CLAIMS

1. A chemical mechanical planarization (CMP) composition for polishing oxide material consisting of:

an abrasive selected from the group consisting of inorganic oxide particles, doped inorganic oxide particles, surface coated composite inorganic oxide particles, organic polymer particles, inorganic oxide coated organic polymer particles, and combinations thereof;

a removal rate accelerator; and

a solvent; and

optionally at least one additive selected from the group consisting of an additive for removal rate selectivity, a pH adjuster, a surfactant, a dispersant, and a biological growth inhibitor;

wherein the composition further comprises a pH greater than 5;

wherein a conductivity of the CMP composition ranges from 0.3 to 9 millisiemens per centimeter;

wherein the removal rate accelerator is selected from the group consisting of:

an organic acid or an organic acid salt having one selected from the group consisting of a sulfonic acid group, a phosphonic acid group, a pyridine group, and combinations thereof;

a salt selected from the group consisting of nitrate, phosphate and sulphate;

an acid selected from the group consisting of nitric, sulphonic, sulfuric, phosphonic, carboxylic and combinations thereof; and

combinations thereof.

2. The CMP composition of claim 1, wherein the abrasive is selected from the group consisting of cerium oxide (ceria), aluminum oxide, zirconium oxide, zirconium silicate, tin oxide, silicon dioxide, titanium oxide, germanium oxide, vanadium oxide, doped inorganic oxide, composite inorganic oxide and combinations thereof.

3. The CMP composition in claim 2, wherein the abrasive comprises cerium oxide selected from the group consisting of calcined ceria, colloidal ceria, ceria coated silica particles, and combinations thereof.

4. The CMP composition of claim 3, wherein the abrasive comprises ceria coated silica particles, the ceria coated silica particles comprising an amorphous silica core particle coated with crystalline ceria nanoparticles.

5. The CMP composition of claim 4, wherein the crystalline ceria nanoparticles comprise a single crystal.

6. The CMP composition of claim 4, wherein a weight ratio of the ceria nanoparticles to the amorphous silica core particle is 0.01 to 1.5 or greater.

7. The CMP composition of claim 4, wherein the amorphous silica core particles comprise a diameter ranging from 20 to 550 nanometers and the ceria nanoparticles comprise a diameter greater than 10 nanometers, wherein the diameter of the amorphous silica core particles is greater than the diameter of the ceria nanoparticles.

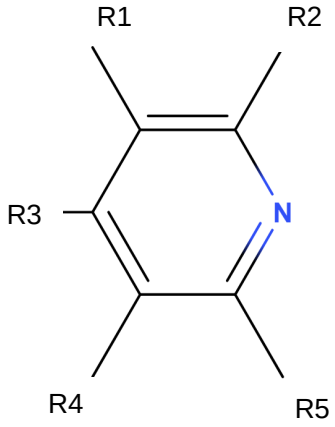
8. The CMP composition in claim 1, wherein the solvent is selected from the group consisting of water, a polar non-aqueous solvent, and a mixture thereof.

9. The CMP composition in claim 8, wherein the solvent comprises a polar non-aqueous solvent, further wherein the polar non-aqueous solvent is selected from the group consisting of alcohol, ether, ketone and combinations thereof.

10. The CMP composition of claim 1, wherein the removal rate accelerator is an acid selected from the group consisting of phenyl phosphonic acid, benzoic acid, acetic acid, malonic acid, glutaric acid, oxalic acid and combinations thereof.

11. The CMP composition of claim 1, wherein the removal rate accelerator is a sulfonic acid selected from the group consisting of methanesulfonic acid, benzenesulfonic acid, toluene sulfonic acid, p- toluene sulfonic acid, ethane di sulfonic acid, naphthalene di sulfonic acid, acrylamido propane sulfonic acid, morpholinopropanesulfonic acid, 3-(N-Morpholino)propanesulfonic acid (MOPS), 4-Morpholineethanesulfonic acid (MES), beta.-Hydroxy-4-morpholinepropanesulfonic acid (MOPSO), 4-(2-Hydroxyethyl)piperazine-1-ethanesulfonic acid (HEPES), 1,4-piperazinediethanesulfonic acid (PIPES), piperazine-1,4-bis(2-hydroxypropanesulfonic acid)dihydrate (POPSO), 4-(2-Hydroxyethyl)-1-piperazinepropanesulfonic acid (EPPS), piperazinediethane sulfonic acid, hydroxyethylpiperazine ethane sulfonic acid, and combinations thereof.

12. The CMP composition in Claim 1, wherein the removal rate accelerator is an organic acid having a pyridine group having a structure of:



wherein R1, R2, R3, R4 and R5 are independently selected from the group consisting of hydrogen, a carboxylic acid, a carboxylic acid ester, an organic sulfonic acid, an organic amine, an organic amide and a hydroxyl group.

13. The CMP composition in Claim 12, wherein at least one of R1, R2, R3, R4 and R5 is a carboxylic acid.

14. The CMP composition of claim 1, wherein the removal rate accelerator is a pyridine compound selected from the group consisting of: pyridine; pyridine monocarboxylic acid; pyridine dicarboxylic acid; picolinic acid; nicotinic acid; isonicotinic acid; dipicolinic acid; 2,5-pyridinedicarboxylic acid; 3,5-pyridinedicarboxylic acid; 2,3-pyridinedicarboxylic acid; and 3,4-pyridinedicarboxylic acid.

15. The CMP composition of claim 1, wherein a pH of the CMP composition ranges from 7 to 11.

16. The CMP composition of claim 1, wherein the composition comprises at least one additive selected from the group consisting of an additive for removal rate selectivity, a pH adjuster, a surfactant, a dispersant, and a biological growth inhibitor.

17. The CMP composition in Claim 1, wherein the abrasive comprises particles having a zeta potential more negative than -25 millivolts.

18. A polishing method for chemical mechanical planarization (CMP) of a semiconductor device comprising a first material and a second material, comprising the steps of:

(a) contacting at least one surface of the first material with a CMP polishing pad;

(b) delivering the CMP polishing composition of claim 1 to the at least one surface;

(c) polishing the at least one surface with the polishing composition to remove the first material at a removal rate of greater than 10000 Angstroms/minute.

19. The polishing method of claim 18, wherein the first material is a silicon oxide material selected from the group consisting of thermal oxide, TEOS films deposited using Tetra Ethyl Ortho Silicate (TEOS) precursors, High Density Plasma (HDP) oxide, High Aspect Ratio Process (HARP) films, fluorinated oxide films, doped oxide films, Spin-On Glass (SOG), flowable Chemical Vapor Deposited (CVD) films, optical glass, display glass, and combinations thereof.

20. The polishing method of Claim 19, wherein the second material is selected from the group of silicon nitride, polysilicon, and combinations thereof.

21. A system for chemical mechanical planarization, comprising:

(a) a patterned substrate comprising at least one surface having a first material and a second material;

(b) a polishing pad; and

(c) the CMP polishing composition of claim 1;

wherein the at least one surface is in contact with the polishing pad and the polishing composition and the first material is a silicon oxide material selected from the group consisting of thermal oxide, TEOS films deposited using Tetra Ethyl Ortho Silicate (TEOS) precursors, High Density Plasma (HDP) oxide, High Aspect Ratio Process (HARP) films, fluorinated oxide films, doped oxide films, Spin-On Glass (SOG), flowable Chemical Vapor Deposited (CVD) films, optical glass, display glass, and combinations thereof.