CLAIMS

1. A chemical mechanical polishing composition for a copper bulk and Through Silica Via (TSV) comprises:

    a) abrasive;

    b) at least two chelators; and

    c) oxidizing agent;

    d) at least one Cu static etching rate reducing agent ;

    e) water;

    optionally

    f) corrosion inhibitor;

    g) organic quaternary ammonium salt;

    h) biocide; and

    i) pH adjusting agent;

    wherein

    the at least two chelators are different chelators and independently selected from the group consisting of amino acids, amino acid derivatives, and combinations therefor;
    the at least one Cu static etching rate reducing agent is an organic alkyl sulfonic acid with straight or branched alkyl chains, and its salts thereof;
    and
    pH of the composition is from 4.0 to 9.0.

2. The chemical mechanical polishing composition of claim 1, wherein the abrasive is selected from the group consisting of colloidal silica; colloidal silica particles doped by other inorganic oxide within lattice of the colloidal silica; colloidal aluminum oxide including alpha-, beta-, and gamma-types of aluminum oxides; colloidal and photoactive titanium dioxide; cerium oxide; colloidal cerium oxide; alumina; titania; zirconia; ceria; nano-sized diamond particles; nano-sized silicon nitride particles; mono-modal, bi-modal, multi-modal colloidal abrasive particles; organic polymer-based soft abrasives; surface-coated or modified abrasives; and combinations thereof; preferably the abrasive is colloidal silica.

~~3. The chemical mechanical polishing composition of claim 1, wherein the abrasive is selected from the group consisting of colloidal silica; colloidal silica particles doped by other inorganic oxide within lattice of the colloidal silica; cerium oxide; colloidal cerium oxide; alumina; titania; zirconia; and combinations thereof.~~

~~4. The chemical mechanical polishing composition of claim 1, wherein the abrasive is colloidal silica.~~

~~5.~~3. The chemical mechanical polishing composition of claim 1, wherein the at least two chelators are different and are independently selected from the group consisting of glycine, D-alanine, L-alanine, DL-alanine, beta-alanine, bicine, tricine, sarcosine, valine, leucine, isoleucine, phenylamine, proline, serine, threonine, tyrosine, glutamine, asparagine, glutamic acid, aspartic acid, tryptophan, histidine, arginine, lysine, methionine, cysteine, iminodiacetic acid, and combinations thereof; preferably the at least two chelators are different and are independently selected from the group consisting of glycine, alanine, bicine, sarcosine, and combinations thereof.

~~6. The chemical mechanical polishing composition of claim 1, wherein the at least two chelators are different independently selected from the group consisting of glycine, D-alanine, L-alanine, DL-alanine, bicine, tricine, sarcosine, and combinations thereof.~~

~~7. The chemical mechanical polishing composition of claim 1, wherein the at least two chelators are different and are independently selected from the group consisting of glycine, alanine, bicine, sarcosine, and combinations thereof.~~

~~8.~~4. The chemical mechanical polishing composition of claim 1, wherein 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 combinations thereof; preferably the oxidizing agent is hydrogen peroxide.

~~9. The chemical mechanical polishing composition of claim 1, wherein the oxidizing agent is hydrogen peroxide.~~

~~10.~~5. The chemical mechanical polishing composition of claim 1, wherein the at least one Cu static etching rate reducing agent is selected from the group consisting of dodecyl sulfonic acid, dodecyl sulfonate, ammonium dodecyl sulfonate, potassium dodecyl sulfonate, sodium dodecyl sulfonate, and combinations thereof; preferably the at least one Cu static etching rate reducing agent is ammonium dodecyl sulfonate.

~~11. The chemical mechanical polishing composition of claim 1, wherein the at least one Cu static etching rate reducing agent is ammonium dodecyl sulfonate, potassium dodecyl sulfonate, sodium dodecyl sulfonate, and combinations thereof.~~

~~12.~~6. The chemical mechanical polishing composition of claim 1, wherein the corrosion inhibitor is selected from the group consisting of hetero aromatic compounds containing nitrogen atom in their aromatic rings.

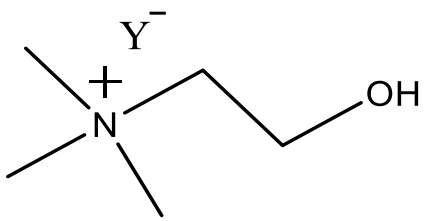
~~13.~~7. The chemical mechanical polishing composition of claim 1, wherein the corrosion inhibitor is selected from the group consisting of 1,2,4-triazole, amitrole (or called 3-amino-1,2,4-triazole), 3,5-dimino-1,2,4-triazole, benzotriazole or benzotriazole derivatives, tetrazole or tetrazole derivatives, imidazole or imidazole derivatives, benzimidazole or benzimidazole derivatives, pyrazole or pyrazole derivatives, tetrazole or tetrazole derivatives, and combinations thereof; preferably the corrosion inhibitor is selected from the group consisting of amitrole, 2-amino-benzimidazole, imidazole or imidazole derivatives, and combinations thereof.

~~14. The chemical mechanical polishing composition of claim 1, wherein the corrosion inhibitor is selected from the group consisting of amitrole, 2-amino-benzimidazole, imidazole or imidazole derivatives, and combinations thereof.~~

~~15. The chemical mechanical polishing composition of claim 1, wherein the organic quaternary ammonium salt is selected from the group consisting of choline salts.~~

~~16. The chemical mechanical polishing composition of claim 1, wherein the organic quaternary ammonium salt is a choline bicarbonate salt, or a salt formed between choline and other anionic counter ions.~~

~~17.~~8. The chemical mechanical polishing composition of claim 1, wherein the organic quaternary ammonium salt is a choline salt having a general molecular structure of:



wherein anion Y^- is selected from the group consisting of bicarbonate, hydroxide, p-toluene-sulfonate, bitartrate, and combinations thereof; preferably the organic quaternary ammonium salt is a choline bicarbonate salt.

~~18.~~9. The chemical mechanical polishing composition of claim 1, wherein the biocide comprises 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.

~~19.~~10. The chemical mechanical polishing composition of claim 1, 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 combinations thereof; or the pH adjusting agent is selected from the group consisting of sodium hydride, potassium hydroxide, ammonium hydroxide, tetraalkyl ammonium hydroxide, organic amines, and combinations thereof.

~~20.~~11. The chemical mechanical polishing composition of claim 1, wherein the chemical mechanical polishing composition comprises colloidal silica; at least two different amino acids independently selected from the group consisting glycine, alanine, bicine, sarcosine, and combinations thereof; at least one Cu static etching rate reducing agent is ammonium dodecyl sulfonate, potassium dodecyl sulfonate, sodium dodecyl sulfonate, and

combinations thereof; hydrogen peroxide; and the pH of the chemical mechanical polishing composition is from 5.0 to 9.0.

~~21.~~12. The chemical mechanical polishing composition of claim 1, wherein the chemical mechanical polishing composition comprises colloidal silica; at least two different amino acids independently selected from the group consisting glycine, alanine, bicine, sarcosine, and combinations thereof; a corrosion inhibitor selected from the group consisting of amitrole, 2-amino-benzimidazole, imidazole, and combinations thereof; at least one Cu static etching rate reducing agent is selected from the group consisting of ammonium dodecyl sulfonate, potassium dodecyl sulfonate, sodium dodecyl sulfonate, and combinations thereof; a choline bicarbonate salt; hydrogen peroxide; and the pH of the chemical mechanical polishing composition is from 5.0 to 9.0.

~~22.~~13. The chemical mechanical polishing composition of claim 1, wherein the chemical mechanical polishing composition comprises colloidal silica; at least two different amino acids independently selected from the group consisting glycine, alanine, bicine, sarcosine, and combinations thereof; at least one Cu static etching rate reducing agent is selected from the group consisting of ammonium dodecyl sulfonate, potassium dodecyl sulfonate, sodium dodecyl sulfonate, and combinations thereof; hydrogen peroxide; and the pH of the chemical mechanical polishing composition is from 6.0 to 8.5.

~~23.~~14. The chemical mechanical polishing composition of claim 1, wherein the chemical mechanical polishing composition comprises colloidal silica; at least two different amino acids independently selected from the group consisting glycine, alanine, bicine, sarcosine, and combinations thereof; a corrosion inhibitor selected from the group consisting of amitrole, 2-amino-benzimidazole, imidazole, and combinations thereof; at least one Cu static etching rate reducing agent is selected from the group consisting of ammonium dodecyl sulfonate, potassium dodecyl sulfonate, sodium dodecyl sulfonate, and combinations thereof; a choline bicarbonate salt; hydrogen peroxide; and the pH of the chemical mechanical polishing composition is from 6.0 to 8.5.

~~24.~~15. A method of chemical mechanical polishing a semiconductor substrate containing at least one copper or copper-containing surface, comprising steps of:

a) providing the semiconductor substrate;

b) providing a polish pad;

c) providing the chemical mechanical polishing composition according to any one of claims 1 to 23;

d) contacting the semiconductor substrate with the polish pad and the chemical mechanical polishing composition; and

e) polishing the semiconductor substrate;

wherein at least one portion of the at least one copper or copper-containing surface is in contact with both the polishing pad and the chemical mechanical polishing composition.

~~25.~~16. A method of chemical mechanical polishing a semiconductor substrate containing a first material and a second material, comprising steps of:

a) providing a semiconductor substrate having at least one surface containing a first material and at least one second material;

b) providing a polishing pad;

c) providing the chemical mechanical polishing composition according to any one of claims 1 to ~~23~~14;

d) polishing the semiconductor substrate to selectively remove the first material;

wherein removal rate of the first material to removal rate of the second material is equal or greater than 500:1; 1000:1; or 3000:1; and

the first material comprises copper and the second material is selected from the group consisting of barrier layer material selected from the group consisting of Ta, TaN, Ti, TiN, SiN, and combinations thereof; dielectric layer material selected from the group consisting of TEOS, low-k, ultra-low-k, and combinations thereof.

~~26.~~17. A system of chemical mechanical polishing a semiconductor substrate containing at least one copper or copper-containing surface, comprising

1) the semiconductor substrate;

2) a polish pad; and

3) the chemical mechanical polishing composition according to any one of claims 1 to ~~23~~14;

wherein at least one portion of the at least one copper or copper-containing surface is in contact with both the polishing pad and the chemical mechanical polishing composition.