Claims

1. A polishing composition consisting of:
colloidal silica and/or ceria-silica composite particles ranging from 0.01 wt.% to 15 wt.%;
a compound to enhance removal rate of films comprising elemental silicon ranging from 0.001 wt.% to 0.5 wt.%;
liquid carrier; and optionally
polymers or copolymers comprising acrylic acid groups; and/or
one or more pH adjusting agents;
wherein the pH of the polishing composition is between 2 and 12; and
wherein the compound to enhance removal rate of films comprising elemental silicon is selected from the group consisting of isothiazolinone and derivatives; thiazolinone and derivatives; and combinations thereof.

2. The polishing composition of Claim 1, wherein the isothiazolinone and derivative is selected from the group consisting of methylisothiazolinone (MIT), chloromethylisothiazolinone (CMIT), benzisothiazolinone (BIT), octylisothiazolinone (OIT), dichlorooctylisothiazolinone (DCOIT), butylbenzisothiazolinone (BBIT), and combinations thereof; and the thiazolinone and derivative is selected from the group consisting of 2-Benzothiazol-1,1,3-trione (Saccharin), N-methyl 2-Benzothiazolinone, thiazolinone, and combinations thereof.

3. The polishing composition of any preceding claim, wherein the liquid carrier is water; and the pH of the polishing composition is between 4 and 10.

4. The polishing composition of any preceding claim, wherein the polishing composition comprises ceria-silica composite particles and colloidal silica particles.

5. The polishing composition of any preceding claim, wherein the polymer or copolymer comprising acrylic acid groups has a molecular weight ranging from 500 to 100,000.

6. The polishing composition of Claim 4, wherein the polymer or copolymer comprising acrylic acid groups is present in an amount from 0.1 ppm to 0.5 wt. %.

7. The polishing composition of Claim 5 or Claim 6, wherein the polymer or copolymer comprising acrylic acid groups is ammonium polyacrylate.

8. The polishing composition of any preceding claim,
wherein the pH adjusting agent is selected from the group consisting of sodium hydroxide, cesium hydroxide, potassium hydroxide, cesium hydroxide, ammonium hydroxide, quaternary organic ammonium hydroxide (e.g. tetramethylammonium hydroxide), salts of polyacrylic acid, citric acid, acetic acid, carbonic acid, bicine, tricine, Tris, 4-(2-hydroxyethyl)-1-piperazineethanesulfonic acid, N-cyclohexyl-3-aminopropanesulfonic acid, 3-(N-morpholino)propanesulfonic acid, and piperazine-N,N-bis(2-ethanesulfonic acid), and mixtures thereof; and wherein the pH adjusting agent ranges from 0.0005 % to 1 wt. %.

9. A polishing method for chemical mechanical planarization of a semiconductor substrate comprising at least one surface containing elemental silicon, comprising the steps of:
contacting the at least one surface containing elemental silicon with a polishing pad;
delivering a polishing composition to the at least one surface containing elemental silicon;
wherein the polishing composition consists of:
colloidal silica and/or ceria-silica composite particles ranging from 0.01 wt.% to 15 wt.%;
a compound to enhance removal rate of films comprising elemental silicon ranging from 0.001 wt.% to 0.5 wt.%;
liquid carrier; and optionally
polymers or copolymers comprising acrylic acid groups; and/or
one or more pH adjusting agents;
wherein the pH of the polishing composition is between 2 and 12;
wherein the compound to enhance removal rate of films comprising elemental silicon is selected from the group consisting of isothiazolinone and derivatives, thiazolinone and derivatives, and combinations thereof; and
polishing the at least one surface containing elemental silicon with the polishing composition.

10. The polishing method of Claim 9, wherein the isothiazolinone and derivative is selected from the group consisting of methylisothiazolinone (MIT), chloromethylisothiazolinone (CMIT), benzisothiazolinone (BIT), octylisothiazolinone (OIT), dichlorooctylisothiazolinone (DCOIT), butylbenzisothiazolinone (BBIT), and combinations thereof; and the thiazolinone and derivative is selected from the group consisting of 2-Benzothiazol-1,1,3-trione (Saccharin), N-methyl 2-Benzothiazolinone, thiazolinone, and combinations thereof; and combinations thereof.

11. The polishing method of Claim 9 or Claim 10, wherein the polishing composition comprises methylisothiazolinone (MIT); the liquid carrier is water; and the pH of the polishing composition is between 4 and 10.

12. The polishing method of any one of Claims 9 to 11, wherein the semiconductor substrate further comprises at least one surface containing silicon oxide, silicon nitride or combinations thereof; and the polishing composition comprises from 0.1 ppm to 0.5 wt. % of a polyacrylic acid or its salts with molecular weight ranging between 500 and 100,000; wherein removal rate selectivity between elemental silicon and silicon oxide or silicon nitride is tunable between 0.1 to 110.

13. The polishing method of any one of Claims 9 to 12, wherein the polishing composition comprises methylisothiazolinone (MIT); ammonium polyacrylate with molecular weight ranging between 500 and 100,000; the liquid carrier is water; and the pH of the polishing composition is between 4 and 10.

14. The polishing method of any one of Claims 9 to 13, wherein the pH adjusting agent is selected from the group consisting of sodium hydroxide, cesium hydroxide, potassium hydroxide, cesium hydroxide, ammonium hydroxide, quaternary organic ammonium hydroxide (e.g. tetramethylammonium hydroxide), salts of polyacrylic acid, citric acid, acetic acid, carbonic acid, bicine, tricine, Tris, 4-(2-hydroxyethyl)-1-piperazineethanesulfonic acid, N-cyclohexyl-3-aminopropanesulfonic acid, 3-(N-morpholino)propanesulfonic acid, and piperazine-N,N-bis(2-ethanesulfonic acid), and mixtures thereof; and wherein the pH adjusting agent ranges from 0.0005 % to 1 wt. %.

15. A system for chemical mechanical planarization of a semiconductor substrate comprising at least one surface containing elemental silicon, comprising:
the semiconductor substrate;

a polishing pad; and

a polishing composition consisting of:
colloidal silica and/or ceria-silica composite particles ranging from 0.01 wt.% to 15 wt.%;
a compound to enhance removal rate of films comprising elemental silicon ranging from 0.001 wt.% to 0.5 wt.%;
liquid carrier; and optionally
polymers or copolymers comprising acrylic acid groups; and/or
one or more pH adjusting agents;
wherein the pH of the polishing composition is between 2 and 12;
wherein the compound to enhance removal rate of films comprising elemental silicon is selected from a group consisting of isothiazolinone and derivatives, thiazolinone and derivatives, and combinations thereof; and
wherein the semiconductor substrate is in contact with the polishing composition and the pad.

16. The system of Claim 15, wherein the) isothiazolinone and derivative is selected from the group consisting of methylisothiazolinone (MIT), chloromethylisothiazolinone (CMIT), benzisothiazolinone (BIT), octylisothiazolinone (OIT), dichlorooctylisothiazolinone (DCOIT), butylbenzisothiazolinone (BBIT), and combinations thereof; and the thiazolinone and derivative is selected from the group consisting of 2-Benzothiazol-1,1,3-trione (Saccharin), N-methyl 2-Benzothiazolinone, thiazolinone, and combinations thereof; and combinations thereof.

17. The system of Claim 15 or Claim 16, wherein the polishing composition comprises methylisothiazolinone (MIT); the liquid carrier is water; and the pH of the polishing composition is between 4 and 10.

18. The system of any one of Claims 15 to 17, wherein the semiconductor substrate further comprises at least one surface containing silicon oxide, silicon nitride or combinations thereof; and the polishing composition comprises from 0.1 ppm to 0.5 wt. % of a polyacrylic acid or its salts with molecular weight ranging between 500 and 100,000;
wherein the system provides a tunable removal rate selectivity between elemental silicon and silicon oxide or silicon nitride between 0.1 to 110.

19. The system of any one of Claims 15 to 18, wherein the polishing composition comprises methylisothiazolinone (MIT); ammonium polyacrylate with molecular weight ranging between 500 and 100,000; the liquid carrier is water; and the pH of the polishing composition is between 4 and 10.

20. The system of any one of Claims 15 to 19, wherein the pH adjusting agent selected from the group consisting of sodium hydroxide, cesium hydroxide, potassium hydroxide, cesium hydroxide, ammonium hydroxide, quaternary organic ammonium hydroxide (e.g. tetramethylammonium hydroxide), salts of polyacrylic acid, citric acid, acetic acid, carbonic acid, bicine, tricine, Tris, 4-(2-hydroxyethyl)-1-piperazineethanesulfonic acid, N-cyclohexyl-3-aminopropanesulfonic acid, 3-(N-morpholino)propanesulfonic acid, and piperazine-N,N-bis(2-ethanesulfonic acid), and mixtures thereof; and wherein the pH adjusting agent ranges from 0.0005 % to 1 wt. %.