CLAIMS

1. A polishing composition comprising:
composite particles comprising core particles with surfaces covered by nanoparticles;
an additive selected from a compound having a functional group selected from the group consisting of organic carboxylic acids, amino acids, amidocarboxylic acids, N-acylamino acids, and their salts thereof; organic sulfonic acids and salts thereof; organic phosphonic acids and salts thereof; polymeric carboxylic acids and salts thereof; polymeric sulfonic acids and salts thereof; polymeric phosphonic acids and salts thereof; arylamines, aminoalcohols, aliphatic amines, heterocyclic amines, hydroxamic acids, substituted phenols, sulfonamides, thiols, polyols having hydroxyl groups, and combinations thereof;
a pH-adjusting agent selected from the group consisting of sodium hydroxide, potassium hydroxide, cesium hydroxide, ammonium hydroxide, quaternary organic ammonium hydroxide, and combinations thereof;
and
the remaining being water;
wherein
the core particle is selected from the group consisting of silica, alumina, titania, zirconia, polymer particle, and combinations thereof; and the nanoparticle is selected from the compounds of a group consisting of zirconium, titanium, iron, manganese, zinc, cerium, yttrium, calcium, magnesium, fluorine, lanthanum, strontium nanoparticle, and combinations thereof;
change of size distribution of composite particles under ultrasonication treatment is less than 10%, the ultrasonication treatment comprises 30 mins immersion in bath with 42 KHz frequency at 100W output;
and
the polishing composition has a pH of about 2 to about 12.

2. The polishing composition of Claim 1 wherein the core particle is silica particle, the nanoparticle is ceria nanoparticle, and the composite particles are ceria coated silica composite particles.

3. The polishing composition of Claim 2 wherein the composite particles are amorphous silica particles having surfaces covered by singly crystalline ceria nanoparticles.

4. The polishing composition of Claim 1 has a pH ranging from 4 to 10; and the change of size distribution of composite particles under ultrasonication treatment is less than 5%.

5. The polishing composition of Claim 1 comprises ceria coated silica composite particles, the additive selected from the group consisting of polyacrylic acid (PAA) or salt, poly(methyl methacrylate) (PMMA), and combinations thereof; ammonium hydroxide; has a pH ranging from 4.5 to 7.5; and the change of size distribution of composite particles under ultrasonication treatment is less than 2%.

6. The polishing composition of Claim 1 further comprises
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;
and
a biological growth inhibitor selected from the group consisting of tetramethylammonium chloride, tetraethylammonium chloride, tetrapropylammonium chloride, alkylbenzyldimethylammonium chloride with the alkyl chain ranges from 1 to 20 carbon atoms, alkylbenzyldimethylammonium hydroxide with the alkyl chain ranges from 1 to 20 carbon atoms, sodium chlorite, sodium hypochlorite, and combinations thereof.

7. A polishing method for chemical mechanical planarization of a semiconductor substrate comprising at least one surface having at least one oxide layer, comprising the steps of:
   a) contacting the at least one oxide layer with a polishing pad;
   b) delivering a polishing composition to the at least one surface, the polishing composition comprising:
      composite particles comprising core particles with surfaces covered by nanoparticles;

an additive selected from a compound having a functional group selected from the group consisting of organic carboxylic acids, amino acids, amidocarboxylic acids, N-acylamino acids, and their salts thereof; organic sulfonic acids and salts thereof; organic phosphonic acids and salts thereof; polymeric carboxylic acids and salts thereof; polymeric sulfonic acids and salts thereof; polymeric phosphonic acids and salts thereof; arylamines, aminoalcohols, aliphatic amines, heterocyclic amines, hydroxamic acids, substituted phenols, sulfonamides, thiols, polyols having hydroxyl groups, and combinations thereof;

a pH-adjusting agent selected from the group consisting of sodium hydroxide, potassium hydroxide, cesium hydroxide, ammonium hydroxide, quaternary organic ammonium hydroxide, and combinations thereof; and

the remaining being water;

wherein

change of size distribution of composite particles under ultrasonication treatment is less than 10%, the ultrasonication treatment comprises 30 mins immersion in bath with 42 KHz frequency at 100W output;

the core particle is selected from the group consisting of silica, alumina, titania, zirconia, polymer particle, and combinations thereof; and the nanoparticle is selected from the compounds of a group consisting of zirconium, titanium, iron, manganese, zinc, cerium, yttrium, calcium, magnesium, fluorine, lanthanum, strontium nanoparticle, and combinations thereof; and

the polishing composition has a pH of about 2 to about 12;

and

c) polishing the at least one oxide layer with the polishing composition.

8. The method of Claim 7, wherein the nanoparticle is ceria nanoparticle, and the composite particles are amorphous silica particles having surfaces covered by singly crystalline ceria nanoparticles.

9. The method of Claim 7, wherein the polishing composition has a pH ranging from 4 to 10; and the change of size distribution of composite particles under ultrasonication treatment is less than 5%.

10. The method of Claim 7, wherein the polishing composition further comprises 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;
and
a biological growth inhibitor selected from the group consisting of tetramethylammonium chloride, tetraethylammonium chloride, tetrapropylammonium chloride, alkylbenzyldimethylammonium chloride with the alkyl chain ranges from 1 to 20 carbon atoms, alkylbenzyldimethylammonium hydroxide with the alkyl chain ranges from 1 to 20 carbon atoms, sodium chlorite, sodium hypochlorite, and combinations thereof.

11. The method of Claim 7, wherein the polishing composition comprises ceria coated silica composite particles, the additive selected from the group consisting of polyacrylic acid (PAA) or salt, poly(methyl methacrylate) (PMMA), and combinations thereof; ammonium hydroxide; has a pH ranging from 4.5 to 7.5; and the change of size distribution of composite particles under ultrasonication treatment is less than 2%.

12. The method of Claim 7, wherein the at least one oxide layer is a silicon oxide layer.

13. The method of Claim 7, wherein the polishing pad is a soft pad.

14. The method of Claim 13, wherein polishing removal rate for the at least one oxide layer is equal or greater than 500 Å/min.

15. A system for chemical mechanical planarization, comprising:
a semiconductor substrate comprising at least one surface having at least one oxide layer;

a polishing pad; and

a polishing composition comprising:

composite particles comprising core particles with surfaces covered by nanoparticles;

an additive selected from a compound having a functional group selected from the group consisting of organic carboxylic acids, amino acids, amidocarboxylic acids, N-acylamino acids, and their salts thereof; organic sulfonic acids and salts thereof; organic phosphonic acids and salts thereof; polymeric carboxylic acids and salts thereof; polymeric sulfonic acids and salts thereof; polymeric phosphonic acids and salts thereof; arylamines, aminoalcohols, aliphatic amines, heterocyclic amines, hydroxamic acids, substituted phenols, sulfonamides, thiols, polyols having hydroxyl groups, and combinations thereof;

a pH-adjusting agent selected from the group consisting of sodium hydroxide, potassium hydroxide, cesium hydroxide, ammonium hydroxide, quaternary organic ammonium hydroxide, and combinations thereof;

and

the remaining being water;

wherein

change of size distribution of composite particles under ultrasonication treatment is less than 10%, the ultrasonication treatment comprises 30 mins immersion in bath with 42 KHz frequency at 100W output;

the core particle is selected from the group consisting of silica, alumina, titania, zirconia, polymer particle, and combinations thereof; and the nanoparticle is selected from the compounds of a group consisting of zirconium, titanium, iron, manganese, zinc, cerium, yttrium, calcium, magnesium, fluorine, lanthanum, strontium nanoparticle, and combinations thereof; and

the polishing composition has a pH of about 2 to about 12;

and

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

16. The system of Claim 15, wherein the nanoparticle is ceria nanoparticle, and the composite particles are amorphous silica particles having surfaces covered by singly crystalline ceria nanoparticles.

17. The system of Claim 15, wherein the polishing composition has a pH ranging from 4 to 10; and the change of size distribution of composite particles under ultrasonication treatment is less than 5%.

18. The system of Claim 15, wherein the polishing composition further comprises 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;
and
a biological growth inhibitor selected from the group consisting of tetramethylammonium chloride, tetraethylammonium chloride, tetrapropylammonium chloride, alkylbenzyldimethylammonium chloride with the alkyl chain ranges from 1 to 20 carbon atoms, alkylbenzyldimethylammonium hydroxide with the alkyl chain ranges from 1 to 20 carbon atoms, sodium chlorite, sodium hypochlorite, and combinations thereof.

19. The system of Claim 15, wherein the polishing composition comprises ceria coated silica composite particles, the additive selected from the group consisting of polyacrylic acid (PAA) or salt, poly(methyl methacrylate) (PMMA), and combinations thereof; ammonium hydroxide; has a pH ranging from 4.5 to 7.5; and the change of size distribution of composite particles under ultrasonication treatment is less than 2%.

20. The system of Claim 15, wherein the at least one oxide layer is a silicon oxide layer.

21. The system of Claim 15, wherein the polishing pad is a soft pad.