CLAIMS

1. A post Chemical Mechanical Planarization(CMP) cleaning composition consisting essentially of:

   at least one organic acid or salts thereof selected from the group consisting of dicarboxylic acid, hydroxycarboxylic acid, polycarboxylic acid, salts thereof, and combinations thereof;

   a fluoride compound selected from the group consisting of hydrofluoric acid, ammonium fluoride, ammonium bifluoride, quaternary ammonium fluoride and combinations thereof;

   at least one polymeric additive selected from the group consisting of anionic polymer, non-ionic polymer and cationic polymer and combinations thereof; and

   water;

   optionally

   a surfactant selected from the group consisting of non-ionic surfactants, anionic surfactants, cationic surfactants, ampholytic surfactants, and mixtures thereof;

   chelating agent;

   corrosion inhibitor;

   biological preservative;

   defoaming agent; and

   pH adjusting agent;

   wherein the composition has a pH of between 1 to 7, and

   wherein malonic acid or salts thereof when present, are present in an amount from 0.5 to 5 wt. % of the composition.

2. The post CMP cleaning composition of Claim 1, wherein the polymeric additive is selected from the group consisting of acrylic acid- acrylamido propane sulfonic acid copolymer and salts thereof; poly(acrylic acid) and salts thereof; poly(meth-acrylic acid) and salts thereof; poly(2-acrylamido-2-methyl-1-propanesulfonic acid and salts thereof, carboxymethyl cellulose, methyl cellulose, hydroxypropyl methyl cellulose, poly-(1-vinylpyrroliddone-co-2-dimethylaminoethyl methacrylate), poly(sodium 4-styrenesulfonate), polymer or copolymer comprising ethylene oxide, propylene oxide, or combinations of ethylene oxide and propylene oxide; poly(4-sytrenesulfonic acid) and salts thereof; polyacrylamide; poly(acrylamide/acrylic acid) copolymer and salts thereof;

and combinations thereof; and the polymeric additive has a molecular weight range between 100-1,000,000

3. The post CMP cleaning composition of Claim 1, wherein the at least one organic acid or salts thereof ranges from 1 to 30 wt.%, the polymeric additive ranges from 0.1 to 3 wt.%, the fluoride compound ranges from 1 to 25 wt.%, and the post CMP cleaning composition is optionally diluted with DI water 2 to 500 times at point of use.

4. The post CMP cleaning composition of Claim 1, wherein the at least one organic acid or salts thereof is selected from the group consisting of hydroxycarboxylic acid or salts thereof, dicarboxylic acid or salts thereof, and combinations thereof.

5. The post CMP cleaning composition of Claim 1, wherein the organic acid or salts thereof is selected from the group consisting of oxalic acid, citric acid, malonic acid or salts thereof and combinations thereof; the polymeric additive is selected from the group consisting of anionic polymer or copolymer comprising ethylene oxide, propylene oxide, or combinations of ethylene oxide and propylene oxide; and combinations thereof.

6. The post CMP cleaning composition of Claim 1, wherein the post CMP cleaning composition comprises 0.5 to 5 wt.% oxalic acid or salts thereof, 0.5 to 5 wt.% citric acid or salts thereof, 0.5 to 5 wt.% malonic acid or salts thereof; and 0.1 to 2 wt.% polymeric additive selected from the group consisting of acrylic acid- acrylamido propane sulfonic acid copolymer, polypropylene glycol, polyethylene oxide and combinations thereof; and 1 to 25 wt.% of fluoride compound.

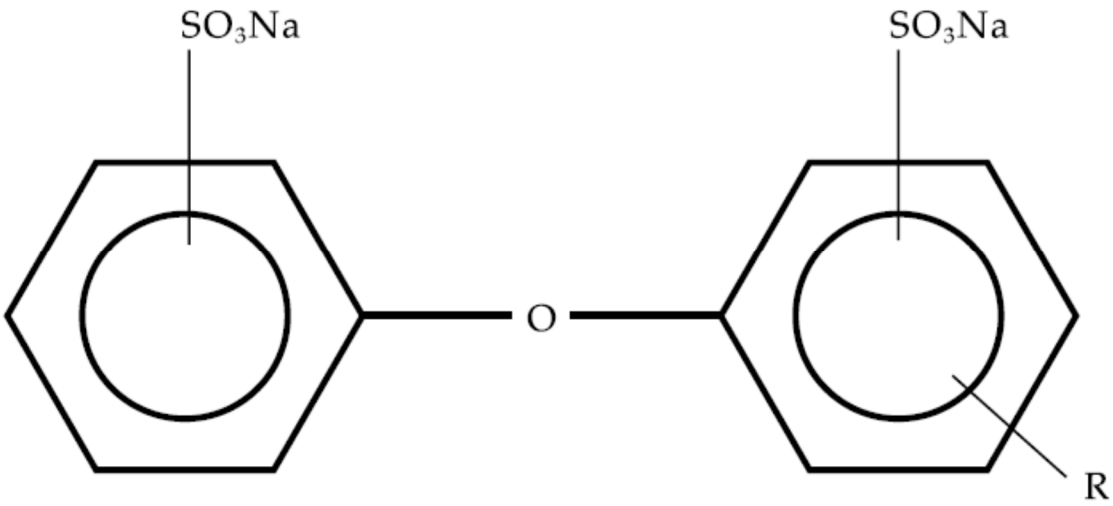
7. The post CMP cleaning composition of Claim 1, wherein the post CMP cleaning composition comprises 1 to 30 wt.% citric acid or salts thereof; 0.1 to 3 wt.% polymeric additive selected from the group consisting of acrylic acid- acrylamido propane sulfonic acid copolymer, polypropylene glycol, polyethylene oxide and combinations thereof; and 1 to 25 wt.% of fluoride compound.

8. The post CMP cleaning composition of Claim 1, wherein the post CMP cleaning composition comprises 0.0001wt.% to 10 wt. % a surfactant; wherein the surfactant is

stable in the composition having conductivity of ≥ 40 mS/cm without any turbidity or precipitation.

9. The post CMP cleaning composition 1, wherein the surfactant comprises at least two negatively charged anionic groups.

10. The post CMP cleaning composition 1, wherein the surfactant is a diphenyl disulfonic acid or its salt having a structure of



wherein R is selected from H, or a linear or branched alkyl group with carbon chain length between 1 and 20.

11. A method of post Chemical Mechanical Planarization (CMP) cleaning semiconductor wafer comprising at least one surface selected from the group consisting of metallic film, dielectric film, and combinations thereof, comprising

providing the semiconductor wafer;

providing a post Chemical Mechanical Planarization (CMP) cleaning composition as defined in any one of claims 1 to 10; and

cleaning the semiconductor wafer using the post CMP cleaning composition.

12. The method of post CMP cleaning of claim 11, wherein the metallic film is selected from the group consisting of copper, tungsten, cobalt, aluminum, titanium, ruthenium, their alloys and combinations thereof; the dielectric layer is selected from the group consisting of silicon oxide film derived from Tetra Ethyl Ortho Silicate (TEOS) precursors, dielectric film with at least one element selected from the group consisting of silicon, carbon, nitrogen, oxygen, hydrogen, and combinations thereof.

13. The method of post CMP cleaning of claim 11, wherein the method of post CMP cleaning is selected from the group consisting of brush box cleaning, spray cleaning, megasonic cleaning, buff cleaning on a pad, single wafer spray tools, batch immersion cleaning tools, and combinations thereof.

14. The method of post CMP cleaning of claim 11, wherein

the post CMP cleaning composition is optionally diluted with DI water 2 to 500 times at point of use; and the diluted CMP cleaning composition etches the dielectric films at an etch rate between 0.2 to 50 Angstroms/min.; etches tungsten at an etch rate less than 1 Angstroms/min; and etches titanium nitride films at etch rates less than 5 angstroms/min at room temperature; and

the at least one surface comprises at least one of SiO_2, W, Ti, TiN, and SiN film.

15. A system for post Chemical Mechanical Planarization (CMP) cleaning semiconductor wafer comprising at least one surface selected from the group consisting of metallic film, dielectric film, and combinations thereof, comprising

the semiconductor wafer; and

a post Chemical Mechanical Planarization (CMP) cleaning composition as defined in any one of claims 1 to 10; and

wherein the at least one surface is in touch with the post CMP cleaning composition.

16. The system for post CMP cleaning of claim 15, wherein the metallic film is selected from the group consisting of copper, tungsten, cobalt, aluminum, titanium, iron, ruthenium, their alloys and combinations thereof; the dielectric layer is selected from the group

consisting of silicon oxide film derived from Tetra Ethyl Ortho Silicate (TEOS) precursors, dielectric film with at least one element selected from the group consisting of silicon, carbon, nitrogen, oxygen, hydrogen, and combinations thereof.

17. The system for post CMP cleaning of claim 15, wherein the system is used for one cleaning method selected from the group consisting of brush box cleaning, spray cleaning, megasonic cleaning, buff cleaning on a pad, single wafer spray tools, batch immersion cleaning tools, and combinations thereof.

18. The system for post CMP cleaning of claim 15, wherein

the post CMP cleaning composition is optionally diluted with DI water 2 to 500 times at point of use; and the diluted CMP cleaning composition etches the dielectric films at an etch rate between 0.2 to 50 Angstroms/min.; etches tungsten at an etch rate less than 1 Angstroms/min; and etches titanium nitride films at etch rates less than 5 angstroms/min at room temperature; and

the at least one surface comprises at least one of SiO_2, W, Ti, TiN, and SiN film.