

CLAIMS

1. A chemical mechanical polishing (CMP) polishing composition for cobalt-containing substrate, comprising:
 - 5 0.005 wt. % to 25 wt.% of abrasive;
 - 0.05 wt. % to 5 wt. % of α -alanine;
 - from 2 ppm to 100 ppm of phosphate compound comprising $\text{H}_2\text{PO}_4^{1-}$, HPO_4^{2-} , or PO_4^{3-} ;
 - 0.0005 wt. % to 0.25 wt. % of corrosion inhibitor;
 - 10 0.005 wt. % to 10 wt. % of oxidizer; and
 - water;wherein the chemical mechanical polishing (CMP) polishing composition having a pH from 2.0 to about 12.
- 15 2. The chemical mechanical polishing (CMP) polishing composition for cobalt-containing substrate of Claim 1, further comprises at least one of:
 - 0.0001 wt. % to 0.20 wt. % of amine compound;
 - 0.01 wt.% to 10 wt.% of chelating agent;
 - 20 0.01 wt. % to 0.5 wt. % of pH adjusting agent;
 - 0.00001 wt. % to 0.10 wt. % of biocide; and
 - 0.0005 wt. % to 0.15 wt. % of surfactant.
- 25 3. The chemical mechanical polishing (CMP) polishing composition for cobalt-containing substrate of Claim 1, wherein the abrasive is selected from the group consisting of nano-sized colloidal silica or high purity colloidal silica particles; nano-sized inorganic metal oxide particles selected from the group consisting of alumina, titania, zirconia, ceria and combinations thereof; nano-sized diamond particles; nano-sized silicon nitride particles; mono-modal, bi-modal, or multi-modal colloidal abrasive

particles; organic polymer-based soft abrasives; surface-coated or modified abrasives; and combinations thereof; and ranges from 0.05 wt.% to 5 wt.%;

the alanine is selected from the group consisting of D-Alanine, L-Alanine, DL-Alanine, and combinations thereof; and ranges from 0.5 wt.% to 2 wt.%;

- 5 the phosphate compound comprising $\text{H}_2\text{PO}_4^{1-}$, HPO_4^{2-} , or PO_4^{3-} is in a form selected from the group consisting of phosphate ion (tribasic), hydrogen phosphate ion (dibasic), dihydrogen phosphate (mono-basic), trihydrogen phosphate (acid), and combinations thereof; and ranges from 2 ppm to 50 ppm;

- 10 the corrosion inhibitor is selected from the group consisting of 1,2,4-triazole and its derivatives, benzotriazole and its derivatives, 1,2,3-triazole and its derivatives, pyrazole and its derivatives, imidazole and its derivatives, benzoimidazole and its derivatives, benzoimidazole and its derivatives, isocyanurate and its derivatives, and combinations thereof; and ranges from 0.0025 wt. % to 0.25 wt. %;

- 15 the oxidizing agent is selected from the group consisting of periodic acid, hydrogen peroxide, potassium iodate, potassium permanganate, ammonium persulfate, ammonium molybdate, ferric nitrate, nitric acid, potassium nitrate, and mixtures thereof; and ranges from 0.25 wt. % to 3 wt. %; and

the chemical mechanical polishing (CMP) polishing composition having a pH from 6.0 to about 10.

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4. The chemical mechanical polishing (CMP) polishing composition for cobalt-containing substrate of Claim 3, further comprises at least one of
- 25 the chelating agent ranges from 0.1 wt. % to 5 wt. % and is selected independently from the group consisting of glycine, serine, proline, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, valine, arginine, asparagine, aspartic acid, cysteine, glutamic acid, glutamine, ornithine, picolinic acid, selenocysteine, tyrosine, sarcosine, bicine, tricine, aceglutamide, n-acetylaspartic acid, acetylcarnitine, acetylcysteine, n-acetylglutamic acid, acetylleucine, acivicin, s-adenosyl-l-homocysteine, agaritine, alanosine, aminohippuric acid, l-arginine ethyl
- 30 ester, aspartame, aspartylglucosamine, benzylmercapturic acid, biocytin, brivanib alaninate, carbocysteine, n(6)-carboxymethyllysine, carglumic acid, cilastatin, citiolone, coprine, dibromotyrosine, dihydroxyphenylglycine, eflornithine, fenclonine,

4-fluoro-l-threonine, n-formylmethionine, gamma-l-glutamyl-l-cysteine, 4-(γ-glutamylamino)butanoic acid, glutaurine, glycoxyamine, hadacidin, hepapressin, lisinopril, lymecycline, n-methyl-d-aspartic acid, n-methyl-l-glutamic acid, milacemide, nitrosoproline, nocardicin a, nopaline, octopine, ombrabulin, opine, orthanilic acid, oxaceprol, polylysine, remacemide, salicyluric acid, silk amino acid, stampidine, tabtoxin, tetrazolyglycine, thiorphan, thymectacin, tiopronin, tryptophan tryptophylquinone, valaciclovir, valganciclovir, and combinations thereof;

the amine compound ranges from 0.0010 wt. % to 0.10 wt. %, and is selected independently from the group consisting of ethylene diamine, propylene diamine, organic amine compound containing multi amino groups in the same molecular, and combinations thereof;

the pH adjusting agent ranges from 0.05 wt. % to 0.15 wt.%, and is selected from the group consisting of nitric acid, hydrochloric acid, sulfuric acid, phosphoric acid, sodium hydroxide, potassium hydroxide, ammonium hydroxide, tetraalkylammonium hydroxide, organic amines, and mixtures thereof;

the biocide ranges from 0.0001 wt. % to 0.005 wt. %, and is selected from the group consisting of methylisothiazolinone; methylchloroisothiazolinone; quaternary ammonium compound selected from the group consisting of tetramethylammonium chloride, tetraethylammonium chloride, tetrapropylammonium chloride, alkylbenzyltrimethylammonium chloride and alkylbenzyltrimethylammonium hydroxide; wherein the alkyl chain ranges from 1 to about 20 carbon atoms; chloro-containing compound selected from the group consisting of chlorite and sodium hypochlorite; biguanide; aldehyde; ethylene oxide; metallic salt, isothiazolinone; indophor; and combinations thereof; and

the surfactant ranges from 0.001 wt. % to 0.05 wt. %, and is selected from the group consisting of non-ionic surfactant selected from the group consisting of alcohol ethoxylates, acetylenic diol surfactants, and combinations thereof; anionic surfactant selected from the group consisting of secondary alkane sulfonates, dodecyl sulfate, sodium salt, lauryl sulfate, potassium salt, and combinations thereof; cationic surfactant selected from the group consisting of quaternary ammonium based surfactant; and amphoteric surfactant selected from the group consisting of betaine and amino acid derivatives based surfactant; and combinations thereof.

5. The chemical mechanical polishing (CMP) polishing composition for cobalt-containing substrate of Claim 3, wherein the phosphate compound is an inorganic salt of phosphoric acid or an organophosphate compound.
- 5 6. The chemical mechanical polishing (CMP) polishing composition for cobalt-containing substrate of Claim 1 comprises 0.1 wt.% to 2.5 wt.% of nano-sized colloidal silica or high purity colloidal silica particles; 0.825 wt. % to 1.65 wt. % of alanine selected from the group consisting of D-Alanine, L-Alanine, DL-Alanine, and combinations thereof; 5 ppm to 20 ppm of ammonium phosphate or potassium phosphate in monobasic, dibasic or tribasic form; 0.05 wt. % to 0.15 wt. % of 1,2,4-
10 triazole and its derivatives, benzotriazole and its derivatives, 1,2,3-triazole and its derivatives, pyrazole and its derivatives, imidazole and its derivatives, benzoimidazole and its derivatives, benzoimidazole and its derivatives, isocyanurate and its derivatives, and combinations thereof; 0.5 wt.% to 1.5 wt.% of periodic acid,
15 hydrogen peroxide, potassium iodate, potassium permanganate, ammonium persulfate, ammonium molybdate, ferric nitrate, nitric acid, potassium nitrate, and mixtures thereof; and the chemical mechanical polishing (CMP) polishing composition having a pH from 7.0 to about 9.0.
- 20 7. The chemical mechanical polishing (CMP) polishing composition for cobalt-containing substrate of Claim 6, further comprises at least one of
0.5 wt. % to 2 wt. % of glycine, picolinic acid, and combinations thereof;
0.0025 wt. % to 0.050 wt. % of ethylene diamine, propylene diamine, organic amine compound containing multi amino groups in the same molecular, and combinations
25 thereof;
0.05 wt. % to 0.15 wt.% of nitric acid, hydrochloric acid, sulfuric acid, phosphoric acid, sodium hydroxide, potassium hydroxide, ammonium hydroxide, tetraalkylammonium hydroxide, and mixtures thereof;
0.00015 wt. % to 0.0025 wt. % of isothiazolinone selected from the group consisting of methylisothiazolinone, methylchloroisothiazolinone, benzisothiazolinone, and
30 combinations thereof; and
0.0025 wt.% to 0.025 wt.% of the surfactant.

8. The chemical mechanical polishing (CMP) polishing composition for cobalt-containing substrate of Claim 6 comprises high purity colloidal silica particles; DL-Alanine, ammonium phosphate or potassium phosphate in monobasic, dibasic or tribasic form; 3-amino-1,2,4-triazole, 1,3,5-Tris(2-hydroxyethyl)isocyanurate, or combinations of 3-amino-1,2,4-triazole and 1,3,5-Tris(2-hydroxyethyl)isocyanurate, hydrogen peroxide, and ethylene diamine.
9. A method of chemical mechanical polishing comprising:
 - a) providing a semiconductor substrate having a surface containing a first material and at least one second material; wherein the first material is Co and the second material is selected from the group consisting of dielectric film, low-k and ultra low-k film, and barrier film;
 - b) providing a polishing pad;
 - providing a chemical mechanical polishing composition comprising
 - 0.005 wt. % to 25 wt.% of abrasive;
 - 0.05 wt. % to 5 wt. % of α -alanine;
 - from 2 ppm to 100 ppm of phosphate compound comprising $\text{H}_2\text{PO}_4^{1-}$, HPO_4^{2-} , or PO_4^{3-} ;
 - 0.0005 wt. % to 0.25 wt. % of corrosion inhibitor;
 - 0.005 wt. % to 10 wt. % of oxidizer;
 - water; and
 - the chemical mechanical polishing (CMP) polishing composition having a pH from 2.0 to about 12;
 - and optionally
 - 0.0001 wt. % to 0.20 wt. % of amine compound;
 - 0.01 wt.% to 10 wt.% of chelating agent;
 - 0.01 wt. % to 0.5 wt. % of pH adjusting agent;
 - 0.00001 wt. % to 0.10 wt. % of biocide; and

0.0005 wt. % to 0.15 wt. % of surfactant;

and

- c) polishing the surface of the semiconductor substrate to remove the first material; and

5 wherein at least a portion of the surface is in contact with both the polishing pad and the chemical mechanical polishing composition.

10. The method of chemical mechanical polishing of Claim 9, wherein the second material is selected from the group consisting of TEOS, SixNy (with $1.0 < x < 3.0$,
10 $1.33 < y < 4.0$), Ta, TaN, Ti, and TiN.

11. The method of chemical mechanical polishing of Claim 9, wherein the chemical mechanical polishing composition comprises

15 the abrasive is selected from the group consisting of nano-sized colloidal silica or high purity colloidal silica particles; nano-sized inorganic metal oxide particles selected from the group consisting of alumina, titania, zirconia, ceria and combinations thereof; nano-sized diamond particles; nano-sized silicon nitride particles; mono-modal, bi-modal, or multi-modal colloidal abrasive particles; organic polymer-based soft abrasives; surface-coated or modified abrasives; and

20 combinations thereof; and ranges from 0.05 wt.% to 5 wt.%;

the alanine is selected from the group consisting of D-Alanine, L-Alanine, DL-Alanine, and combinations thereof; and ranges from 0.5 wt.% to 2 wt.%;

the phosphate compound comprising $\text{H}_2\text{PO}_4^{1-}$, HPO_4^{2-} , or PO_4^{3-} is in a form selected from the group consisting of phosphate ion (tribasic), hydrogen phosphate ion (dibasic), dihydrogen phosphate (mono-basic), trihydrogen phosphate (acid), and

25 combinations thereof; and ranges from 2 ppm to 50 ppm;

the corrosion inhibitor is selected from the group consisting of 1,2,4-triazole and its derivatives, benzotriazole and its derivatives, 1,2,3-triazole and its derivatives, pyrazole and its derivatives, imidazole and its derivatives, benzoimidazole and its

30 derivatives, benzoimidazole and its derivatives, isocyanurate and its derivatives, and combinations thereof; and ranges from 0.0025 wt. % to 0.25 wt. %;

- the oxidizing agent is selected from the group consisting of periodic acid, hydrogen peroxide, potassium iodate, potassium permanganate, ammonium persulfate, ammonium molybdate, ferric nitrate, nitric acid, potassium nitrate, and mixtures thereof; and ranges from 0.25 wt. % to 3 wt. %;
- 5 the chemical mechanical polishing (CMP) polishing composition having a pH from 6.0 to about 10;
- and optionally
- the chelating agent range from 0.1 wt. % to 5 wt. % and is selected independently from the group consisting of glycine, serine, proline, histidine, isoleucine, leucine,
- 10 lysine, methionine, phenylalanine, threonine, tryptophan, valine, arginine, asparagine, aspartic acid, cysteine, glutamic acid, glutamine, ornithine, picolinic acid, selenocysteine, tyrosine, sarcosine, bicine, tricine, aceglutamide, n-acetylaspartic acid, acetylcarnitine, acetylcysteine, n-acetylglutamic acid, acetylleucine, acivicin, s-
- 15 adenosyl-L-homocysteine, agaritine, alanosine, aminohippuric acid, L-arginine ethyl ester, aspartame, aspartylglucosamine, benzylmercapturic acid, biocytin, brivanib alaninate, carbocysteine, n(6)-carboxymethyllysine, carglumic acid, cilastatin, citiolone, coprine, dibromotyrosine, dihydroxyphenylglycine, eflornithine, fenclonine, 4-fluoro-L-threonine, n-formylmethionine, gamma-L-glutamyl-L-cysteine, 4-(γ-
- 20 glutamylamino)butanoic acid, glutaaurine, glycocysteine, hadacidin, hepapressin, lisinopril, lymecycline, n-methyl-D-aspartic acid, n-methyl-L-glutamic acid, milacemide, nitrosoproline, nocardicin A, nopaline, octopine, ombrabulin, opine, orthanilic acid, oxaceprol, polylysine, remacemide, salicylic acid, silk amino acid, stampidine, tabtoxin, tetrazolylglycine, thiorphan, thymectacin, tiopronin, tryptophan tryptophylquinone, valaciclovir, valganciclovir, and combinations thereof;
- 25 the amine compound ranges from 0.0010 wt. % to 0.10 wt. %, and is selected independently from the group consisting of ethylene diamine, propylene diamine, organic amine compound containing multi amino groups in the same molecular, and combinations thereof;
- the pH adjusting agent ranges from 0.05 wt. % to 0.15 wt.%, and is selected from the
- 30 group consisting of nitric acid, hydrochloric acid, sulfuric acid, phosphoric acid, sodium hydroxide, potassium hydroxide, ammonium hydroxide, tetraalkylammonium hydroxide, organic amines, and mixtures thereof;

- the biocide ranges from 0.0001 wt. % to 0.005 wt. %, and is selected from the group consisting of methylisothiazolinone; methylchloroisothiazolinone; quaternary ammonium compound selected from the group consisting of tetramethylammonium chloride, tetraethylammonium chloride, tetrapropylammonium chloride, alkylbenzyltrimethylammonium chloride and alkylbenzyltrimethylammonium hydroxide; wherein the alkyl chain ranges from 1 to about 20 carbon atoms; chloro-containing compound selected from the group consisting of chlorite and sodium hypochlorite; biguanide; aldehyde; ethylene oxide; metallic salt, isothiazolinone; indophor; and combinations thereof;
- the surfactant ranges from 0.001 wt. % to 0.05 wt. %, and is selected from the group consisting of non-ionic surfactant selected from the group consisting of alcohol ethoxylates, acetylenic diol surfactants, and combinations thereof; anionic surfactant selected from the group consisting of secondary alkane sulfonates, dodecyl sulfate, sodium salt, lauryl sulfate, potassium salt, and combinations thereof; cationic surfactant selected from the group consisting of quaternary ammonium based surfactant; and amphoteric surfactant selected from the group consisting of betaine and amino acid derivatives based surfactant; and combinations thereof.
12. The method of chemical mechanical polishing of Claim 11, wherein the phosphate compound is an inorganic salt of phosphoric acid or an organophosphate compound.
13. The method of chemical mechanical polishing of Claim 9, wherein the chemical mechanical polishing (CMP) polishing comprises 0.1 wt.% to 2.5 wt.% of nano-sized colloidal silica or high purity colloidal silica particles; 0.825 wt. % to 1.65 wt. % of alanine selected from the group consisting of D-Alanine, L-Alanine, DL-Alanine, and combinations thereof; 5 ppm to 20 ppm of ammonium phosphate or potassium phosphate in monobasic, dibasic or tribasic form; 0.05 wt. % to 0.15 wt. % of 1,2,4-triazole and its derivatives, benzotriazole and its derivatives, 1,2,3-triazole and its derivatives, pyrazole and its derivatives, imidazole and its derivatives, benzoimidazole and its derivatives, benzoimidazole and its derivatives, isocyanurate and its derivatives, and combinations thereof; 0.5 wt.% to 1.5 wt.% of periodic acid, hydrogen peroxide, potassium iodate, potassium permanganate, ammonium persulfate, ammonium molybdate, ferric nitrate, nitric acid, potassium nitrate, and

- mixtures thereof; and the chemical mechanical polishing (CMP) polishing composition having a pH from 7.0 to about 9.0;
- and optionally
- 0.5 wt. % to 2 wt. % of glycine, picolinic acid, and combinations thereof;
- 5 0.0025 wt. % to 0.050 wt. % of ethylene diamine, propylene diamine, organic amine compound containing multi amino groups in the same molecular, and combinations thereof;
- 0.05 wt. % to 0.15 wt.% of nitric acid, hydrochloric acid, sulfuric acid, phosphoric acid, sodium hydroxide, potassium hydroxide, ammonium hydroxide,
- 10 tetraalkylammonium hydroxide, and mixtures thereof;
- 0.00015 wt. % to 0.0025 wt. % of isothiazolone selected from the group consisting of methylisothiazolinone, methylchloroisothiazolinone, benzisothiazolinone, and combinations thereof; and
- 0.0025 wt.% to 0.025 wt. %.of the surfactant.
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14. The method of chemical mechanical polishing of Claim 13, wherein the chemical mechanical polishing (CMP) polishing composition comprises high purity colloidal silica particles; DL-Alanine, ammonium phosphate or potassium phosphate in monobasic, dibasic or tribasic form; 3-amino-1,2,4-triazole, 1,3,5-Tris(2-
- 20 hydroxyethyl)isocyanurate, or combinations of 3-amino-1,2,4-triazole and 1,3,5-Tris(2-hydroxyethyl)isocyanurate, hydrogen peroxide, and ethylene diamine.
15. The method of chemical mechanical polishing of Claim 14, wherein at least a portion of the surface is in contact with both the polishing pad and the chemical mechanical
- 25 polishing composition; and the second material is selected from the group consisting of TEOS, SixNy (with $1.0 < x < 3.0$, $1.33 < y < 4.0$), Ta, TaN, Ti, and TiN.
16. A chemical mechanical polishing (CMP) system comprising:
- a semiconductor substrate having a surface containing a first material and at least
- 30 one second material;

- wherein the first material is Co and the second material is selected from the group consisting of dielectric films (such as TEOS, SixNy (with $1.0 < x < 3.0$, $1.33 < y < 4.0$), low-k and ultra low-k films, and barrier films (such as Ta, TaN, Ti, and TiN films);
- a polishing pad;
- 5 a chemical mechanical polishing composition comprising
- 0.005 wt. % to 25 wt.% of abrasive;
- 0.05 wt. % to 5 wt. % of α -alanine;
- from 2 ppm to 100 ppm of phosphate compound comprising $\text{H}_2\text{PO}_4^{1-}$, HPO_4^{2-} , or PO_4^{3-} ;
- 10 0.0005 wt. % to 0.25 wt. % of corrosion inhibitor;
- 0.005 wt. % to 10 wt. % of oxidizer;
- water;
- the chemical mechanical polishing (CMP) polishing composition having a pH from 2.0 to about 12;
- 15 and optionally:
- 0.0001 wt. %t to 0.20 wt. % of amine compound;
- 0.01 wt.% to 10 wt.% of chelating agent;
- 0.01 wt. % to 0.5 wt. % of pH adjusting agent;
- 0.00001 wt. % to 0.10 wt. % of biocide; and
- 20 0.0005 wt. % to 0.15 wt. % of surfactant;
- and
- wherein at least a portion of the surface is in contact with both the polishing pad and the chemical mechanical polishing composition.
- 25 17. The chemical mechanical polishing (CMP) system of Claim 16, wherein the chemical mechanical polishing composition comprises
- the abrasive is selected from the group consisting of nano-sized colloidal silica or high purity colloidal silica particles; nano-sized inorganic metal oxide particles selected from the group consisting of alumina, titania, zirconia, ceria and

combinations thereof; nano-sized diamond particles; nano-sized silicon nitride particles; mono-modal, bi-modal, or multi-modal colloidal abrasive particles; organic polymer-based soft abrasives; surface-coated or modified abrasives; and combinations thereof; and ranges from 0.05 wt.% to 5 wt.%;

5 the alanine is selected from the group consisting of D-Alanine, L-Alanine, DL-Alanine, and combinations thereof; and ranges from 0.5 wt.% to 2 wt.%;

the phosphate compound comprising $\text{H}_2\text{PO}_4^{1-}$, HPO_4^{2-} , or PO_4^{3-} is in a form selected from the group consisting of phosphate ion (tribasic), hydrogen phosphate ion (dibasic), dihydrogen phosphate (mono-basic), trihydrogen phosphate (acid), and

10 combinations thereof; and ranges from 2 ppm to 50 ppm;

the corrosion inhibitor is selected from the group consisting of 1,2,4-triazole and its derivatives, benzotriazole and its derivatives, 1,2,3-triazole and its derivatives, pyrazole and its derivatives, imidazole and its derivatives, benzoimidazole and its derivatives, benzoimidazole and its derivatives, isocyanurate and its derivatives, and

15 combinations thereof; and ranges from 0.0025 wt. % to 0.25 wt. %;

the oxidizing agent is selected from the group consisting of periodic acid, hydrogen peroxide, potassium iodate, potassium permanganate, ammonium persulfate, ammonium molybdate, ferric nitrate, nitric acid, potassium nitrate, and mixtures thereof; and ranges from 0.25 wt. % to 3 wt. %;

20 the chemical mechanical polishing (CMP) polishing composition having a pH from 6.0 to about 10;

and optionally

the chelating agent ranges from 0.1 wt. % to 5 wt. % and is selected independently from the group consisting of glycine, serine, proline, histidine, isoleucine, leucine,

25 lysine, methionine, phenylalanine, threonine, tryptophan, valine, arginine, asparagine, aspartic acid, cysteine, glutamic acid, glutamine, ornithine, picolinic acid, selenocysteine, tyrosine, sarcosine, bicine, tricine, aceglutamide, n-acetylaspartic acid, acetylcarnitine, acetylcysteine, n-acetylglutamic acid, acetylleucine, acivicin, s-adenosyl-L-homocysteine, agaritine, alanosine, aminohippuric acid, L-arginine ethyl

30 ester, aspartame, aspartylglucosamine, benzylmercapturic acid, biocytin, brivanib alaninate, carbocysteine, n(6)-carboxymethyllysine, carglumic acid, cilastatin, citiolone, coprine, dibromotyrosine, dihydroxyphenylglycine, eflornithine, fenclonine,

4-fluoro-l-threonine, n-formylmethionine, gamma-l-glutamyl-l-cysteine, 4-(γ-glutamylamino)butanoic acid, glutaurine, glycocycamine, hadacidin, hepapressin, lisinopril, lymecycline, n-methyl-d-aspartic acid, n-methyl-l-glutamic acid, milacemide, nitrosoproline, nocardicin a, nopaline, octopine, ombrabulin, opine, orthanilic acid, oxaceprol, polylysine, remacemide, salicyluric acid, silk amino acid, stampidine, tabtoxin, tetrazolyglycine, thiorphan, thymectacin, tiopronin, tryptophan tryptophylquinone, valaciclovir, valganciclovir, and combinations thereof;

the amine compound ranges from 0.0010 wt. % to 0.10 wt. %, and is selected independently from the group consisting of ethylene diamine, propylene diamine, organic amine compound containing multi amino groups in the same molecular, and combinations thereof;

the pH adjusting agent ranges from 0.05 wt. % to 0.15 wt.%, and is selected from the group consisting of nitric acid, hydrochloric acid, sulfuric acid, phosphoric acid, sodium hydroxide, potassium hydroxide, ammonium hydroxide, tetraalkylammonium hydroxide, organic amines, and mixtures thereof.

the biocide ranges from 0.0001 wt. % to 0.005 wt. %, and is selected from the group consisting of methylisothiazolinone; methylchloroisothiazolinone; quaternary ammonium compound selected from the group consisting of tetramethylammonium chloride, tetraethylammonium chloride, tetrapropylammonium chloride, alkylbenzyltrimethylammonium chloride and alkylbenzyltrimethylammonium hydroxide; wherein the alkyl chain ranges from 1 to about 20 carbon atoms; chloro-containing compound selected from the group consisting of chlorite and sodium hypochlorite; biguanide; aldehyde; ethylene oxide; metallic salt, isothiazolinone; indophor; and combinations thereof;

the surfactant ranges from 0.001 wt. % to 0.05 wt. %, and is selected from the group consisting of non-ionic surfactant selected from the group consisting of alcohol ethoxylates, acetylenic diol surfactants, and combinations thereof; anionic surfactant selected from the group consisting of secondary alkane sulfonates, dodecyl sulfate, sodium salt, lauryl sulfate, potassium salt, and combinations thereof; cationic surfactant selected from the group consisting of quaternary ammonium based surfactant; and amphoteric surfactant selected from the group consisting of betaine and amino acid derivatives based surfactant; and combinations thereof.

18. The chemical mechanical polishing (CMP) system of Claim 17, wherein the phosphate compound is an inorganic salt of phosphoric acid or an organophosphate compound.
- 5 19. The chemical mechanical polishing (CMP) system of Claim 16, wherein the chemical mechanical polishing (CMP) polishing comprises 0.1 wt.% to 2.5 wt.% of nano-sized colloidal silica or high purity colloidal silica particles; 0.825 wt. % to 1.65 wt. % of alanine selected from the group consisting of D-Alanine, L-Alanine, DL-Alanine, and combinations thereof; 5 ppm to 20 ppm of ammonium phosphate or potassium
- 10 phosphate in monobasic, dibasic or tribasic form; 0.05 wt. % to 0.15 wt. % of 1,2,4-triazole and its derivatives, benzotriazole and its derivatives, 1,2,3-triazole and its derivatives, pyrazole and its derivatives, imidazole and its derivatives, benzoimidazole and its derivatives, benzoimidazole and its derivatives, isocyanurate and its derivatives, and combinations thereof; 0.5 wt.% to 1.5 wt.% of periodic acid,
- 15 hydrogen peroxide, potassium iodate, potassium permanganate, ammonium persulfate, ammonium molybdate, ferric nitrate, nitric acid, potassium nitrate, and mixtures thereof; and the chemical mechanical polishing (CMP) polishing composition having a pH from 7.0 to about 9.0;
- and optionally
- 20 0.5 wt. % to 2 wt. % of glycine, picolinic acid, and combinations thereof;
- 0.0025 wt. % to 0.050 wt. % of ethylene diamine, propylene diamine, organic amine compound containing multi amino groups in the same molecular, and combinations thereof;
- 0.05 wt. % to 0.15 wt.% of nitric acid, hydrochloric acid, sulfuric acid, phosphoric
- 25 acid, sodium hydroxide, potassium hydroxide, ammonium hydroxide, tetraalkylammonium hydroxide, and mixtures thereof;
- 0.00015 wt. % to 0.0025 wt. % of isothiazolone selected from the group consisting of methylisothiazolinone, methylchloroisothiazolinone, benzisothiazolinone, and combinations thereof; and
- 30 0.0025 wt.% to 0.025 wt. %.of the surfactant.

20. The chemical mechanical polishing (CMP) system of Claim 19, wherein the chemical mechanical polishing (CMP) polishing composition comprises high purity colloidal silica particles; DL-Alanine, ammonium phosphate or potassium phosphate in monobasic, dibasic or tribasic form; 3-amino-1,2,4-triazole, 1,3,5-Tris(2-hydroxyethyl)isocyanurate, or combinations of 3-amino-1,2,4-triazole and 1,3,5-Tris(2-hydroxyethyl)isocyanurate, hydrogen peroxide, and ethylene diamine.
21. The method of any one of claims 9-15, wherein the method is a selective chemical mechanical polishing method of selectively removing the first material, wherein ratio of removal rate of the first material to removal rate of the second material is equal or greater than 50 and wherein the chemical mechanical polishing composition comprises from 2 ppm to 25 ppm of phosphate compound comprising $\text{H}_2\text{PO}_4^{1-}$, HPO_4^{2-} , or PO_4^{3-} .
22. The method of claim 15, wherein the method is a selective chemical mechanical polishing method of selectively removing the first material, wherein ratio of removal rate of the first material to removal rate of the second material is equal or greater than 100 and wherein the chemical mechanical polishing composition comprises from 2 ppm to 25 ppm of phosphate compound comprising $\text{H}_2\text{PO}_4^{1-}$, HPO_4^{2-} , or PO_4^{3-} .