CLAIMS

1. A chemical mechanical polishing composition comprising:

ceria-coated inorganic oxide particles;

oxide trench~~ing~~ dishing reducer selected from the group consisting of organic polymer acid, its ester derivative, its salt, and combinations thereof;

water based solvent; and

optionally

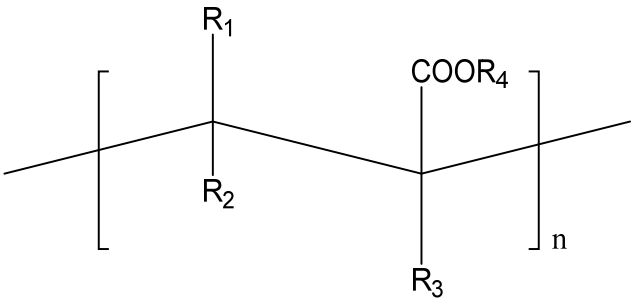
biocide; and

pH adjuster;

wherein

the composition has a pH of 3 to 10; and

the oxide trench dishing reducer has a general molecular structure as shown below:



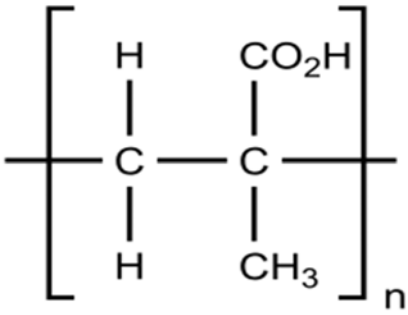
wherein R1 and R2 each independently is selected from the group consisting of hydrogen and an alkyl group C_mH_{2m+1} and m is from 1 to 4; R3 is an alkyl group C_mH_{2m+1} and m is from 1 to 4; R4 is selected from the group consisting of hydrogen, an alkyl group C_mH_{2m+1} and m is from 1 to 4, metal ion, and ammonium ion; and n is chosen to give a molecular weight from 1,000 to ~~1,000,000~~15,000.

2. The chemical mechanical polishing composition of Claim 1, wherein

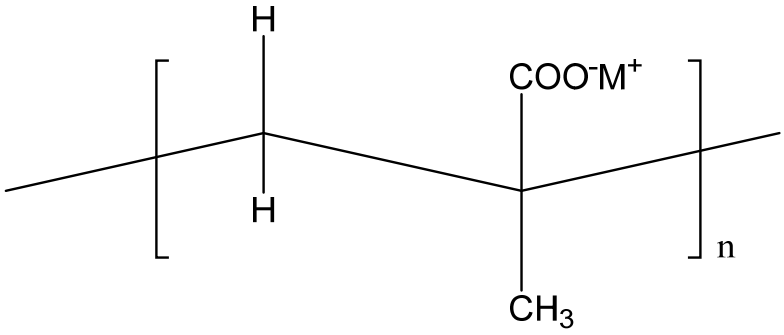
the ceria-coated inorganic oxide particles are selected from the group consisting of ceria-coated colloidal silica, ceria-coated high purity colloidal silica, ceria-coated alumina, ceria-coated titania, ceria-coated zirconia particles and combinations thereof;

the oxide trench dishing reducer has a general molecular structure selected from the group consisting of:

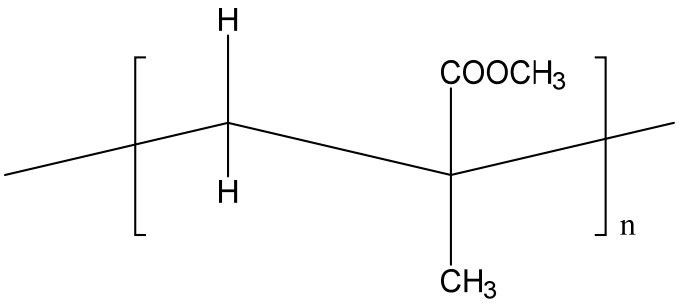
(a) poly(methacrylic acid) when R1, R2, and R4 are hydrogen, and R3 is methyl;



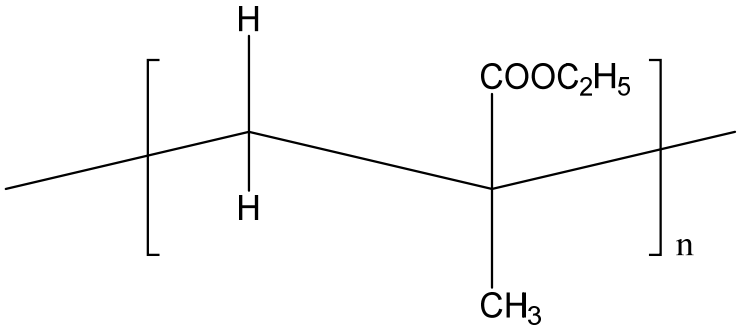
(b) salt of poly(methacrylic acid) when R1 and R2 are hydrogen, R3 is methyl, and R4 is a metal ion or ammonium M^+;



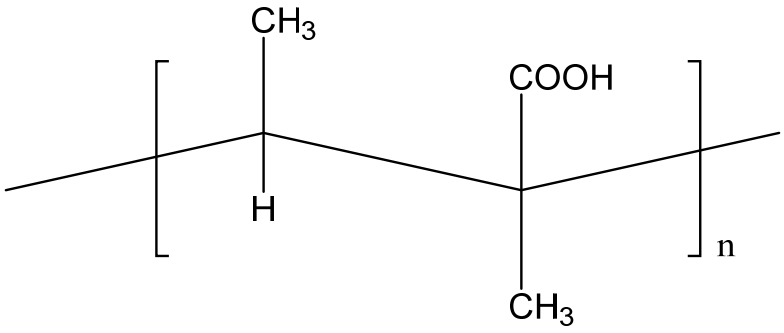
(c) poly (methyl methacrylate) (PMMA) when R1 and R2 are hydrogen, R3 and R4 are methyl;



(d) poly (ethyl methacrylate) (PEMA) when R1 and R2 are hydrogen, R3 is methyl, and R4 is ethyl;



(e) 2-methyl-poly (methacrylic acid) when R1 and R4 are hydrogen, R2 and R3 are methyl;



and combinations thereof; and

the water based solvent is selected from the group consisting of deionized (DI) water, distilled water, and alcoholic organic water based solvents.

3. The chemical mechanical polishing composition of Claim 1, wherein the chemical mechanical polishing composition further comprises at least one of
the biocide having an active ingredient selected from the group consisting of 5-chloro-2-methyl-4-isothiazolin-3-one, 2-methyl-4-isothiazolin-3-one, and combinations thereof; and
the pH adjustor selected from the group consisting of nitric acid, hydrochloric acid, sulfuric acid, phosphoric acid, and combinations thereof for acidic pH conditions; or is selected from the group consisting of sodium hydride, potassium hydroxide, ammonium hydroxide, tetraalkyl ammonium hydroxide, organic quaternary ammonium hydroxide compounds, organic amines, and combinations thereof for alkaline pH conditions.

4. The chemical mechanical polishing composition of Claim 1, wherein
the ceria-coated inorganic oxide particles are consisting of ceria-coated colloidal silica, ceria-coated high purity colloidal silica, and combinations thereof;
the oxide trench dishing reducer has a molecular weight of 1,200 to ~~100,000~~15,000 and is selected from the group consisting of poly (methacrylic acid), salt of poly(methacrylic acid), and combinations thereof;
the water based solvent is deionized (DI) water; and
the chemical mechanical polishing composition has a pH of 3.5 to 9.

5. The chemical mechanical polishing composition of claim 1, wherein the chemical mechanical polishing composition comprises
the ceria-coated inorganic oxide particles are selected from the group consisting of ceria-coated colloidal silica, ceria-coated high purity colloidal silica, and combinations thereof;
the oxide trench dishing reducer has a molecular weight of 1,500 to 15,000 and is selected from the group consisting of poly (methacrylic acid), salt of poly(methacrylic acid), and combinations thereof;
deionized (DI) water;

the biocide having an active ingredient selected from the group consisting of 5-chloro-2-methyl-4-isothiazolin-3-one, 2-methyl-4-isothiazolin-3-one, and combinations thereof;

nitric acid or ammonium hydroxide; and

the chemical mechanical polishing composition has a pH of 4 to 7.

6. The chemical mechanical polishing composition of claim 1 comprises ceria-coated colloidal silica; poly (methacrylic acids) having a molecular weight of 1,200 to ~~100,000~~15,000; deionized (DI) water; and the chemical mechanical polishing composition has a pH of 3.5 to 9.

7. The chemical mechanical polishing composition of claim 1, wherein the chemical mechanical polishing composition comprises

ceria-coated colloidal silica;

poly (methacrylic acids) having a molecular weight of 1,200 to ~~100,000~~15,000;

deionized (DI) water;

the biocide having an active ingredient selected from the group consisting of 5-chloro-2-methyl-4-isothiazolin-3-one, 2-methyl-4-isothiazolin-3-one, and combinations thereof;

nitric acid or ammonium hydroxide;

and the chemical mechanical polishing composition has a pH of 4 to 7.

8. A method of chemical mechanical polishing (CMP) a semiconductor substrate having at least one surface comprising a silicon oxide film, comprising

providing the semiconductor substrate;

providing a polishing pad;

providing the chemical mechanical polishing (CMP) composition comprising

ceria-coated inorganic oxide particles;

oxide trench~~ing~~ dishing reducer selected from the group consisting of organic polymer acid, its ester derivative, its salt, and combinations thereof;

water based solvent; and

optionally

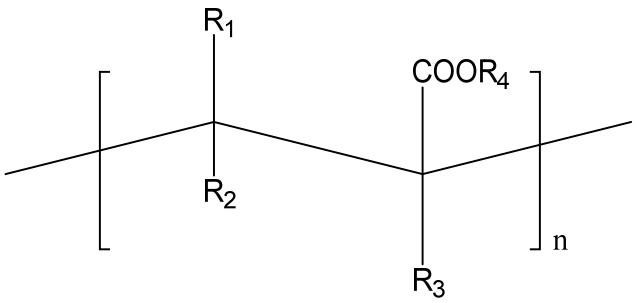
biocide; and

pH adjuster;

wherein

the composition has a pH of 3 to 9; and

the oxide trench dishing reducer has a general molecular structure as shown below:



wherein R1 and R2 each independently is selected from the group consisting of hydrogen and an alkyl group C_mH_{2m+1} and m is from 1 to 4; R3 is an alkyl group C_mH_{2m+1} and m is from 1 to 4; R4 is selected from the group consisting of hydrogen, an alkyl group C_mH_{2m+1} and m is from 1 to 4, metal ion, and ammonium ion; and n is chosen to give a molecular weight in from 1,000 to ~~1,000,000~~15,000;

contacting the at least one surface of the semiconductor substrate with the polishing pad and the chemical mechanical polishing composition; and

polishing the at least one surface comprising the silicon oxide film;

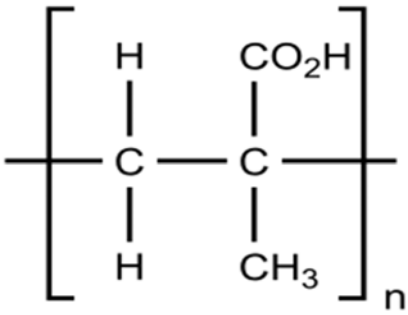
wherein the silicon oxide film is selected from the group consisting of Chemical vapor deposition (CVD), Plasma Enhance CVD (PECVD), High Density Deposition CVD(HDP), or spin on silicon oxide film.

9. The method of claim 8; wherein

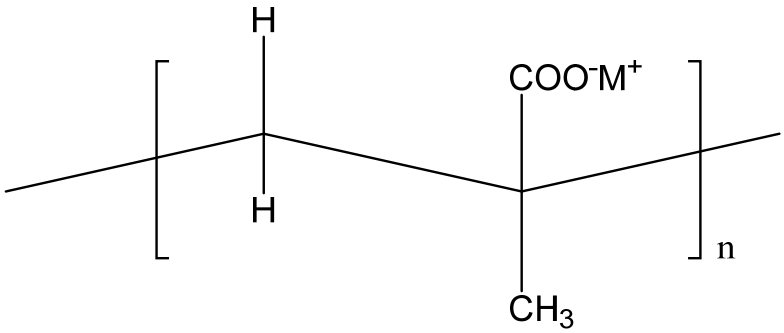
the ceria-coated inorganic oxide particles are selected from the group consisting of ceria-coated colloidal silica, ceria-coated high purity colloidal silica, ceria-coated alumina, ceria-coated titania, ceria-coated zirconia particles and combinations thereof;

the oxide trench dishing reducer has a general molecular structure selected from the group consisting of:

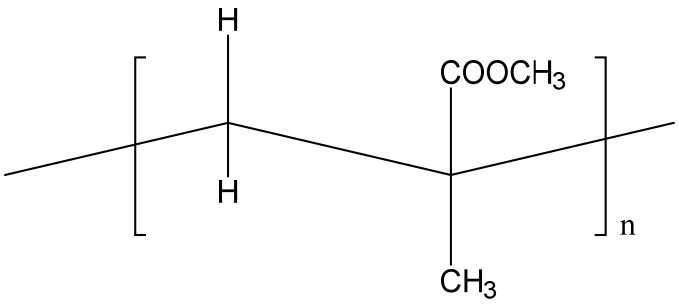
(a) poly(methacrylic acid) when R1, R2, and R4 are hydrogen, and R3 is methyl;



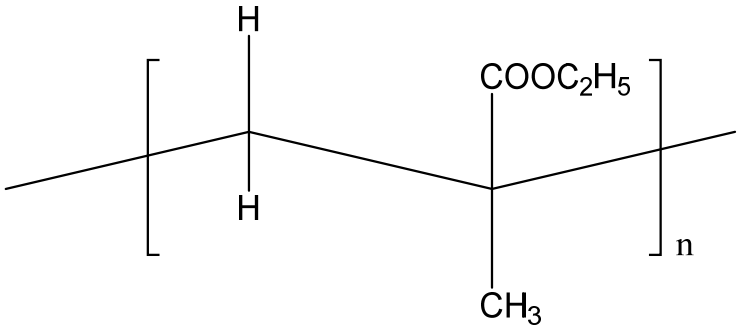
(b) salt of poly(methacrylic acid) when R1 and R2 are hydrogen, R3 is methyl, and R4 is a metal ion or ammonium M^+;



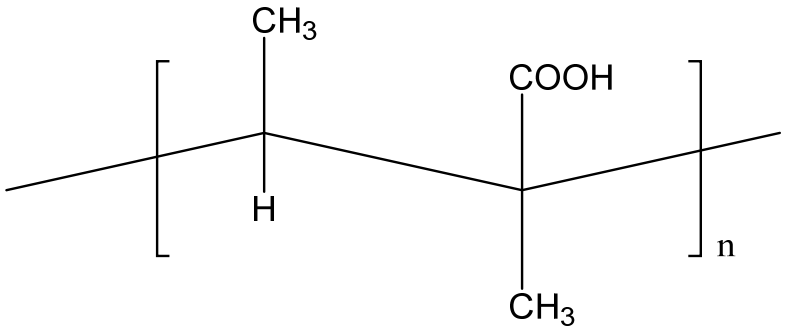
(c) poly (methyl methacrylate) (PMMA) when R1 and R2 are hydrogen, R3 and R4 are methyl;



(d) poly (ethyl methacrylate) (PEMA) when R1 and R2 are hydrogen, R3 is methyl, and R4 is ethyl;



(e) 2-methyl-poly (methacrylic acid) when R1 and R4 are hydrogen, R2 and R3 are methyl;



and combinations thereof; and

the water based solvent is selected from the group consisting of deionized (DI) water, distilled water, and alcoholic organic water based solvents.

10. The method of claim 8; wherein the chemical mechanical polishing composition further comprises at least one of

the biocide having an active ingredient selected from the group consisting of 5-chloro-2-methyl-4-isothiazolin-3-one, 2-methyl-4-isothiazolin-3-one, and combinations thereof; and

the pH adjustor selected from the group consisting of nitric acid, hydrochloric acid, sulfuric acid, phosphoric acid, and combinations thereof for acidic pH conditions; or is selected from the group consisting of sodium hydride, potassium hydroxide, ammonium hydroxide, tetraalkyl ammonium hydroxide, organic quaternary ammonium hydroxide compounds, organic amines, and combinations thereof for alkaline pH conditions.

11. The method of claim 8; wherein the chemical mechanical polishing composition comprises

the ceria-coated inorganic oxide particles selected from the group consisting of ceria-coated colloidal silica, ceria-coated high purity colloidal silica, and combinations thereof;

the oxide trench dishing reducer having a molecular weight of 1,200 to ~~100,000~~15,000 and is selected from the group consisting of poly (methacrylic acid), salt of poly(methacrylic acid), and combinations thereof; deionized (DI) water.

12. The method of claim 8; wherein the chemical mechanical polishing composition comprises

the ceria-coated inorganic oxide particles are selected from the group consisting of ceria-coated colloidal silica, ceria-coated high purity colloidal silica, and combinations thereof;

the oxide trench dishing reducer has a molecular weight of 1,500 to 15,000 and is selected from the group consisting of poly (methacrylic acid), salt of poly(methacrylic acid), and combinations thereof;

deionized (DI) water;

the biocide having an active ingredient selected from the group consisting of 5-chloro-2-methyl-4-isothiazolin-3-one, 2-methyl-4-isothiazolin-3-one, and combinations thereof;

nitric acid or ammonium hydroxide;

and the chemical mechanical polishing composition has a pH of 4 to 7.

13. The method of claim 8; wherein the chemical mechanical polishing composition comprises ceria-coated colloidal silica; poly (methacrylic acids) having a molecular weight of 1,200 to ~~100,000~~15,000; and deionized (DI) water.

14. The method of claim 8; wherein the chemical mechanical polishing composition comprises

ceria-coated colloidal silica;

poly (methacrylic acids) having a molecular weight of 1,500 to 15,000;

deionized (DI) water;

the biocide having an active ingredient selected from the group consisting of 5-chloro-2-methyl-4-isothiazolin-3-one, 2-methyl-4-isothiazolin-3-one, and combinations thereof;

nitric acid or ammonium hydroxide;

and the chemical mechanical polishing composition has a pH of 4 to 7.

15. The method of claim 8; wherein

the silicon oxide film is SiO_2 film;

the semiconductor substrate further having at least one surface comprises a silicon nitride film; and

removal selectivity of silicon oxide: silicon nitride is greater than 10.

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

a. the semiconductor substrate;

b. the chemical mechanical polishing (CMP) composition comprising

ceria-coated inorganic oxide particles;

oxide trench~~ing~~ dishing reducer selected from the group consisting of organic polymer acid, its ester derivative, its salt, and combinations thereof;

water based solvent; and

optionally

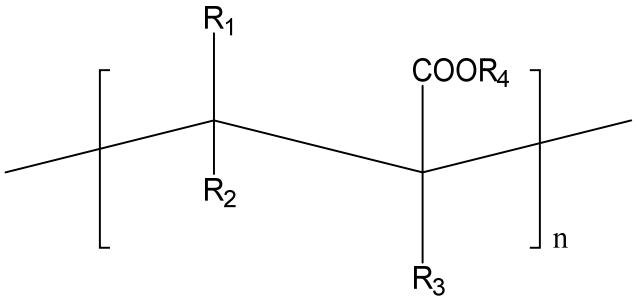
biocide; and

pH adjuster;

wherein

the composition has a pH of 3.5 to 9; and

the oxide trench dishing reducer has a general molecular structure as shown below:



wherein R1 and R2 each independently is selected from the group consisting of hydrogen and an alkyl group C_mH_{2m+1} and m is from 1 to 4; R3 is an alkyl group C_mH_{2m+1} and m is from 1 to 4; R4 is selected from the group consisting of hydrogen, an alkyl group C_mH_{2m+1} and m is from 1 to 4, metal ion, and ammonium ion; and n is chosen to give a molecular weight from 1,000 to ~~1,000,000~~15,000;

c. a polishing pad;

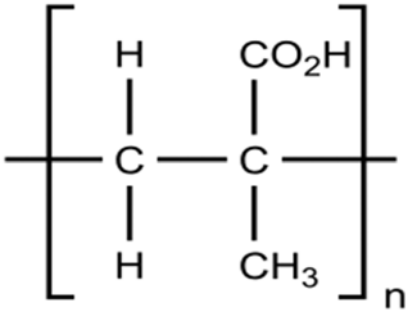
wherein the silicon oxide film is selected from the group consisting of Chemical vapor deposition (CVD), Plasma Enhance CVD (PECVD), High Density Deposition CVD(HDP), or spin on silicon oxide film; and the at least one surface comprising the silicon oxide film is in contact with the polishing pad and the chemical mechanical polishing composition.

17. The system of claim 16; wherein

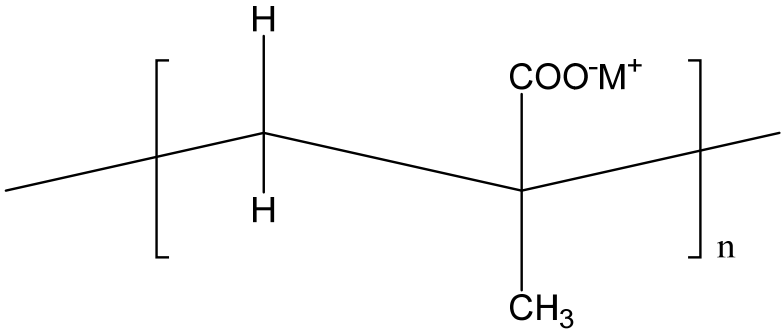
the ceria-coated inorganic oxide particles are selected from the group consisting of ceria-coated colloidal silica, ceria-coated high purity colloidal silica, ceria-coated alumina, ceria-coated titania, ceria-coated zirconia particles and combinations thereof;

the oxide trench dishing reducer has a general molecular structure selected from the group consisting of:

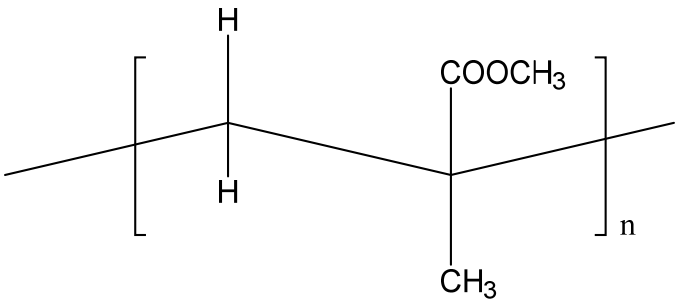
(a) poly(methacrylic acid) when R1, R2, and R4 are hydrogen, and R3 is methyl;



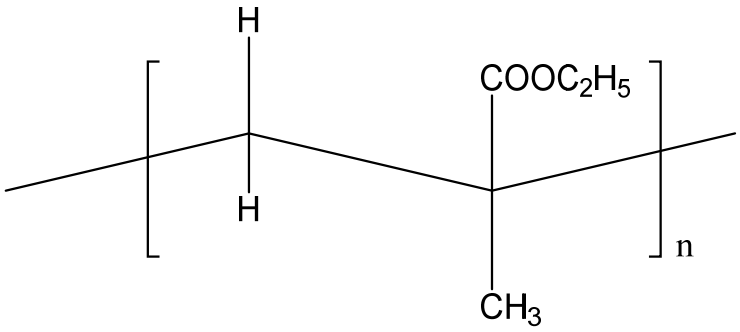
(b) salt of poly(methacrylic acid) when R1 and R2 are hydrogen, R3 is methyl, and R4 is a metal ion or ammonium M^+;



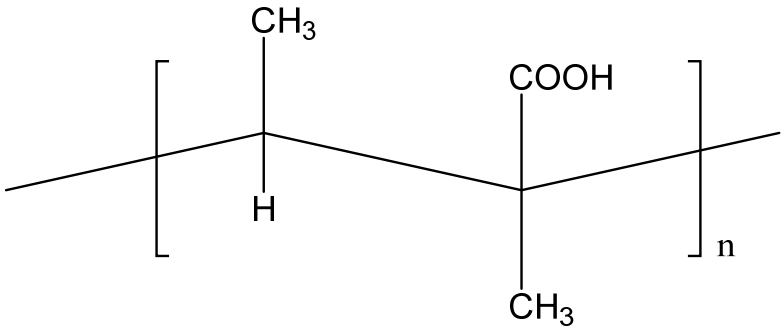
(c) poly (methyl methacrylate) (PMMA) when R1 and R2 are hydrogen, R3 and R4 are methyl;



(d) poly (ethyl methacrylate) (PEMA) when R1 and R2 are hydrogen, R3 is methyl, and R4 is ethyl;



(e) 2-methyl-poly (methacrylic acid) when R1 and R4 are hydrogen, R2 and R3 are methyl;



and combinations thereof; and

the water based solvent is selected from the group consisting of deionized (DI) water, distilled water, and alcoholic organic water based solvents.

18. The system of claim 16; wherein the chemical mechanical polishing composition further comprises
the biocide having an active ingredient selected from the group consisting of 5-chloro-2-methyl-4-isothiazolin-3-one, 2-methyl-4-isothiazolin-3-one, and combinations thereof; and
the pH adjustor selected from the group consisting of nitric acid, hydrochloric acid, sulfuric acid, phosphoric acid, and combinations thereof for acidic pH conditions; or is selected from the group consisting of sodium hydride, potassium hydroxide, ammonium hydroxide, tetraalkyl ammonium hydroxide, organic quaternary ammonium hydroxide compounds, organic amines, and combinations thereof for alkaline pH conditions.

19. The system of claim 16; wherein the chemical mechanical polishing composition comprises
the ceria-coated inorganic oxide particles selected from the group consisting of ceria-coated colloidal silica, ceria-coated high purity colloidal silica, and combinations thereof;
the oxide trench dishing reducer having a molecular weight of 1,200 to ~~100,000~~15,000 and is selected from the group consisting of poly (methacrylic acid), salt of poly(methacrylic acid), and combinations thereof; and
deionized (DI) water.

20. The system of claim 16; the chemical mechanical polishing composition comprises
the ceria-coated inorganic oxide particles are selected from the group consisting of ceria-coated colloidal silica, ceria-coated high purity colloidal silica, and combinations thereof;
the oxide trench dishing reducer ~~has a molecular weight of 1,500 to 15000 and~~ is selected from the group consisting of poly (methacrylic acid), salt of poly(methacrylic acid), and combinations thereof;
deionized (DI) water;

the biocide having an active ingredient selected from the group consisting of 5-chloro-2-methyl-4-isothiazolin-3-one, 2-methyl-4-isothiazolin-3-one, and combinations thereof;
nitric acid or ammonium hydroxide;
and the chemical mechanical polishing composition has a pH of 4 to 7.

21. The system of claim 16; wherein the chemical mechanical polishing composition comprises
ceria-coated colloidal silica, poly (methacrylic acids) ~~having a molecular weight of 1,500 to 15,000~~; biocide having an active ingredient selected from the group consisting of 5-chloro-2-methyl-4-isothiazolin-3-one, 2-methyl-4-isothiazolin-3-one, and combinations thereof; nitric acid or ammonium hydroxide; deionized (DI) water; and the chemical mechanical polishing composition has a pH of 4 to 7.

22. The system of claim 16; wherein
the silicon oxide film is SiO_2 film;
the semiconductor substrate further having at least one surface comprises a silicon nitride film, wherein the at least one surface comprising a silicon nitride film is in contact with the polishing pad and the chemical mechanical polishing composition;
and removal selectivity of silicon oxide: silicon nitride is greater than 10, when the at least surface comprising a silicon oxide film and the at least one surface comprising a silicon nitride film are polished with the polishing pad and the chemical mechanical polishing composition.