water soluble aluminium compound selected from the
20 group consisting of sodium aluminate, potassium aluminate, aluminium acetate, aluminium chloride, aluminium hydroxide, and combinations thereof;
- at least one of:
- 0.0001 wt % to 5 wt % of a pH adjusting agent;
- 0.0001 wt% to 10 wt % of a surfactant selected from the group consisting of a).
25 non-ionic surface wetting agents; b). anionic surface wetting agents; c). cationic surface wetting agents; d). ampholytic surface wetting agents; and mixtures thereof;
- 0.0005wt % to 0.5wt % of a corrosion inhibitor;
- 0.01 wt % to 10 wt % of an oxidizing agent selected from the group consisting of
30 peroxy-compound comprising at least one peroxy group (O–O), oxidized halide, perboric acid, perborate, percarbonate, peroxyacid, permanganate, chromate, cerium compound, ferricyanide, and mixtures thereof; and
- 0.1 wt % to 5 wt % of an organic acid;
- and

water;

wherein the polishing composition has a pH above 7;

- c) polishing the at least one surface with the polishing composition to remove the first material and to stop-on the second material;

5 wherein

the first material is selected from the group consisting of a metal, a barrier or liner material, a dielectric material, and combinations thereof; and the second material comprises at least one silicon containing material.

10 7. The method of Claim 6, wherein

the corrosion inhibitor in the polishing composition is a chemical additive containing nitrogen atoms in the molecules selected from the group consisting of benzotriazole (BTA) and its derivatives, triazole and its relative derivatives; imidazole and its derivatives, pyrazole and its derivatives, benzimidazole and its derivatives, and combinations thereof;

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the pH-adjusting agent is selected from the group consisting of hydrochloric acid, nitric acid, sulfuric acid, chloroacetic acid, tartaric acid, succinic acid, citric acid, malic acid, malonic acid, sulfonic acid, phosphoric acid, fatty acid, polycarboxylic acid, hydrogen chloride, and mixtures thereof; or is selected from the group consisting of potassium hydroxide, sodium hydroxide, ammonia, quaternary organic ammonium hydroxide, ethylenediamine, piperazine, polyethyleneimine, modified polyethyleneimine, and mixtures thereof;

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and

the organic acid is selected from the group consisting of aromatic organic acid, amino acid or salt thereof, and combinations thereof.

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8. The method of Claim 6, wherein

the non-ionic surface wetting agent is selected from the group consisting of ethoxylated alcohol, ethoxylated acetylenic diol surfactant, polyethylene glycol alkyl ether, propylene glycol alkyl ether, glucoside alkyl ether, polyethylene glycol octylphenyl ether, polyethylene glycol alkylphenyl ether, glycerol alkyl ester, polyoxyethylene glycol sorbiton alkyl ester, sorbiton alkyl ester, cocamide monoethanol amine, cocamide diethanol amine, dodecyl dimethylamine oxide,

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- block copolymers of polyethylene glycol and polypropylene glycol,
polyethoxylated tallow amines, fluorosurfactant, and combinations thereof;
the anionic surface wetting agent is selected from the group consisting of alkyl
carboxylate, alkyl polyacrylic salt, alkyl sulfate, alkyl phosphate, alkyl
5 bicarboxylate, alkyl bisulfate, alkyl biphosphate, alkoxy carboxylate, alkoxy
sulfate, alkoxy phosphate, alkoxy bicarboxylate, alkoxy bisulfate, alkoxy
biphosphate, substituted aryl carboxylate, substituted aryl sulfate, substituted aryl
phosphate, substituted aryl bicarboxylate, substituted aryl bisulfate, substituted
aryl biphosphate, and combinations thereof;
- 10 the cationic surface wetting agent is a halide of molecules comprising
hydrophobic chain and cationic charge center selected from the group consisting
of amine, quaternary ammonium, benzyalkonium and alkylpyridinium ion;
and
the ampholytic surface wetting agent possess both positive (cationic) and
15 negative (anionic) charges on the main molecular chains and with their relative
counter ions.
9. The method of Claim 6, wherein
the polishing composition comprises high purity colloidal silica particles; water
20 soluble aluminium compound selected from the group consisting of sodium
aluminate, potassium aluminate, aluminium acetate, aluminium chloride,
aluminium hydroxide, and combinations thereof; and the polishing composition
has a pH of 8 to 12; and the first material is selected from the group consisting of
metal film selected from the group consisting of Cu, W, Co, Al and combinations
25 thereof; barrier or liner film selected from the group consisting of Ta, TaN, Ti, TiN,
Ru and combinations thereof; low-k material dielectric film; and combinations
thereof; and the at least one silicon containing material is selected from the group
consisting of silicon nitride, silicon oxide, silicon carbide, and combinations
thereof.
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10. The method of Claim 9, wherein the polishing composition further comprising
corrosion inhibitor selected from the group consisting of benzotriazole (BTA) and
its derivatives, triazole and its derivatives, and combinations thereof; potassium

hydroxide; benzenesulfonic acid; optionally a peroxy-compound comprising at least one peroxy group; and the polishing composition has a pH of 10 to 12.

11. A system for chemical mechanical planarization, comprising:

- 5 a patterned substrate comprising at least one surface having a first material selected from the group consisting of a metal, a barrier or liner material, a dielectric material and combinations thereof; and a second material comprising at least one silicon containing material;
- a polishing pad; and
- 10 a polishing composition to the at least one surface, the polishing composition comprising:
- 0.01 wt % to 20 wt% of an abrasive selected from the group consisting of high purity colloidal silica particles, alumina, ceria, germania, silica, titania, zirconia, alumina dopes colloidal silica in lattices, and mixtures thereof;
- 15 0.01 % to 10 wt % of a water soluble aluminium compound selected from the group consisting of sodium aluminate, potassium aluminate, aluminium acetate, aluminium chloride, aluminium hydroxide, and combinations thereof;
- at least one of:
- 0.0001 wt % to 5 wt % of a pH adjusting agent;
- 20 0.0001 wt% to 10 wt % of a surfactant selected from the group consisting of a). non-ionic surface wetting agents; b). anionic surface wetting agents; c). cationic surface wetting agents; d). ampholytic surface wetting agents; and mixtures thereof;
- 0.0005wt % to 0.5wt % of a corrosion inhibitor;
- 25 0.01 wt % to 10 wt % of an oxidizing agent selected from the group consisting of peroxy-compound comprising at least one peroxy group (O–O), oxidized halide, perboric acid, perborate, percarbonate, peroxyacid, permanganate, chromate, cerium compound, ferricyanide, and mixtures thereof; and
- 0.1 wt % to 5 wt % of an organic acid;
- 30 and
- water;
- wherein the polishing composition has a pH above 7;
- and

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

12. The system of Claim 11, wherein

5 the corrosion inhibitor in the polishing composition is a chemical additive containing nitrogen atoms in the molecules selected from the group consisting of benzotriazole (BTA) and its derivatives, triazole and its derivatives; imidazole and its derivatives, pyrazole and its derivatives, benzimidazole and its derivatives, and combinations thereof;

10 the pH-adjusting agent is selected from the group consisting of hydrochloric acid, nitric acid, sulfuric acid, chloroacetic acid, tartaric acid, succinic acid, citric acid, malic acid, malonic acid, sulfonic acid, phosphoric acid, fatty acid, polycarboxylic acid, hydrogen chloride, and mixtures thereof; or is selected from the group consisting of potassium hydroxide, sodium hydroxide, ammonia, quaternary organic ammonium hydroxide, ethylenediamine, piperazine, polyethyleneimine, modified polyethyleneimine, and mixtures thereof;

15 and

the organic acid is selected from the group consisting of aromatic organic acid, amino acid or salt thereof, and combinations thereof.

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13. The system of Claim 11, wherein

the non-ionic surface wetting agent is selected from the group consisting of ethoxylated alcohol, ethoxylated acetylenic diol surfactant, polyethylene glycol alkyl ether, propylene glycol alkyl ether, glucoside alkyl ether, polyethylene glycol octylphenyl ether, polyethylene glycol alkylphenyl ether, glycerol alkyl ester, polyoxyethylene glycol sorbiton alkyl ester, sorbiton alkyl ester, cocamide monoethanol amine, cocamide diethanol amine, dodecyl dimethylamine oxide, block copolymers of polyethylene glycol and polypropylene glycol, polyethoxylated tallow amines, fluorosurfactant, and combinations thereof;

25 the anionic surface wetting agent is selected from the group consisting of alkyl carboxylate, alkyl polyacrylic salt, alkyl sulfate, alkyl phosphate, alkyl bicarboxylate, alkyl bisulfate, alkyl biphosphate, alkoxy carboxylate, alkoxy sulfate, alkoxy phosphate, alkoxy bicarboxylate, alkoxy bisulfate, alkoxy biphosphate, substituted aryl carboxylate, substituted aryl sulfate, substituted aryl

phosphate, substituted aryl bicarboxylate, substituted aryl bisulfate, substituted aryl biphosphate, and combinations thereof;
the cationic surface wetting agent is a halide of molecules comprising hydrophobic chain and cationic charge center selected from the group consisting of amine, quaternary ammonium, benzyalkonium and alkylpyridinium ion;
and
the ampholytic surface wetting agent possess both positive (cationic) and negative (anionic) charges on the main molecular chains and with their relative counter ions.

14. The system of Claim 11, wherein

the polishing composition comprises high purity colloidal silica particles; water soluble aluminium compound selected from the group consisting of sodium aluminate, potassium aluminate, aluminium acetate, aluminium chloride, aluminium hydroxide, and combinations thereof; and the polishing composition has a pH of 8 to 12;

the metal film is selected from the group consisting of Cu, W, Co, Al and combinations thereof; the barrier or liner film is selected from the group consisting of Ta, TaN, Ti, TiN, Ru and combinations thereof; and the dielectric film is a low-k material; and

the at least one silicon containing material is selected from the group consisting of silicon nitride, silicon oxide, silicon carbide, and combinations thereof.

15. The system of Claim 14, wherein

the polishing composition further comprises corrosion inhibitor selected from the group consisting of benzotriazole (BTA) and its derivatives, triazole and its derivatives, and combinations thereof; potassium hydroxide; benzenesulfonic acid; optionally a peroxy-compound comprising at least one peroxy group; and the polishing composition has a pH of 10 to 12.