Claims

1. A copper chemical mechanical polishing (CMP) formulation comprising:

0.001 to 0.25 wt % particulate materials,

0.01 to 16 wt % at least two amino acids,

0.25 to 5 wt% oxidizer,

0.00001 to 2 wt % corrosion inhibitor,

and

rest being water;

wherein

the particulate material is selected from the group consisting of fumed silica, colloidal silica, fumed alumina, colloidal alumina, cerium oxide, titanium dioxide, zirconium oxide, polystyrene, polymethyl methacrylate, mica, hydrated aluminum silicate, and mixtures thereof;

wherein

the amino acid is independently selected from the group consisting of aminoacetic acid (glycine), serine, lysine, glutamine, L-alanine, DL-alanine, Beta-alanine, iminoacetic acid, asparagine, aspartic acid, valine, sarcosine, bicine, tricin, proline, and mixtures thereof;

wherein

the corrosion inhibitor comprises a nitrogenous cyclic compound selected from the group consisting of 1, 2, 3-triazole, 1, 2, 4 triazole, 1, 2, 3-benzotriazole, 5-methylbenzotriazole, benzotriazole, 1-hydroxybenzotriazole, 4-hydroxybenzotriazole, 4-amino-4H-1, 2, 4-triazole, benzimidazole; 5-amino triazole, benzothiazole, triazinethiol, triazinedithiol, and triazinetrithiol; isocyanurate and combinations thereof; and

the formulation has a pH from 4 to 9.

2. The chemical mechanical polishing (CMP) formulation of claim 1, wherein weight concentration ratio of one amino acid to another amino acid used in the formulation ranges from 1:99 to 99:1.

3. The chemical mechanical polishing (CMP) formulation of claim 1, wherein the oxidizer is selected from the group consisting of hydrogen peroxide, ammonium dichromate, ammonium perchlorate, ammonium persulfate, benzoyl peroxide,

bromates, calcium hypochlorite, ceric sulfate, chlorates, chromium trioxide, ferric trioxide, ferric chloride, iodates, iodine, magnesium perchlorate, magnesium dioxide, nitrates, periodic acid, permanganic acid, potassium dichromate, potassium ferricyanide, potassium permanganate, potassium persulfate, sodium bismuthate, sodium chlorite, sodium dichromate, sodium nitrite, sodium perborate, sulfates, peracetic acid, urea-hydrogen peroxide, perchloric acid, di-t-butyl peroxide, monopersulfates, dipersulfates, and combinations thereof.

4. The chemical mechanical polishing (CMP) formulation of claim 1, further comprises a surfactant selected from the group consisting of phenyl ethoxylate surfactant, acetylenic diol surfactant, sulfate or sulfonate surfactant, glyceroal propoxylate, glyceroal ethoxylate, polysorbate surfactant, non-ionic alkyl ethoxylate surfactant, glycerol propoxylate-block-ethoxylate, amine oxide surfactant, glycolic acid ethoxylate oleyl ether, polyethylene glycol, polyethylene oxide, ethoxylated alcohols, ethoxylate-propoxylate surfactant, polyether defoaming dispersion, and combinations thereof.

5. The chemical mechanical polishing (CMP) formulation of claim 4, wherein the particulate material is colloidal silica; the amino acid is selected from the group consisting of aminoacetic acid (glycine), alanine, bicine, and sarcosine; the oxidizer is hydrogen peroxide; the corrosion inhibitor is selected from the group consisting of 1,2,4-triazole and 5-amino triazole; the surfactant is selected from the group consisting of phenyl ethoxylate surfactant, acetylenic diol surfactant, ethoxylate-propoxylate surfactant, polyether dispersion; the water is deionized water; and the pH is from 6 to 8.

6. The chemical mechanical polishing (CMP) formulation of claim 1, further comprises at least one selected from the group consisting of pH adjusting agent, biocide, dispersing agent, and wetting agent.

7. A method of chemical mechanical polishing a copper containing semiconductor substrate, comprising steps of:

Providing the semiconductor substrate having a surface containing copper ;

providing a polishing pad;

providing a chemical mechanical polishing (CMP) formulation comprising

0.001 to 0.25 wt % particulate materials,

0.01 to 16 wt % at least two amino acids,

0.25 to 5 wt% oxidizer,

0.00001 to 2 wt % corrosion inhibitor,

and

rest being water;

wherein

the particulate material is selected from the group consisting of fumed silica, colloidal silica, fumed alumina, colloidal alumina, cerium oxide, titanium dioxide, zirconium oxide, polystyrene, polymethyl methacrylate, mica, hydrated aluminum silicate, and mixtures thereof;

wherein

the amino acid is independently selected from the group consisting of aminoacetic acid (glycine), serine, lysine, glutamine, L-alanine, DL-alanine, Beta-alanine, iminoacetic acid, asparagine, aspartic acid, valine, sarcosine, bicine, tricin, proline, and mixtures thereof;

wherein

the corrosion inhibitor comprises a nitrogenous cyclic compound selected from the group consisting of 1, 2, 3-triazole, 1, 2, 4 triazole, 1, 2, 3-benzotriazole, 5-methylbenzotriazole, benzotriazole, 1-hydroxybenzotriazole, 4-hydroxybenzotriazole, 4-amino-4H-1, 2, 4-triazole, benzimidazole; benzothiazole, 5-amino triazole, triazinethiol, triazinedithiol, and triazinetrithiol; isocyanurate and combinations thereof; and

the formulation has a pH from 4 to 9;

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

polishing the surface of the semiconductor;

wherein at least a portion of the surface containing copper is in contact with both the polishing pad and the chemical mechanical polishing formulation.

8. The method of Claim 7, wherein weight concentration ratio of one amino acid to another amino acid used in the formulation ranges from 1:99 to 99:1.

9. The method of Claim 7, wherein the oxidizer is selected from the group consisting of hydrogen peroxide, ammonium dichromate, ammonium perchlorate, ammonium persulfate, benzoyl peroxide, bromates, calcium hypochlorite, ceric sulfate, chlorates, chromium trioxide, ferric trioxide, ferric chloride, iodates, iodine, magnesium perchlorate, magnesium dioxide, nitrates, periodic acid, permanganic acid, potassium dichromate, potassium ferricyanide, potassium permanganate, potassium persulfate, sodium bismuthate, sodium chlorite, sodium dichromate, sodium nitrite, sodium perborate, sulfates, peracetic acid, urea-hydrogen peroxide, perchloric acid, di-t-butyl peroxide, monopersulfates, dipersulfates, and combinations thereof.

10. The method of Claim 7, wherein the CMP formulation further comprises a surfactant selected from the group consisting of phenyl ethoxylate surfactant, acetylenic diol surfactant, sulfate or sulfonate surfactant, glyceroal propoxylate, glyceroal ethoxylate, polysorbate surfactant, non-ionic alkyl ethoxylate surfactant, glycerol propoxylate-block-ethoxylate, amine oxide surfactant, glycolic acid ethoxylate oleyl ether, polyethylene glycol, polyethylene oxide, ethoxylated alcohols, ethoxylate-propoxylate surfactant, polyether defoaming dispersion, and combinations thereof.

11. The method of Claim 10, wherein the particulate material is colloidal silica; the amino acid is selected from the group consisting of aminoacetic acid (glycine), alanine, bicine, and sarcosine; the oxidizer is hydrogen peroxide; the corrosion inhibitor is selected from the group consisting of 1,2,4-triazole and 5-amino triazole; the surfactant is selected from the group consisting of phenyl ethoxylate surfactant, acetylenic diol surfactant, ethoxylate-propoxylate surfactant, polyether dispersion; the water is deionized water; and the pH is from 6 to 8.

12. The method of Claim 7, wherein the CMP formulation further comprises at least one selected from the group consisting of pH adjusting agent, biocide, dispersing agent, and wetting agent.

13. A system of chemical mechanical polishing, comprising

a semiconductor substrate having a surface containing copper ;

providing a polishing pad;

providing a chemical mechanical polishing (CMP) formulation comprising

0.001 to 0.25 wt % particulate materials,

0.01 to 16 wt % at least two amino acids,

0.25 to 5 wt% oxidizer,

0.00001 to 2 wt % corrosion inhibitor,

and

rest being water;

wherein

the particulate material is selected from the group consisting of fumed silica, colloidal silica, fumed alumina, colloidal alumina, cerium oxide, titanium dioxide, zirconium oxide, polystyrene, polymethyl methacrylate, mica, hydrated aluminum silicate, and mixtures thereof;

wherein

the amino acid is independently selected from the group consisting of aminoacetic acid (glycine), serine, lysine, glutamine, L-alanine, DL-alanine, Beta-alanine, iminoacetic acid, asparagine, aspartic acid, valine, sarcosine, bicine, tricin, proline, and mixtures thereof;

wherein

the corrosion inhibitor comprises a nitrogenous cyclic compound selected from the group consisting of 1, 2, 3-triazole, 1, 2, 4 triazole, 1, 2, 3-benzotriazole, 5-methylbenzotriazole, benzotriazole, 1-hydroxybenzotriazole, 4-hydroxybenzotriazole, 4-amino-4H-1, 2, 4-triazole, 5-amino triazole; benzimidazole; benzothiazole, triazinethiol, triazinedithiol, and triazinetrithiol; isocyanurate and combinations thereof; and

the formulation has a pH from 4 to 9;

wherein at least a portion of the surface containing copper is in contact with both the polishing pad and the chemical mechanical polishing formulation.

14. The system of Claim 13, wherein weight concentration ratio of one amino acid to another amino acid used in the formulation ranges from 1:99 to 99:1.

15. The system of Claim 13, wherein the oxidizer is selected from the group consisting of hydrogen peroxide, ammonium dichromate, ammonium perchlorate, ammonium persulfate, benzoyl peroxide, bromates, calcium hypochlorite, ceric sulfate, chlorates, chromium trioxide, ferric trioxide, ferric chloride, iodates, iodine, magnesium perchlorate, magnesium dioxide, nitrates, periodic acid, permanganic acid, potassium dichromate, potassium ferricyanide, potassium permanganate, potassium persulfate, sodium bismuthate, sodium chlorite, sodium dichromate, sodium nitrite, sodium perborate, sulfates, peracetic acid, urea-hydrogen peroxide, perchloric acid, di-t-butyl peroxide, monopersulfates, dipersulfates, and combinations thereof.

16. The system of Claim 13, wherein the CMP formulation further comprises a surfactant selected from the group consisting of phenyl ethoxylate surfactant, acetylenic diol surfactant, sulfate or sulfonate surfactant, glyceroal propoxylate, glyceroal ethoxylate, polysorbate surfactant, non-ionic alkyl ethoxylate surfactant, glycerol propoxylate-block-ethoxylate, amine oxide surfactant, glycolic acid

ethoxylate oleyl ether, polyethylene glycol, polyethylene oxide, ethoxylated alcohols, ethoxylate-propoxylate surfactant, polyether defoaming dispersion, and combinations thereof.

17. The system of Claim 16, wherein the particulate material is colloidal silica; the amino acid is selected from the group consisting of aminoacetic acid (glycine), alanine, bicine, and sarcosine; the oxidizer is hydrogen peroxide; the corrosion inhibitor is selected from the group consisting of 1,2,4-triazole and 5-amino triazole; the surfactant is selected from the group consisting of phenyl ethoxylate surfactant, acetylenic diol surfactant, ethoxylate-propoxylate surfactant, polyether dispersion; the water is deionized water; and the pH is from 6 to 8.

18. The system of Claim 13, wherein the CMP formulation further comprises at least one selected from the group consisting of pH adjusting agent, biocide, dispersing agent, and wetting agent.