[0051] The STI CMP compositions disclosed herein comprise from 0.0001 wt.% to 2.0% wt.%, preferably from 0.001 wt.% to 1.0 wt.%, more preferably from 0.002 wt.% to 0.5 wt.%, and most preferably from 0.0025 wt.% to 0.25 wt.% gelatin compounds as oxide film removal rate boosting agents, SiN film removal rate suppressing agents and oxide trenching dishing reducers.

[0052] The STI CMP compositions disclosed herein comprise from 0.001 wt.% to 2.0% wt.%, preferably from 0.0025 wt.% to 1.0 wt.%, and more preferably from 0.05 wt.% to 0.5 wt.% at least one non-ionic organic molecule having more than one hydroxyl functional group.

[0053] Dual chemical additives selected from two types of chemical additives (at least one gelatin and at least one non-ionic organic molecule having more than one hydroxyl functional group) and used in the same STI CMP polishing compositions provide the benefits of achieving high oxide film removal rates, low SiN film removal rates, high and tunable Oxide: SiN selectivity, and more importantly, providing significantly reduced oxide trench dishing and improving over polishing window stability on polishing patterned wafers.

[0054] The ceria-coated inorganic oxide particles include, but are not limited to, ceria-coated colloidal silica, ceria-coated alumina, ceria-coated titania, ceria-coated zirconia, or any other ceria-coated inorganic oxide particles. These ceria-coated inorganic oxide particles can be used as abrasives at relative low concentrations and still desirable and high oxide film removal rates can be achieved.

[0055] The particle sizes of these ceria-coated inorganic oxide particles in the disclosed invention herein are ranged from 10nm to 1,000nm, the preferred mean particle sized are ranged from 20nm to 500nm, the more preferred mean particle sizes are ranged from 50nm to 250nm.

[0056] The concentrations of these ceria-coated inorganic oxide particles can be in low concentration range which is from 0.01 wt.% to 2 wt.%, preferably from 0.02 wt.% to 0.5 wt.%, more preferably from 0.025 wt.% to 0.2 wt.%, and most preferably 0.05 wt. % to 0.1 wt. %.

[0057] The preferred ceria-coated inorganic oxide particles are ceria-coated colloidal silica particles.

Claims

1. A chemical mechanical polishing composition comprising:

ceria-coated inorganic oxide particles;
at least one gelatin compound having a negative and a positive charge;
at least one non-ionic organic molecule having more than one hydroxyl functional group;
a solvent; and
optionally, at least one biocide; and
at least one pH adjuster,
wherein the composition has a pH of from 2 to 12.

2. The chemical mechanical polishing composition of claim 1 wherein the pH is from 3 to 10.

3. The chemical mechanical polishing composition of claim 2 wherein the pH is from 4 to 9.

4. The chemical mechanical polishing composition of claim 3 wherein the pH is from 4.5 to 7.5.

5. 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, wherein the particles are present in the composition at a concentration range selected from the group consisting of from 0.01 wt.% to 20 wt.%, from 0.05 wt.% to 10 wt.%, and from 0.1 wt.% to 5 wt.%.

6. 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, wherein the particles are present in the composition at a concentration range selected from the

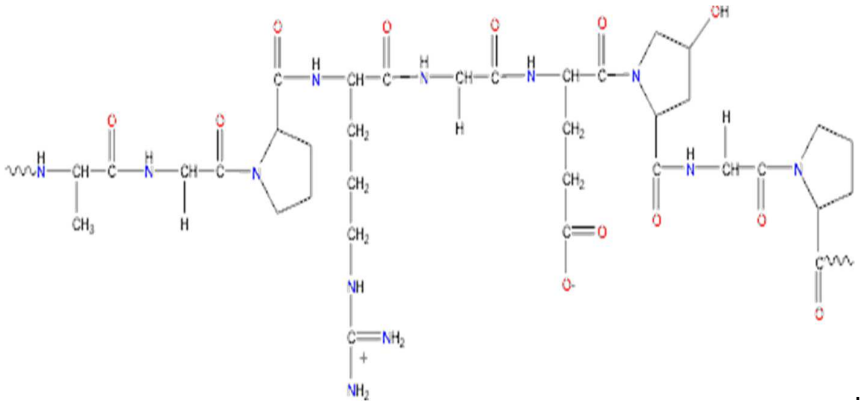
group consisting of from 0.01 wt.% to 2 wt.%, from 0.02 wt.% to 0.5 wt.%, from 0.025 wt.% to 0.2 wt.%, and from 0.05 wt. % to 0.1 wt.%.

7. The chemical mechanical polishing composition of claim 1, wherein the water-soluble solvent is selected from the group consisting of deionized (DI) water, distilled water, and alcoholic organic solvents.

8. The chemical mechanical polishing composition of claim 1, wherein the at least one gelatin compound is present in the composition at a concentration range selected from the group consisting of from 0.0001 wt.% to 2.0% wt.%, from 0.001 wt.% to 1.0 wt.%, from 0.002 wt.% to 0.5 wt.%**,** and from 0.0025 wt.% to 0.25 wt.%**.**

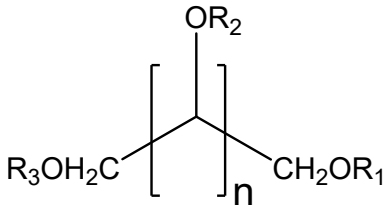
9. The chemical mechanical polishing composition of claim 8, wherein the at least one gelatin compound is made from animal skin comprising cold water fish skin, porcine skin, or bovine skin.

10. The chemical mechanical polishing composition of claim 8, wherein the at least one gelatin compound comprises a compound having the following chemical structure:



.

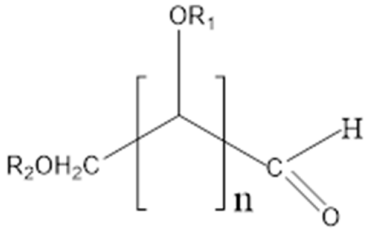
11. The chemical mechanical polishing composition of claim 1, wherein the at least one non-ionic organic molecule having more than one hydroxyl functional group has a general molecular structure selected from the group consisting of:



(a)

wherein for structure (a), R_1, R_2, and R_3 are independently selected from the group consisting of hydrogen, an alkyl group C_xH_{2x+1}, wherein x is from 1 to 12, an alkoxy, an organic group with one or more hydroxyl groups, a substituted organic sulfonic acid, a substituted organic sulfonic acid salt, a substituted organic carboxylic acid, a substituted organic carboxylic acid salt, an organic carboxylic ester, an organic amine groups, and combinations thereof, wherein at least two of R_1, R_2, and R_3 are hydrogen atoms; and

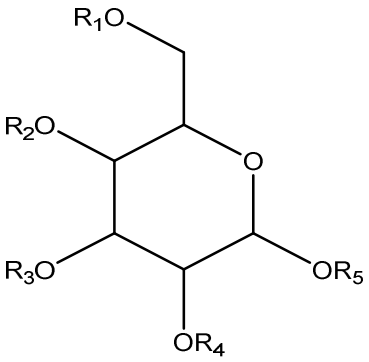
n is a number selected from the group consisting of from 2 to 5,000, from 3 to 12, and from 4 to 6;



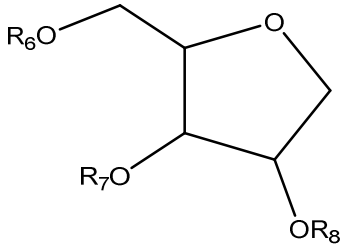
(b),

wherein for structure (b), R_1 and R_2 are independently selected from the group consisting of hydrogen, alkyl, alkoxy, organic group with one or more hydroxyl groups, substituted organic sulfonic acid, substituted organic sulfonic acid salt, substituted organic carboxylic acid, substituted organic carboxylic acid salt, organic carboxylic ester, organic amine groups, and combinations thereof, wherein one -CHO functional group is located at one end of the molecule as a terminal functional group; and

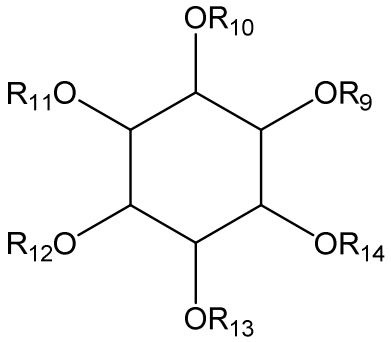
n is a number selected from the group consisting of from 2 to 5,000, from 3 to 12, and from 4 to 7;



(c),

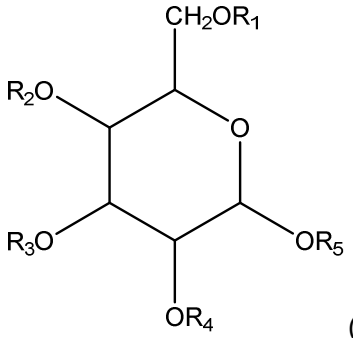


(d),



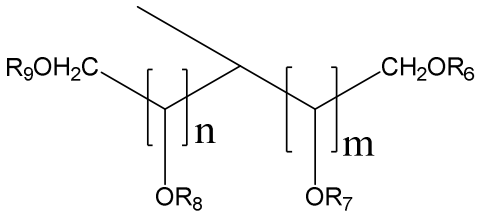
(e) ,

wherein, for structures (c), (d), and (e), R_1 to R_{14} are each independently selected from the group consisting of hydrogen, an alkyl, an alkoxy, an organic group with one or more hydroxyl groups, a substituted organic sulfonic acid, a substituted organic sulfonic acid salt, a substituted organic carboxylic acid, a substituted organic carboxylic acid salt, an organic carboxylic ester, and an organic amine group, wherein at least two of R_1 to R_{14} are hydrogen atoms;



(f),

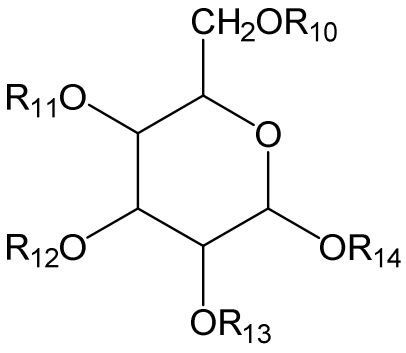
wherein, in structure (f), at least one of R_1 to R_5 is a polyol moiety having a structure (i):



(i),

wherein, for structure (i), n and m is selected from 1 to 5; each of R_6, R_7, R_8, and R_9 is independently selected from the group consisting of hydrogen, an alkyl, an alkoxy, an organic group with one or more hydroxyl groups, a substituted organic sulfonic acid, a substituted organic sulfonic acid salt, a substituted organic carboxylic acid, a substituted organic carboxylic acid salt, an organic carboxylic ester, and an organic amine, wherein at least two of R_6, R_7, R_8, and R_9 are hydrogen atoms; and

in structure (f), each of R_1 to R_5 is independently selected from the group consisting of hydrogen, an alkyl, an alkoxy, an organic group with one or more hydroxyl groups, a substituted organic sulfonic acid or salt, a substituted organic carboxylic acid or salt, an organic carboxylic ester, an organic amine, and a six-member ring polyol having a structure shown in (ii):



(ii)

wherein the structure (ii) is connected through an oxygen-carbon bond to structure (f) by removing one of R_{11} to R_{14} and wherein, for structure (ii), each of R_{10} to R_{14} is independently selected from the group consisting of hydrogen, an alkyl, an alkoxy, an organic group with one or more hydroxyl groups, a substituted organic sulfonic acid or salt, a substituted organic carboxylic acid or salt, an organic carboxylic ester, and an organic amine, wherein at least two of R_1 to R_9 in structure (f) are hydrogen atoms,

wherein the wherein the at least one non-ionic organic molecule having more than one hydroxyl functional group is present in the composition at a concentration selected from

the group consisting of from 0.001 wt.% to 2.0% wt.%, from 0.0025 wt.% to 1.0 wt.%, and from 0.05 wt.% to 0.5 wt.%.

12. The composition of claim 1 wherein the at least one non-ionic organic molecule having more than one hydroxyl functional group is selected from the group consisting of maltitol, lactitol, maltotritol, ribitol, D-sorbitol, mannitol, dulcitol, iditol, D-(-)-fructose, sorbitan, sucrose, ribose, Inositol, glucose, D-arabinose, L-arabinose, D-mannose, L-mannose, meso-erythritol, beta-lactose, arabinose, D-(+)-mannose, beta-lactose, and combinations thereof.

13. The composition of claim 12 wherein the at least one non-ionic organic molecule having more than one hydroxyl functional group is selected from the group consisting of maltitol, lactitol, maltotritol, D-sorbitol, mannitol, dulcitol, D-(-)-Fructose, beta-lactose, and combinations thereof.

14. The chemical mechanical polishing composition of claim 1, wherein the composition further comprises the at least one biocide, wherein the biocide comprises 5-chloro-2-methyl-4-isothiazolin-3-one and 2-methyl- -isothiazolin-3-one, wherein the biocide is present at a concentration selected from the group consisting of from 0.0001 wt.% to 0.05 wt.%, from 0.0005 wt.% to 0.025 wt.%, and from 0.001 wt.% to 0.01 wt.%.

15. The chemical mechanical polishing composition of claim 1, wherein the composition comprises the at least one pH adjusting agent wherein the pH adjusting agent is selected from the group consisting of nitric acid, hydrochloric acid, sulfuric acid, phosphoric acid, other inorganic or organic acids, and mixtures thereof for acidic pH conditions; or 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, and wherein the pH adjusting agent is present in the composition at a composition selected from the group consisting of from 0 wt.% to 1 wt.%, from 0.01 wt.% to 0.5 wt.%, and from 0.1 wt.% to 0.25 wt.%.

16. The chemical mechanical polishing composition of claim 1, comprising ceria-coated colloidal silica; the at least one the gelatin compound is selected from the group

consisting of cold water fish skin, porcine skin, bovine skin, and combinations thereof; and the at least one non-ionic organic molecule having more than one hydroxyl functional group is selected from the group consisting of Dulcitol, D-sorbitol, Maltitol, Lactitol, and combinations thereof.

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

providing the semiconductor substrate;

providing a polishing pad;

providing the chemical mechanical polishing (CMP) composition of claim 1;

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

polishing the least one surface comprising silicon dioxide.

18. The method of claim 17, wherein the silicon oxide film is a SiO_2 film.

19. The method of claim 18, wherein the semiconductor substrate further comprises a silicon nitride surface, and a removal selectivity of silicon oxide: silicon nitride is greater than 40.

20. The method of claim 19, wherein the removal selectivity of silicon oxide: silicon nitride is greater than 90.

21. A system for chemical mechanical polishing (CMP) a semiconductor substrate having at least one surface comprising silicon a oxide film, the system comprising:

a. the semiconductor substrate;

b. the chemical mechanical polishing (CMP) composition of claim 1; and

c. a polishing pad,

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

22. The system of claim 21, wherein the silicon oxide film is a SiO_2 film.

23. The system of claim 22, wherein the semiconductor substrate further comprises a silicon nitride surface, and removal selectivity of silicon oxide: silicon nitride is greater than 40.

24. The system of claim 23, wherein the removal selectivity of silicon oxide: silicon nitride is greater than 90.