acceptable roughness. If the surface is too smooth, the read/write head may bind to the surface of the disk. If the surface is too rough, the head may be unable to fly over the disk surface on its air cushion in the proper manner. Moreover, surface roughness can affect a component's chemical and physical stability. Surfaces that have to stand up to hostile environments (e.g., temperature, humidity, or chemicals) must be as smooth as possible in order to present the minimum surface area for attack, and to have as few defects or weak spots as possible.

[0005] Conventional polishing compositions for silicon wafers exhibit high removal rates for silicon, but produce increased nanotopography and roughness of the silicon wafers. The increased nanotopography puts increased demands on the second, final polishing step to produce silicon wafers suitable for further processing into semiconductor substrates.

[0006] Thus, there remains an important need in the art for improved polishing compositions for silicon wafers.

BRIEF SUMMARY ~~OF THE INVENTION~~

[0007] The ~~invention~~disclosure provides a chemical-mechanical polishing composition comprising (a) silica, (b) one or more tetraalkylammonium salts, (c) one or more bicarbonate salts, one or more alkali metal hydroxides, (d) one or more aminophosphonic acids, (e) one or more rate accelerator compounds, (g) one or more polysaccharides, and (f) water.

[0008] The ~~invention~~disclosure also provides a method of chemically-mechanically polishing a substrate comprising (i) contacting a substrate with a polishing pad and a chemical-mechanical polishing composition comprising (a) silica, (b) one or more tetraalkylammonium salts, (c) one or more bicarbonate salts, (d) one or more alkali metal hydroxides, (e) one or more aminophosphonic acids, (f) one or more rate accelerator compounds, (g) one or more polysaccharides, and (f) water; (ii) moving the polishing pad relative to the substrate with chemical-mechanical polishing composition therebetween; and (iii) abrading at least a portion of the substrate to polish the substrate.

[0008a] In one aspect, there is provided a chemical-mechanical polishing composition comprising:

(a) silica,

(b) one or more tetraalkylammonium salts,

(c) one or more bicarbonate salts,

(d) one or more alkali metal hydroxides,

(e) one or more aminophosphonic acids,

(f) one or more rate accelerator compounds selected from the group consisting of heterocyclic amines, mono amino acids, and hydroxy acids, wherein the heterocyclic amine is heterocyclic aliphatic amines,

(g) one or more polysaccharides selected from the group consisting of hydroxyalkylcelluloses, dextrans, carboxylated dextrans, and sulfonated dextrans, wherein at least one polysaccharide has an average molecular weight less than 300,000 g mol, and

(f) water.

[0008b] In another aspect, there is provided a method of chemically-mechanically polishing a substrate comprising:

(i) contacting a substrate with a polishing pad and the chemical-mechanical polishing composition as defined above,

(ii) moving the polishing pad relative to the substrate with chemical-mechanical polishing composition therebetween, and

(iii) abrading at least a portion of the substrate to polish the substrate.

DETAILED DESCRIPTION OF THE INVENTION

[0009] The invention provides a chemical-mechanical polishing composition and a method of chemically-mechanically polishing a substrate.

[0010] In an embodiment, the polishing composition comprises, consists essentially of, or consists of (a) silica, (b) one or more tetraalkylammonium salts, (c) one or more bicarbonate

CLAIMS

1. A chemical-mechanical polishing composition comprising:

(a) silica,

(b) one or more tetraalkylammonium salts,

(c) one or more bicarbonate salts,

(d) one or more alkali metal hydroxides,

(e) one or more aminophosphonic acids,

(f) one or more rate accelerator compounds selected from the group consisting of heterocyclic amines, mono amino acids, and hydroxy acids,

(g) one or more polysaccharides selected from the group consisting of hydroxyalkylcelluloses, dextrans, carboxylated dextrans, and sulfonated dextrans, wherein at least one polysaccharide has an average molecular weight less than 300,000 g/mol, and

(f) water.

2. The polishing composition of claim 1, wherein at least one rate accelerator compound is a heterocyclic amine.

3. The polishing composition of claim 2, wherein the heterocyclic amine is selected from the group consisting of heterocyclic aromatic amines and heterocyclic aliphatic amines.

4. The polishing composition of claim 3, wherein the heterocyclic amine is a heterocyclic aromatic amine.

5. The polishing composition of claim 4, wherein the heterocyclic aromatic amine is 1,2,4-triazole.

6. The polishing composition of claim 3, wherein the heterocyclic amine is a heterocyclic aliphatic amine.

7. The polishing composition of claim 6, wherein the heterocyclic aliphatic amine is aminoethylpiperazine.

8. The polishing composition of claim 1, wherein at least one rate accelerator compound is a mono amino acid.

9. The polishing composition of claim 8, wherein the mono amino acid is glycine.

10. The polishing composition of claim 1, wherein at least one rate accelerator compound is a hydroxy acid.

11. The polishing composition of claim 10, wherein the hydroxy acid is lactic acid.

12. The polishing composition of claim 1, wherein at least one polysaccharide is a hydroxyalkylcellulose.

13. The polishing composition of claim 12, wherein the hydroxyalkylcellulose is hydroxyethylcellulose.

14. The polishing composition of claim 1, wherein at least one polysaccharide is a dextran.

15. The polishing composition of claim 1, wherein at least one polysaccharide is a carboxylated dextran.

16. The polishing composition of claim 1, wherein at least one polysaccharide is a sulfonated dextran.

17. The polishing composition of claim 1, wherein at least one tetraalkylammonium salt is selected from the group consisting of tetramethylammonium hydroxide, tetraethylammonium hydroxide, and tetrapropylammonium hydroxide.

18. The polishing composition of claim 1, wherein the aminophosphonic acid is amino tri(methylene phosphonic acid).

19. The polishing composition of claim 1, wherein the silica is present in an amount of 8 wt. % to 12 wt. % of the polishing composition.

20. The polishing composition of claim 17, wherein the tetraalkylammonium salt is present in an amount of 2 wt. % to 3 wt. % of the polishing composition.

21. The polishing composition of claim 1, wherein the rate accelerator compound is present in an amount of 0.125 wt. % to 0.375 wt. % of the polishing composition.

22. The polishing composition of claim 1, wherein the polysaccharide is present in an amount up to 0.05 wt. % of the polishing composition.

23. A method of chemically-mechanically polishing a substrate comprising:

(i) contacting a substrate with a polishing pad and the chemical-mechanical polishing composition of claim 1,

(ii) moving the polishing pad relative to the substrate with chemical-mechanical polishing composition therebetween, and

(iii) abrading at least a portion of the substrate to polish the substrate.

CLAIMS

1. A chemical-mechanical polishing composition comprising:

(a) silica,

(b) one or more tetraalkylammonium salts,

(c) one or more bicarbonate salts,

(d) one or more alkali metal hydroxides,

(e) one or more aminophosphonic acids,

(f) one or more rate accelerator compounds selected from the group consisting of heterocyclic amines, mono amino acids, and hydroxy acids, wherein the heterocyclic amine is heterocyclic aliphatic amines,

(g) one or more polysaccharides selected from the group consisting of hydroxyalkylcelluloses, dextrans, carboxylated dextrans, and sulfonated dextrans, wherein at least one polysaccharide has an average molecular weight less than 300,000 g mol, and

(f) water.

2. The polishing composition of claim 1, wherein at least one rate accelerator compound is a heterocyclic aliphatic amine.

3. The polishing composition of claim 1, wherein the heterocyclic aliphatic amine is aminoethylpiperazine.

4. The polishing composition of claim 1, wherein at least one rate accelerator compound is a mono amino acid.

5. The polishing composition of claim 4, wherein the mono amino acid is glycine.

6. The polishing composition of claim 1, wherein at least one rate accelerator compound is a hydroxy acid.

7. The polishing composition of claim 6, wherein the hydroxy acid is lactic acid.

8. The polishing composition of claim 1, wherein at least one polysaccharide is a hydroxyalkylcellulose.

9. The polishing composition of claim 8, wherein the hydroxyalkylcellulose is hydroxyethylcellulose.

10. The polishing composition of claim 1, wherein at least one polysaccharide is a dextran.

11. The polishing composition of claim 1, wherein at least one polysaccharide is a carboxylated dextran.

12. The polishing composition of claim 1, wherein at least one polysaccharide is a sulfonated dextran.

13. The polishing composition of claim 1, wherein at least one tetraalkylammonium salt is selected from the group consisting of tetramethylammonium hydroxide, tetraethylammonium hydroxide, and tetrapropylammonium hydroxide.

14. The polishing composition of claim 1, wherein the aminophosphonic acid is amino tri(methylene phosphonic acid).

15. The polishing composition of claim 1, wherein the silica is present in an amount of 8 wt.% to 12 wt.% of the polishing composition.

16. The polishing composition of claim 13, wherein the tetraalkylammonium salt is present in an amount of 2 wt.% to 3 wt.% of the polishing composition.

17. The polishing composition of claim 1, wherein the rate accelerator compound is present in an amount of 0.125 wt. % to 0.375 wt.% of the polishing composition.

18. The polishing composition of claim 1, wherein the polysaccharide is present in an amount up to 0.05 wt. % of the polishing composition.

19. A method of chemically-mechanically polishing a substrate comprising:

(i) contacting a substrate with a polishing pad and the chemical-mechanical polishing composition of claim 1,

(ii) moving the polishing pad relative to the substrate with chemical-mechanical polishing composition therebetween, and

(iii) abrading at least a portion of the substrate to polish the substrate.