CLAIMS

1. A polishing composition comprising:

0.01 wt % to 20 wt% of abrasive selected from the group consisting of composite particles comprising core particles with surfaces covered by nanoparticles; abrasive particles selected from the group consisting of silica, alumina, zirconia, titania, ceria, surface modified inorganic oxide particles, and combinations thereof; and combinations thereof;

0.0001 wt % to 5 wt % of a pH-adjusting agent;

0.0005wt % to 0.5wt % of a corrosion inhibitor; and

remaining being water;

wherein

the core particles are selected from the group consisting of silica, alumina, titania, zirconia, polymer particle, and combinations thereof; and the nanoparticles are selected from the group consisting of zirconium, titanium, iron, manganese, zinc, cerium, yttrium, calcium, magnesium, lanthanum, strontium nanoparticle, oxide forms thereof, and combinations thereof;

and

the polishing composition has a pH of from about 2 to 11.

2. The polishing composition of Claim 1 further comprises at least one of

(1)0.0010wt % to about 1.0wt % of dispersing additive selected from the group consisting of organic acid or its salt; polymeric acid or its salt; water soluble copolymer or its salt; copolymer or its salt containing at least two acid groups selected from the group consisting of carboxylic acid group, sulfonic acid group, and phosphonic acid group in the same molecule of a copolymer; polyvinyl acid or its salt, polyethylene oxide; polypropylene oxide; and combinations thereof;

(2)0.001 wt% to 5 wt% of an oxidizer selected from the group consisting of hydrogen peroxide, periodic acid, periodate salt, perbromic acid, perbromate salt, perchloric acid, perchloric salt, perboric acid, and perborate salt, permanganate, bromate, chlorate, chromate, iodate, iodic acid, and combinations thereof;

(3) 0.001 wt % to 5 wt % of a chelating agent selected from the group consisting of organic acid or its salt; polymeric acid or its salt; water soluble copolymer or its salt; copolymer or its salt containing at least two acid groups selected from the

group consisting of carboxylic acid group, sulfonic acid group, phosphoric acid, and pyridine acid in the same molecule of a copolymer; polyvinyl acid or its salt; inorganic potassium silicate; ammonium silicate; polyethylene oxide; polypropylene oxide; pyridine or its derivative; bipyridine or its derivative; bipyridine or its derivative; and combinations thereof; and

(4)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 combinations thereof.

3. The polishing composition of Claim 1, wherein

the core particles are silica particles; the nanoparticles are ceria nanoparticles; and the composite particles are amorphous silica particles having surfaces covered by single crystalline ceria nanoparticles;

the abrasive particles are silica particles;

the pH-adjusting agent is selected from the group consisting of sodium hydroxide, potassium hydroxide, ammonium hydroxide, quaternary organic ammonium hydroxide, nitric acid, sulfonic acid, phosphoric acid, hydrogen chloride and combinations thereof; and

the corrosion inhibitor is selected from the group consisting of benzotriazole (BTA), imidazole, triazole, pyrazole, benzoimidazole, tetrazole, their relative derivatives, and combinations thereof.

4. The polishing composition of Claim 1 comprises ceria coated silica composite particles; a corrosion inhibitor selected from the group consisting of benzotriazole, imidazole, triazole and combinations thereof; ammonium hydroxide or potassium hydroxide.

5. The polishing composition of Claim 4 further comprises at least one of (1)a dispersing additive selected from the group consisting of a polymeric acid or its salt, and combinations thereof; wherein the polymeric acid is selected from the group consisting of polyacrylic acid, poly-methacrylic acid, polystyrene sulfonic acid or its salt, and combinations thereof; (2) potassium silicate or ammonium silicate; (3)a surfactant selected from the group consisting of acetylenic diol

surfactant, alcohol ethoxylate surfactant, and combination thereof; and (4) silica abrasive particles.

6. The polishing composition of Claim 1 comprises ceria coated silica composite particles; a corrosion inhibitor selected from the group consisting of benzotriazole, imidazole, triazole and combinations thereof; ammonium hydroxide or potassium hydroxide; and further comprises silica abrasive particles; potassium silicate or ammonium silicate; and a surfactant selected from the group consisting of acetylenic diol surfactant, alcohol ethoxylate surfactant and combination thereof.

7. The polishing composition of Claim 1 comprises ceria coated silica composite particles; a corrosion inhibitor selected from the group consisting of benzotriazole, imidazole, triazole and combinations thereof; ammonium hydroxide or potassium hydroxide; and further comprises silica abrasive particles; hydrogen peroxide; potassium silicate or ammonium silicate; and a surfactant selected from the group consisting of acetylenic diol surfactant, alcohol ethoxylate surfactant and combination thereof.

8. A polishing method for chemical mechanical planarization of a semiconductor device comprising at least one surface having a first material selected from the group consisting of metallic or alloy form of Co, Cu, Al, and combinations, 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 composition comprising:
      0.01 wt % to 20 wt% of abrasive selected from the group consisting of composite particles comprising core particles with surfaces covered by nanoparticles; abrasive particles selected from the group consisting of silica, alumina, zirconia, titania, ceria, surface modified inorganic oxide particles, and combinations thereof; and combinations thereof;
      0.0001 wt % to 5 wt % of a pH-adjusting agent;
      0.0005wt % to 0.5wt % of a corrosion inhibitor; and
      remaining being water;
      wherein

the core particles are selected from the group consisting of silica, alumina, titania, zirconia, polymer particle, and combinations thereof; and the nanoparticles are selected from the group consisting of zirconium, titanium, iron, manganese, zinc, cerium, yttrium, calcium, magnesium, lanthanum, strontium nanoparticle, oxide forms thereof, and combinations thereof; and the polishing composition has a pH of from about 2 to 11;

and

C) polishing the at least one surface with the polishing composition.

9. The polishing method of Claim 8, wherein polishing composition further comprises at least one of

(1)0.0010wt % to about 1.0wt % of dispersing additive selected from the group consisting of organic acid or its salt; polymeric acid or its salt; water soluble copolymer or its salt; copolymer or its salt containing at least two acid groups selected from the group consisting of carboxylic acid group, sulfonic acid group, and phosphonic acid group in the same molecule of a copolymer; polyvinyl acid or its salt, polyethylene oxide; polypropylene oxide; and combinations thereof;

(2)0.001 wt% to 5 wt% of an oxidizer selected from the group consisting of hydrogen peroxide, periodic acid, periodate salt, perbromic acid, perbromate salt, perchloric acid, perchloric salt, perboric acid, and perborate salt, permanganate, bromate, chlorate, chromate, iodate, iodic acid, and combinations thereof;

(3) 0.001 wt % to 5 wt % of a chelating agent selected from the group consisting of organic acid or its salt; polymeric acid or its salt; water soluble copolymer or its salt; copolymer or its salt containing at least two acid groups selected from the group consisting of carboxylic acid group, sulfonic acid group, phosphoric acid, and pyridine acid in the same molecule of a copolymer; polyvinyl acid or its salt; inorganic potassium silicate; ammonium silicate; polyethylene oxide; polypropylene oxide; pyridine or its derivative; bipyridine or its derivative; bipyridine or its derivative; and combinations thereof; and

(4)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 combinations thereof.

10. The polishing method of Claim 8, wherein
the core particles are silica particles; the nanoparticles are ceria nanoparticles; and the composite particles are amorphous silica particles having surfaces covered by single crystalline ceria nanoparticles;
the abrasive particles are silica particles;
the pH-adjusting agent is selected from the group consisting of sodium hydroxide, potassium hydroxide, ammonium hydroxide, quaternary organic ammonium hydroxide, nitric acid, sulfonic acid, phosphoric acid, hydrogen chloride and combinations thereof; and
the corrosion inhibitor is selected from the group consisting of benzotriazole (BTA), imidazole, triazole, pyrazole, benzoimidazole, tetrazole, their relative derivatives, and combinations thereof.

11. The polishing method of Claim 8, wherein the polishing composition comprises ceria coated silica composite particles; a corrosion inhibitor selected from the group consisting of benzotriazole, imidazole, triazole and combinations thereof; ammonium hydroxide or potassium hydroxide.

12. The polishing method of Claim 11, wherein the polishing composition further comprises at least one of (1)a dispersing additive selected from the group consisting of a polymeric acid or its salt, and combinations thereof; wherein the polymeric acid is selected from the group consisting of polyacrylic acid, poly-methacrylic acid, polystyrene sulfonic acid or its salt, and combinations thereof; (2) potassium silicate or ammonium silicate; and (3)a surfactant selected from the group consisting of acetylenic diol surfactant, alcohol ethoxylate surfactant, and combination thereof.

13. The polishing method of Claim 8, wherein the polishing composition comprises ceria coated silica composite particles; a corrosion inhibitor selected from the group consisting of benzotriazole, imidazole, triazole and combinations thereof; ammonium hydroxide or potassium hydroxide; and further comprises at least one of silica abrasive particles; potassium silicate or ammonium silicate; and a surfactant selected from the group consisting of acetylenic diol surfactant, alcohol ethoxylate surfactant and combination thereof.

14. The polishing method of Claim 8, wherein the polishing composition comprises ceria coated silica composite particles; a corrosion inhibitor selected from the group consisting of benzotriazole, imidazole, triazole and combinations thereof; ammonium hydroxide or potassium hydroxide; and further comprises silica abrasive particles; hydrogen peroxide; potassium silicate or ammonium silicate; and a surfactant selected from the group consisting of acetylenic diol surfactant, alcohol ethoxylate surfactant and combination thereof.

15. The polishing method of Claim 8, wherein
the core particles are silica particles; the nanoparticles are ceria nanoparticles; and the composite particles are amorphous silica ceria particles having surfaces covered by single crystalline ceria nanoparticles;
the abrasive particles are silica particles;
the polishing pad is a soft pad;
the first material is Co;
the second material is selected from the group consisting of Co, SiN, SiO_2, W and combinations thereof;
the polishing composition has a pH of 8.0-11;
the polishing composition has removal rate selectivity of 1.0:4.0 to 4.0:1.0 for SiO_2:Co; and 1.0:1.0 to 6.0:1.0 for Co:SiN; and
wherein the polishing composition has stop on polishing W.

16. The polishing method of Claim 8, wherein
the core particles are silica particles; the nanoparticles are ceria nanoparticles; and the composite particles are amorphous silica ceria particles having surfaces covered by single crystalline ceria nanoparticles;
the abrasive particles are silica particles;
the polishing pad is a soft pad;
the at least one other material is selected from the group consisting of Co, SiN, SiO_2, and combinations thereof;
the polishing composition has a pH of 5.0-8.0; and
the polishing composition has removal rate selectivity of 1.0:4.0 to 4.0:1.0 for SiO_2:Co; and 10:1 to 15:1.0 for Co:SiN.

17. The polishing method of Claim 8, wherein

iron, manganese, zinc, cerium, yttrium, calcium, magnesium, lanthanum, strontium nanoparticle, oxide forms thereof, and combinations thereof; and the polishing composition has a pH of from about 2 to 11;

and

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

19. The system of Claim 18, wherein the polishing composition further comprises at least one of

(1)0.0010wt % to about 1.0wt % of dispersing additive selected from the group consisting of organic acid or its salt; polymeric acid or its salt; water soluble copolymer or its salt; copolymer or its salt containing at least two acid groups selected from the group consisting of carboxylic acid group, sulfonic acid group, and phosphonic acid group in the same molecule of a copolymer; polyvinyl acid or its salt, polyethylene oxide; polypropylene oxide; and combinations thereof;

(2)0.001 wt% to 5 wt% of an oxidizer selected from the group consisting of hydrogen peroxide, periodic acid, periodate salt, perbromic acid, perbromate salt, perchloric acid, perchloric salt, perboric acid, and perborate salt, permanganate, bromate, chlorate, chromate, iodate, iodic acid, and combinations thereof;

(3) 0.001 wt % to 5 wt % of a chelating agent selected from the group consisting of organic acid or its salt; polymeric acid or its salt; water soluble copolymer or its salt; copolymer or its salt containing at least two acid groups selected from the group consisting of carboxylic acid group, sulfonic acid group, phosphoric acid, and pyridine acid in the same molecule of a copolymer; polyvinyl acid or its salt; inorganic potassium silicate; ammonium silicate; polyethylene oxide; polypropylene oxide; pyridine or its derivative; bipyridine or its derivative; bipyridine or its derivative; and combinations thereof; and

(4)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 combinations thereof.

20. The system of Claim 18, wherein

the core particles are silica particles; the nanoparticles are ceria nanoparticles; and the composite particles are amorphous silica particles having surfaces covered by single crystalline ceria nanoparticles;
the abrasive particles are silica particles;
the polishing pad is a soft pad;
the pH-adjusting agent is selected from the group consisting of sodium hydroxide, potassium hydroxide, ammonium hydroxide, quaternary organic ammonium hydroxide, nitric acid, sulfonic acid, phosphoric acid, hydrogen chloride and combinations thereof; and
the corrosion inhibitor is selected from the group consisting of benzotriazole (BTA), imidazole, triazole, pyrazole, benzoimidazole, tetrazole, their relative derivatives, and combinations thereof.

21. The system of Claim 18, wherein the polishing composition comprises ceria coated silica composite particles; a corrosion inhibitor selected from the group consisting of benzotriazole, imidazole, triazole and combinations thereof; ammonium hydroxide or potassium hydroxide.

22. The system of Claim 21, wherein the polishing composition further comprises at least one of (1)a dispersing additive selected from the group consisting of a polymeric acid or its salt, and combinations thereof; wherein the polymeric acid is selected from the group consisting of polyacrylic acid, poly-methacrylic acid, polystyrene sulfonic acid or its salt, and combinations thereof; (2) potassium silicate or ammonium silicate; (3) potassium silicate or ammonium silicate; and (4) a surfactant selected from the group consisting of acetylenic diol surfactant, alcohol ethoxylate surfactant, and combination thereof.

23. The system of Claim 18, wherein the polishing composition comprises ceria coated silica composite particles; a corrosion inhibitor selected from the group consisting of benzotriazole, imidazole, triazole and combinations thereof; ammonium hydroxide or potassium hydroxide; and further comprises at least one selected from the group consisting of silica abrasive particles; potassium silicate or ammonium silicate; and a surfactant selected from the group consisting of acetylenic diol surfactant, alcohol ethoxylate surfactant and combination thereof.

24. The system of Claim 18, wherein the polishing composition comprises ceria coated silica composite particles; a corrosion inhibitor selected from the group consisting of benzotriazole, imidazole, triazole and combinations thereof; ammonium hydroxide or potassium hydroxide; and further comprises silica abrasive particles; hydrogen peroxide; potassium silicate or ammonium silicate; and a surfactant selected from the group consisting of acetylenic diol surfactant, alcohol ethoxylate surfactant and combination thereof.