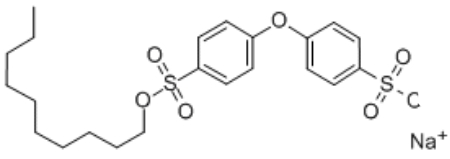
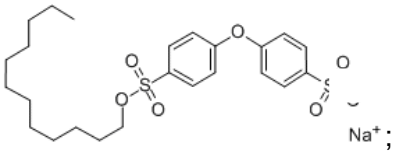
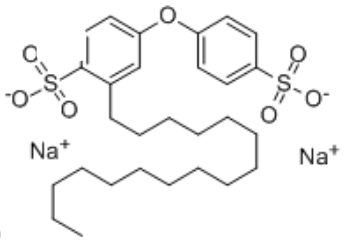
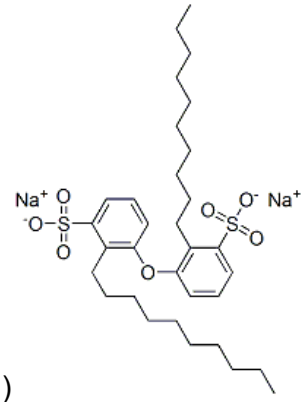
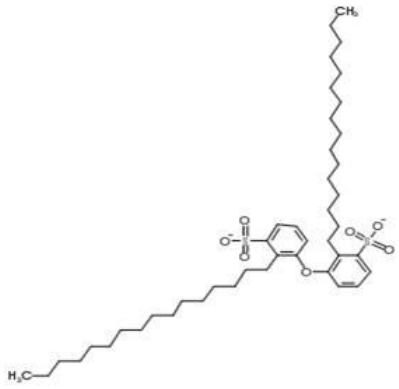
CLAIMS

1. A post Chemical Mechanical Planarization (CMP) cleaning composition comprising:
   at least one organic acid selected from the group consisting of oxalic acid, citric acid, maleic acid, malic acid, malonic acid, gluconic acid, glutaric acid, ascorbic acid, formic acid, acetic acid, ethylene diamine tetraacetic acid, diethylene triamine pentaacetic acid, glycine, a-alanine, cystine, and combinations thereof or its salts;
   at least two surfactants;wherein at least one of the at least two surfactants is a first type surfactant having at least two sulfonic acid groups; and at least one of the at least two surfactants is a second type surfactant which is not the first type surfactant;
   and
   water;
   optionally:
   fluoride compound;
   water soluble polymer or copolymer;
   corrosion inhibitor;
   biological preservative; and
   pH adjusting agent,
   wherein the composition has a pH of between 1 to 7; preferably 2 to 6, or more preferably 3 to 6; and
   the first type surfactant is a diphenyl disulfonic acid or its salt; the second type surfactant comprising a secondary alkane sulfonic acid with C_{12}-C_{17} hydrophobic chain.

2. The post CMP cleaning composition of Claim 1, wherein the first type surfactant has a structure selected from the group consisting of:

(a)  Na^+; (b)  Na^+;

(c)  ; (d)  ;

and (f)  .

3. The post CMP cleaning composition of Claim 1, wherein the second type surfactant has a surface tension of < 50 dynes/cm, preferably of <45 dynes/cm at concentration of 0.01 wt.% in water.

4. The post CMP cleaning composition of Claim 1, wherein
the fluoride compound is selected from the group consisting of hydrofluoric acid, ammonium fluoride, ammonium bifluoride, quaternary ammonium fluorides, and combinations thereof,
the water soluble polymer comprises a group selected from the group consisting of sulfonic acid group, acrylic acid group, and combinations thereof; and the water soluble copolymer comprises monomers having a group selected from the group consisting of sulfonic acid group, acrylic acid group, and combinations thereof;
the corrosion inhibitor is selected from the group consisting of oligomer or polymer comprising of ethyleneimine, propyleneimine, polyethyleneimine (PEI), and combinations

thereof; wherein molecular weight of the oligomer or polymer ranges from between 500 and 15000;
the biological preservative is selected from the group consisting of: tetramethylammonium chloride; tetraethylammonium chloride; tetrapropylammonium chloride; alkylbenzyldimethylammonium chloride; alkylbenzyldimethylammonium hydroxide; sodium chlorite; sodium hypochlorite; isothiazolinone compound selected from the group consisting of methylisothiazolinone, methylchloroisothiazolinone, benzisothiazolinone, and combinations thereof; and/or
the pH adjusting agent is selected from the group consisting of inorganic acid, nitric acid, sulfonic acid, or phosphoric acid; inorganic base selected from the group consisting of ammonium hydroxide, potassium hydroxide or sodium hydroxide; and organic base selected from the group consisting of quaternary ammonium hydroxide, and amine compound.

5. The post CMP cleaning composition of Claim 1, wherein the fluoride compound is ammonium fluoride.

6. The post CMP cleaning composition of Claim 1, wherein the water soluble polymer or copolymer is selected from the group consisting of acrylic acid-acrylamido propane sulfonic acid copolymer, poly(acrylic acid), poly(meth-acrylic acid), poly(2-acrylamido-2-methyl-1-propanesulfonic acid, carboxymethyl cellulose, methyl cellulose, hydroxypropyl methyl cellulose, poly-(1-vinylpyrroliddone-co-2-dimethylaminoethyl methacrylate), poly(sodium 4-styrenesulfonate), poly(ethylene oxide), poly(4-sytrenesulfonic acid), polyacrylamide, poly(acrylamide/acrylic acid) copolymer, and combinations thereof; wherein molecular weight of the water soluble polymer or copolymer ranges from 100 to 10,000,000.

7. The post CMP cleaning composition of Claim 1, wherein the composition has turbidity less than 2.5NTU, preferably 2 NTU, or more preferably 1 NTU.

8. The post CMP cleaning composition of Claim 1, wherein the composition comprises at least one organic acid selected from the group consisting of oxalic acid, citric acid, malonic acid, and combinations thereof; the first type surfactant comprising two or more

sulfonic acid groups is a diphenyl disulfonic acid or its salt; and optionally the fluoride compound selected from the group consisting of hydrofluoric acid, ammonium fluoride, ammonium bifluoride, quaternary ammonium fluorides, and combinations thereof; and optionally the water soluble polymer comprising acrylic acid group or the water soluble copolymer comprising monomers having acrylic acid group.

9. 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 the post Chemical Mechanical Planarization (CMP) cleaning composition of any one of claims 1 to 9; and
cleaning the semiconductor wafer using the post CMP cleaning composition;
wherein the metallic film is selected from the group consisting of tungsten, copper, cobalt, ruthenium, aluminum, and combinations thereof.

10. The method of post Chemical Mechanical Planarization (CMP) cleaning of claim 9; where the method removes metallic residues selected from the group consisting of Fe, W, Ti, TiN and combinations thereof from the at least one surface.

11. The method of post Chemical Mechanical Planarization (CMP) cleaning of claim 9, wherein the composition is diluted with water 2 to 500 times at point of use.

12. 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
the post Chemical Mechanical Planarization (CMP) cleaning composition of any one of claims 1 to 8; and
wherein the at least one surface is in touch with the post CMP cleaning composition and the metallic film is selected from the group consisting of tungsten, copper, cobalt, ruthenium, aluminum, and combinations thereof.