CLAIMS

1. An acidic aqueous polishing composition suitable for polishing a silicon nitride-containing substrate in a chemical-mechanical polishing (CMP) process, the composition comprising:

(a) 0.01 to 10 percent by weight of a particulate calcined ceria abrasive;

(b) 10 to 100,000 ppm of at least one cationic polymer selected from the group consisting of (a) a poly(vinylpyridine) polymer and (b) a combination of a poly(vinylpyridine) polymer and a quaternary ammonium-substituted polymer;

(c) optionally, 10 to 200,000 ppm of a polyoxyalkylene polymer; and

(d) an aqueous carrier therefor.

2. The composition of claim 1 wherein the abrasive is present in the composition at a concentration in the range of 0.05 to 5 percent by weight.

3. The composition of claim 1 wherein the at least one cationic polymer is present in the composition at a concentration in the range of 15 to 10,000 ppm.

4. The composition of claim 1 wherein the polyoxyalkylene polymer is present in the composition at a concentration in the range of 200 to 100,000 ppm.

5. The composition of claim 1 wherein the polyoxyalkylene polymer comprises a poly(ethylene glycol) polymer, a poly(ethylene glycol)-co-poly(propylene glycol) block copolymer, or a combination thereof.

6. The composition of claim 1 wherein the polyoxyalkylene polymer comprises a poly(ethylene glycol) polymer comprising an average number of ethylene glycol monomer units in the range of 300 to 1500.

7. The composition of claim 1 wherein the quaternary ammonium-substituted polymer comprises a quaternary ammonium-substituted acrylate or methacrylate polymer.

8. The composition of claim 1 wherein the poly(vinylpyridine) polymer comprises poly(4-vinylpyridine).

9. The composition of claim 1 wherein the poly(vinylpyridine) polymer comprises poly(2-vinylpyridine).

10. The composition of claim 1 wherein the poly(vinylpyridine) polymer is a copolymer comprising at least one vinylpyridine monomer and at least one comonomer selected from the group consisting of a nonionic monomer and a cationic monomer.

11. The composition of claim 1 wherein the at least one cationic polymer comprises a combination of a poly(vinylpyridine) polymer and a quaternary ammonium-substituted acrylate or methacrylate polymer.

12. The composition of claim 1 wherein the at least one cationic polymer comprises a combination of 10 to 90 ppm of a poly(vinylpyridine) polymer and 15 to 100 ppm of a poly(methacryloyloxyethyl trimethylammonium halide) polymer.

13. The composition of claim 1 wherein the aqueous carrier comprises deionized water.

14. The composition of claim 1 wherein the composition has a pH in the range of 3 to 6.

15. An acidic aqueous polishing composition suitable for selective removal of silicon nitride relative to polysilicon in a chemical-mechanical polishing (CMP) process, the composition comprising:

(a) 0.05 to 5 percent by weight of a particulate calcined ceria abrasive;

(b) 15 to 10,000 ppm of at least one cationic polymer selected from the group consisting of (a) a poly(vinylpyridine) polymer and (b) a combination of a poly(vinylpyridine) polymer and a quaternary ammonium-substituted polymer;

(c) 200 to 100,000 ppm of a polyoxyalkylene polymer selected from a poly(ethylene glycol) polymer, a poly(ethylene glycol)-co-poly(propylene glycol) block copolymer, or a combination thereof; and

(d) an aqueous carrier therefor;

wherein the composition has a pH in the range of 3 to 6.

16. The composition of claim 15 wherein the at least one cationic polymer comprises a combination of 10 to 90 ppm of a poly(vinylpyridine) polymer and 15 to 100 ppm of a poly(methacryloyloxyethyl trimethylammonium halide) polymer.

17. The composition of claim 15 wherein the poly(ethylene glycol) polymer comprises an average number of ethylene glycol monomer units in the range of 200 to 2000.

18. A chemical-mechanical polishing (CMP) method for polishing a surface of a substrate, the method comprising abrading the surface of the substrate with a composition of claim 1, wherein the composition, as used, comprises 0.01 to 2 percent by weight of the ceria abrasive, 10 to 1000 ppm of the at least one cationic polymer, and optionally 10 to 2000 ppm of the polyoxyalkylene polymer.

19. The method of claim 18 wherein the surface of the substrate comprises silicon nitride, polysilicon, and silicon dioxide.

20. A chemical-mechanical polishing (CMP) method for polishing a surface of a substrate, the method comprising abrading the surface of the substrate with a composition of claim 15, wherein the composition, as used, comprises 0.05 to 0.5 percent by weight of the ceria

abrasive, 10 to 100 ppm of the at least one cationic polymer, and optionally 200 to 1000 ppm of the polyoxyalkylene polymer.

21. The method of claim 20 wherein the surface of the substrate comprises silicon nitride, polysilicon, and silicon dioxide.

22. A chemical-mechanical polishing (CMP) method for selectively removing silicon nitride from a surface of a substrate in preference to removal of polysilicon, the method comprising the steps of:

(a) contacting a surface of a silicon nitride- and polysilicon-containing substrate with a polishing pad and an acidic aqueous CMP composition; and

(b) causing relative motion between the polishing pad and the substrate while maintaining a portion of the CMP composition in contact with the surface between the pad and the substrate for a time period sufficient to abrade silicon nitride from the surface;

wherein the CMP composition comprises:

(i) 0.01 to 2 percent by weight of a particulate calcined ceria abrasive;

(ii) 10 to 1000 ppm of at least one cationic polymer selected from the group consisting of (a) a poly(vinylpyridine) polymer and (b) a combination of a poly(vinylpyridine) polymer and a quaternary ammonium-substituted polymer;

(iii) optionally, 10 to 2000 ppm of a polyoxyalkylene polymer; and

(iv) an aqueous carrier therefor.

23. The method of claim 22 wherein the at least one cationic polymer of the CMP composition comprises a combination of a poly(vinylpyridine) polymer and a quaternary ammonium-substituted polymer.

24. The method of claim 22 wherein the quaternary ammonium-substituted polymer comprises a quaternary ammonium-substituted acrylate or methacrylate polymer.

25. The method of claim 22 wherein the quaternary ammonium-substituted polymer comprises a poly(methacryloyloxyethyl trimethylammonium halide) polymer.

26. The method of claim 22 wherein the at least one cationic polymer of the CMP composition comprises at least one polymer selected from the group consisting of a poly(2-vinylpyridine) polymer, a poly(4-vinylpyridine) polymer, and a copolymer comprising at least one vinylpyridine monomer and at least one comonomer selected from the group consisting of a nonionic monomer and a cationic monomer .

27. The method of claim 22 wherein the polyoxyalkylene polymer of the CMP composition comprises a poly(ethylene glycol) polymer, a poly(ethylene glycol)-co-poly(propylene glycol) block copolymer, or a combination thereof.

28. The method of claim 22 wherein the CMP composition has a pH in the range of 3 to 6.

29. The method of claim 22 wherein the surface of the substrate also comprises silicon dioxide.

CLAIMS

1. An acidic aqueous polishing composition suitable for polishing a silicon nitride-containing substrate in a chemical-mechanical polishing (CMP) process, the composition comprising:

(a) about 0.01 to about 10 percent by weight of a particulate calcined ceria abrasive;

(b) about 10 to about 100,000 ppm of at least one cationic polymer selected from the group consisting of (a) a poly(vinylpyridine) polymer and (b) a combination of a poly(vinylpyridine) polymer and a quaternary ammonium-substituted polymer;

(c) about 10 to about 200,000 ppm of a polyoxyalkylene polymer; and

(d) an aqueous carrier therefor, wherein the composition has a pH in the range of about 3 to about 6.

2. The composition of claim 1 wherein the abrasive is present in the composition at a concentration in the range of about 0.05 to about 5 percent by weight.

3. The composition of claim 1 wherein the at least one cationic polymer is present in the composition at a concentration in the range of about 15 to about 10,000 ppm.

4. The composition of claim 1 wherein the polyoxyalkylene polymer is present in the composition at a concentration in the range of about 200 to about 100,000 ppm.

5. The composition of claim 1 wherein the polyoxyalkylene polymer comprises a poly(ethylene glycol) polymer, a poly(ethylene glycol)-co-poly(propylene glycol) block copolymer, or a combination thereof.

6. The composition of claim 1 wherein the polyoxyalkylene polymer comprises a poly(ethylene glycol) polymer comprising an average number of ethylene glycol monomer units in the range of about 300 to about 1500.

7. The composition of claim 1 wherein the quaternary ammonium-substituted polymer comprises a quaternary ammonium-substituted acrylate or methacrylate polymer.

8. The composition of claim 1 wherein the poly(vinylpyridine) polymer comprises poly(4-vinylpyridine).

9. The composition of claim 1 wherein the poly(vinylpyridine) polymer comprises poly(2-vinylpyridine).

10. Then composition of claim 1 wherein the poly(vinylpyridine) polymer is a copolymer comprising at least one vinylpyridine monomer and at least one comonomer selected from the group consisting of a nonionic monomer and a cationic monomer.

11. The composition of claim 1 wherein the at least one cationic polymer comprises a combination of a poly(vinylpyridine) polymer and a quaternary ammonium-substituted acrylate or methacrylate polymer.

12. The composition of claim 1 wherein the at least one cationic polymer comprises a combination of about 10 to about 90 ppm of a poly(vinylpyridine) polymer and about 15 to about 100 ppm of a poly(methacryloyloxyethyl trimethylammonium halide) polymer.

13. The composition of claim 1 wherein the aqueous carrier comprises deionized water.

14. A chemical-mechanical polishing (CMP) method for polishing a surface of a substrate, the method comprising abrading the surface of the substrate with a composition of claim 1, wherein the composition, as used, comprises about 0.01 to about 2 percent by weight of the ceria abrasive, about 10 to about 1000 ppm of the at least one cationic polymer, and about 10 to about 2000 ppm of the polyoxyalkylene polymer.

15. The method of claim 14 wherein the surface of the substrate comprises silicon nitride, polysilicon, and silicon dioxide.

16. An acidic aqueous polishing composition suitable for selective removal of silicon nitride relative to polysilicon in a chemical-mechanical polishing (CMP) process, the composition comprising:

(a) about 0.05 to about 5 percent by weight of a particulate calcined ceria abrasive;

(b) about 15 to about 10,000 ppm of at least one cationic polymer selected from the group consisting of (a) a poly(vinylpyridine) polymer and (b) a combination of a poly(vinylpyridine) polymer and a quaternary ammonium-substituted polymer;

(c) about 200 to about 100,000 ppm of a polyoxyalkylene polymer selected from a poly(ethylene glycol) polymer, a poly(ethylene glycol)-co-poly(propylene glycol) block copolymer, or a combination thereof; and

(d) an aqueous carrier therefor;

wherein the composition has a pH in the range of about 3 to about 6.

17. The composition of claim 16 wherein the at least one cationic polymer comprises a combination of about 10 to about 90 ppm of a poly(vinylpyridine) polymer and about 15 to about 100 ppm of a poly(methacryloyloxyethyl trimethylammonium halide) polymer.

18. The composition of claim 16 wherein the poly(ethylene glycol) polymer comprises an average number of ethylene glycol monomer units in the range of about 200 to about 2000.

19. A chemical-mechanical polishing (CMP) method for polishing a surface of a substrate, the method comprising abrading the surface of the substrate with a composition of claim 16, wherein the composition, as used, comprises about 0.05 to about 0.5 percent by weight of the ceria abrasive, about 10 to about 100 ppm of the at least one cationic polymer, and about 200 to about 1000 ppm of the polyoxyalkylene polymer.

20. The method of claim 19 wherein the surface of the substrate comprises silicon nitride, polysilicon, and silicon dioxide.

21. A chemical-mechanical polishing (CMP) method for selectively removing silicon nitride from a surface of a substrate in preference to removal of polysilicon, the method comprising the steps of:

(a) contacting a surface of a silicon nitride- and polysilicon-containing substrate with a polishing pad and an acidic aqueous CMP composition; and

(b) causing relative motion between the polishing pad and the substrate while maintaining a portion of the CMP composition in contact with the surface between the pad and the substrate for a time period sufficient to abrade silicon nitride from the surface;

wherein the CMP composition comprises:

(i) about 0.01 to about 2 percent by weight of a particulate calcined ceria abrasive;

(ii) about 10 to about 1000 ppm of at least one cationic polymer selected from the group consisting of (a) a poly(vinylpyridine) polymer and (b) a combination of a poly(vinylpyridine) polymer and a quaternary ammonium-substituted polymer;

(iii) about 10 to about 2000 ppm of a polyoxyalkylene polymer; and

(iv) an aqueous carrier therefor.

22. The method of claim 21 wherein the at least one cationic polymer of the CMP composition comprises a combination of a poly(vinylpyridine) polymer and a quaternary ammonium-substituted polymer.

23. The method of claim 21 wherein the quaternary ammonium-substituted polymer comprises a quaternary ammonium-substituted acrylate or methacrylate polymer.

24. The method of claim 21 wherein the quaternary ammonium-substituted polymer comprises a poly(methacryloyloxyethyl trimethylammonium halide) polymer.

25. The method of claim 21 wherein the at least one cationic polymer of the CMP composition comprises at least one polymer selected from the group consisting of a poly(2-vinylpyridine) polymer, a poly(4-vinylpyridine) polymer, and a copolymer comprising at

least one vinylpyridine monomer and at least one comonomer selected from the group consisting of a nonionic monomer and a cationic monomer .

26. The method of claim 21 wherein the polyoxyalkylene polymer of the CMP composition comprises a poly(ethylene glycol) polymer, a poly(ethylene glycol)-co-poly(propylene glycol) block copolymer, or a combination thereof.

27. The method of claim 21 wherein the CMP composition has a pH in the range of about 3 to about 6.

28. The method of claim 21 wherein the surface of the substrate also comprises silicon dioxide.