Claims

1. A CMP polishing composition comprising:
silica particles;
a chemical additive containing phosphonic acid;
solvent;
optionally
biocide; and
pH adjuster;
wherein
the composition has a pH of 1 to 6, or 1.5 to 5;
the silica particles having silanol density <4 SiOH/nm^2; or specific surface area (SSA) of <300 m^2/gm or < 150 m^2/gm; and
the solvent is selected from the group consisting of deionized (DI) water, distilled water, and alcoholic organic solvents.

2. The CMP polishing composition of Claim 1, wherein the silica particles are non-spherical, or non-surface modified.

3. The CMP polishing composition of Claim 1, wherein the pH adjuster is selected from the group consisting of amino acid selected from the group consisting of L-glutamic acid, L-histidine, alanine, glycine, cysteine, cystine, aspartic acid, valine, and serine; inorganic acid selected from the group consisting of nitric acid, sulfuric acid, hydrochloric acid and phosphoric acid; inorganic bases selected from the group consisting of ammonium hydroxide, sodium hydroxide, potassium hydroxide, cesium hydroxide, tetramethylammonium hydroxide; tetrabutylammonium hydroxide, tetrabutylphosphonium hydroxide, piperazine, and ethylenediamine.

4. The CMP polishing composition of Claim 1, wherein the pH adjuster is selected from the group consisting of L-glutamic acid, L-histidine, alanine, serine, sulfuric acid, nitric acid, and ammonium hydroxide.

5. The CMP polishing composition of Claim 1, wherein the chemical additive contains two or more phosphonic acid.

6. The CMP polishing composition of Claim 1, wherein the chemical additive is selected from the group consisting of etidronic acid (1-hydroxyethane-1 1-diphosphonic acid), methylenediphosphonic acid, nitrilotris(methylene triphosphonic acid), phenylphosphonic acid, octylphosphonic acid, butylphosphonic acid, (aminomethyl)phosphonic acid, diisooctylphosphinic acid, iminodi(methylphosphonic acid), and 3-phosphonopropionic acid.

7. The CMP polishing composition of Claim 1, wherein the chemical additive is etidronic acid (1-hydroxyethane-1 1-diphosphonic acid).

8. The CMP polishing composition of Claim 1, wherein the composition further comprises from 0.0001 wt.% to 0.05 wt.%; preferably from 0.0005 wt.% to 0.025 wt.%, and more preferably from 0.001 wt.% to 0.01 wt.% of the biocide having active ingredients of 5-chloro-2-methyl-4-isothiazolin-3-one and 2-methyl- -isothiazolin-3-one.

9. The CMP polishing composition of Claim 1, the CMP composition comprises silica particles having silanol density < 0.5 SiOH/nm^2, or SSA <150 m^2/gm, etidronic acid, and L-glutamic acid.

10. The CMP polishing composition of Claim 1, the CMP composition comprises silica particles having silanol density < 0.5 SiOH/nm^2, or SSA <150 m^2/gm, etidronic acid, and L-glutamic acid; wherein the silica particles are non-spherical and are not surface modified; the pH of the CMP polishing composition is from 2 to 4.

11. The CMP polishing composition of Claim 1, the CMP composition comprises silica particles having silanol density < 0.05 SiOH/nm^2 or SSA <150 m^2/gm, etidronic acid, and L-glutamic acid; wherein the silica particles are non-spherical and are not surface modified; the pH of the CMP polishing composition is from 2 to 4.

12. The CMP polishing composition of Claim 1, the CMP composition comprises silica particles having silanol density < 0.01 SiOH/nm^2 or SSA <150 m^2/gm, etidronic acid, and L-glutamic acid; wherein the silica particles are non-spherical and are not surface modified; the pH of the CMP polishing composition is from 2 to 4.

13. A method of CMP polishing a semiconductor substrate having at least one surface comprising silicon oxide film, comprising
providing the semiconductor substrate;
providing a polishing pad;
providing the CMP polishing composition in any of claims 1 to 12;
contacting the surface of the semiconductor substrate with the polishing pad and the CMP polishing composition; and
polishing the least one surface comprising silicon dioxide.

14. The method of claim 13; wherein the silicon oxide film is selected from the group consisting of Chemical vapor deposition (CVD), Plasma Enhance CVD (PECVD), High Density Deposition CVD(HDP), or spin on silicon oxide film.

15. The method of claim 13; wherein the semiconductor substrate further comprises a surface containing silicon nitride, and removal selectivity of SiO_2: SiN is 0.8 to 1.5, or 0.95 to 1.05.

16. A system of CMP polishing a semiconductor substrate having at least one surface comprising silicon oxide film, comprising

a. the semiconductor substrate;

b. the CMP polishing composition in any one of Claims 1 to 12;

c. a polishing pad;

wherein the at least one surface comprising silicon oxide film is in contact with the polishing pad and the CMP polishing composition.

17. The system of claim 16; wherein the silicon oxide film is selected from the group consisting of Chemical vapor deposition (CVD), Plasma Enhance CVD (PECVD), High Density Deposition CVD(HDP), or spin on silicon oxide film.

18. The system of claim 16; wherein the semiconductor substrate further comprises a surface containing silicon nitride, and removal selectivity of SiO_2: SiN is 0.8 to 1.5, or 0.95 to 1.05.

19. The method of claim 13; wherein in the CMP polishing composition:
the silica particles are non-spherical, or non-surface modified;
the pH adjuster is selected from the group consisting of amino acid selected from the group consisting of L-glutamic acid, L-histidine, alanine, glycine, cysteine, cystine, aspartic acid, valine, and serine; inorganic acid selected from the group consisting of nitric acid, sulfuric acid, hydrochloric acid and phosphoric acid; inorganic bases selected from the group consisting of ammonium hydroxide, sodium hydroxide, potassium hydroxide, cesium hydroxide, and tetramethylammonium hydroxide; and
the chemical additive is selected from the group consisting of etidronic acid (1-hydroxyethane-1 1-diphosphonic acid), methylenediphosphonic acid, nitrilotris(methylene triphosphonic acid), phenylphosphonic acid, octylphosphonic acid, butylphosphonic acid, (aminomethyl)phosphonic acid, diisooctylphosphinic acid, iminodi(methylphosphonic acid), and 3-phosphonopropionic acid.

20. The system of claim 16; wherein in the CMP polishing composition:
the silica particles are non-spherical, or non-surface modified;
the pH adjuster is selected from the group consisting of amino acid selected from the group consisting of L-glutamic acid, L-histidine, alanine, glycine, cysteine, cystine, aspartic acid, valine, and serine; inorganic acid selected from the group consisting of nitric acid, sulfuric acid, hydrochloric acid and phosphoric acid; inorganic bases selected from the group consisting of ammonium hydroxide, sodium hydroxide, potassium hydroxide, cesium hydroxide, and tetramethylammonium hydroxide; and
the chemical additive is selected from the group consisting of etidronic acid (1-hydroxyethane-1 1-diphosphonic acid), methylenediphosphonic acid, nitrilotris(methylene triphosphonic acid), phenylphosphonic acid, octylphosphonic acid, butylphosphonic acid, (aminomethyl)phosphonic acid, diisooctylphosphinic acid, iminodi(methylphosphonic acid), and 3-phosphonopropionic acid.