CLAIMS

1. A chemical-mechanical polishing (CMP) composition suitable for polishing a substrate comprising copper and/or silver, the composition comprising:

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

(b) 0.001 to 1 percent by weight of a primary film-forming metal-complexing agent that comprises a compound of formula (I): A−X−Y−OH, a salt thereof, or a partially neutralized form thereof, wherein A is $-N(R^1)-C(=O)-R^2$ or $-C(=O)-NH-OH$; and either X is $-C(R^3)(R^4)-$ and Y is $-C(=O)-$, or X and Y together form an aryl group in which the A and OH groups in formula (I) are positioned in a 1,2 or "ortho" relationship to one another; R^1 is H, substituted C_1-C_4 alkyl, or unsubstituted C_1-C_4 alkyl; R^2 is substituted C_8-C_{20} alkyl or unsubstituted C_8-C_{20} alkyl; and R^3 and R^4 are each independently H, substituted C_1-C_4 alkyl, or unsubstituted C_1-C_4 alkyl;

(c) 0.005 to 0.5 percent by weight of a secondary film-forming metal-passivating agent comprising a compound of formula (II): $Z-X^2(Y^2R^5)(Y^3R^6)$, a salt thereof, or a partially neutralized form thereof; wherein Z is NH_2 or OH; X^2 is P=O or C; Y^2 and Y^3 are each independently N, NH, or O; and R^5 and R^6 can each independently can be $R^7-(OCH_2CH_2)_n-$, or when Y^2 and Y^3 each independently are N or NH, then R^5 and R^6 each independently can be N, NH, or CH, and together Y^2 and Y^3 form a five-membered ring heterocycle with X^2, Y^2 and Y^3; each R^7 independently is H, C_1-C_{20}-alkyl, phenyl, or C_1-C_{20}-alkyl-substituted phenyl; and "n" has an average value in the range of 2 to 1000; and

(d) an aqueous carrier therefor.

2. The composition of claim 1 wherein the primary film-forming metal-complexing agent comprises an N-acyl sarcosine compound, a salt thereof, or a partially neutralized form thereof.

3. The composition of claim 1 wherein the primary film-forming metal-complexing agent comprises an *o*-hydroxyaryl hydroxamic acid, a salt thereof, or a partially neutralized form thereof.

4. The composition of claim 1 wherein the secondary film-forming metal-passivating agent comprises an amine-substituted nitrogen heteroaromatic compound, a bis-(poly(oxyethylene)) phosphate ester, and a combination thereof.

5. The composition of claim 1 wherein the secondary film-forming metal-passivating agent comprises an amine-substituted nitrogen heteroaromatic compound.

6. The composition of claim 5 wherein the amine-substituted nitrogen heteroaromatic compound comprises 5-aminotetrazole.

7. The composition of claim 1 wherein the secondary film-forming metal-passivating agent comprises a bis-(poly(oxyethylene)) phosphate ester.

8. The composition of claim 7 wherein the bis-(poly(oxyethylene)) phosphate ester comprises a bis-(nonylphenylpoly(oxyethylene)) phosphate ester.

9. The composition of claim 1 further comprising 0.01 to 20 percent by weight of an auxiliary metal-chelating agent selected from the group consisting of oxalic acid, an amino-substituted carboxylic acid, a hydroxyl-substituted carboxylic acid, a salt thereof, a partially neutralized form thereof, and a combination of two or more of the foregoing.

10. The composition of claim 1 wherein the auxiliary metal-chelating agent comprises glycine.

11. The composition of claim 1 wherein the particulate abrasive comprises silica.

12. A chemical-mechanical polishing (CMP) composition suitable for polishing a substrate comprising copper and/or silver, the composition comprising:

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

(b) 0.001 to 1 percent by weight of salicylhydroxamic acid, a salt thereof or a partially neutralized form thereof;

(c) 0.005 to 0.5 percent by weight of at least one secondary film-forming metal-passivating agent selected from the group consisting of an amine-substituted nitrogen heteroaromatic compound and a bis-(poly(oxyethylene)) phosphate ester; and

(d) an aqueous carrier therefor.

13. The composition of claim 12 wherein the at least one secondary film-forming metal-passivating agent comprises 5-aminotetrazole.

14. The composition of claim 12 wherein the at least one secondary film-forming metal-passivating agent comprises a bis-(nonylphenylpoly(oxyethylene)) phosphate ester.

15. A method for chemical-mechanical polishing (CMP) a substrate comprising copper and/or silver, the method comprising abrading a surface of the substrate with a CMP composition, wherein the CMP composition comprises:

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

(b) 0.001 to 1 percent by weight of a primary film-forming metal-complexing agent that comprises a compound of formula (I): A−X−Y−OH, a salt thereof, or a partially neutralized form thereof, wherein A is $-N(R^1)-C(=O)-R^2$ or $-C(=O)-NH-OH$; and either X is $-C(R^3)(R^4)-$ and Y is $-C(=O)-$, or X and Y together form an aryl group in which the A and OH groups in formula (I) are positioned in a 1,2 or "ortho" relationship to one another; R^1 is H, substituted C_1-C_4 alkyl, or unsubstituted C_1-C_4 alkyl; R^2 is substituted C_8-C_{20} alkyl or unsubstituted C_8-C_{20} alkyl; and R^3 and R^4 are each independently H, substituted C_1-C_4 alkyl, or unsubstituted C_1-C_4 alkyl;

(c) 0.005 to 0.5 percent by weight of a secondary film-forming metal-passivating agent comprising a compound of formula (II): $Z-X^2(Y^2R^5)(Y^3R^6)$, a salt thereof, or a partially neutralized form thereof; wherein Z is NH_2 or OH; X^2 is P=O or C; Y^2 and Y^3 are each independently N, NH, or O; and R^5 and R^6 can each independently can be $R^7-(OCH_2CH_2)_n-$, or when Y^2 and Y^3 each independently are N or NH, then R^5 and R^6 each independently can be N, NH, or CH, and together Y^2 and Y^3 form a five-membered ring heterocycle with X^2, Y^2 and Y^3; each R^7 independently is H, C_1-C_{20}-alkyl, phenyl, or C_1-C_{20}-alkyl-substituted phenyl; and "n" has an average value in the range of 2 to 1000; and

(d) an aqueous carrier therefor.

16. The method of claim 15 wherein the primary film-forming metal-complexing agent comprises an N-acyl sarcosine compound.

17. The method of claim 15 wherein the primary film-forming metal-complexing agent comprises an o-hydroxyaryl hydroxamic acid, a salt thereof, or a partially neutralized form thereof.

18. The method of claim 15 wherein the secondary film-forming metal-passivating agent is selected from the group consisting of an amine-substituted nitrogen heteroaromatic compound, a bis-(poly(oxyethylene)) phosphate ester, and a combination thereof.

19. The method of claim 15 wherein the secondary film-forming metal-passivating agent is selected from the group consisting of a bis-(nonylphenylpoly(oxyethylene)) phosphate ester, 5-aminotetrazole, and a combination thereof.

20. The method of claim 15 wherein the CMP composition further comprises an auxiliary metal-chelating agent selected from the group consisting of oxalic acid, an amino-substituted carboxylic acid, a hydroxyl-substituted carboxylic acid, a salt thereof, a partially neutralized form thereof, and a combination of two or more of the foregoing.

21. The method of claim 15 wherein the particulate abrasive comprises silica.

22. The method of claim 15 wherein the surface of the substrate is abraded in the presence of 0.1 to 5 percent by weight of an oxidizing agent.

23. The method of claim 15 including the additional step of immersing the substrate in a benzotriazole (BTA) solution after abrading the surface of the substrate with the CMP composition.

CLAIMS

1. A chemical-mechanical polishing (CMP) composition suitable for polishing a substrate comprising copper and/or silver, the composition comprising:

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

(b) 0.001 to 1 percent by weight of a primary film-forming metal-complexing agent that comprises an *o*-hydroxyaryl hydroxamic acid, a salt thereof, or a partially neutralized form thereof;

(c) 0.005 to 0.5 percent by weight of a secondary film-forming metal-passivating agent comprising a compound of formula (II): $Z-X^2(Y^2R^5)(Y^3R^6)$, a salt thereof, or a partially neutralized form thereof; wherein Z is NH_2 or OH; X^2 is P=O or C; Y^2 and Y^3 are each independently N, NH, or O; and R^5 and R^6 can each independently can be $R^7-(OCH_2CH_2)_n-$, or when Y^2 and Y^3 each independently are N or NH, then R^5 and R^6 each independently can be N, NH, or CH, and together Y^2 and Y^3 form a five-membered ring heterocycle with X^2, Y^2 and Y^3; each R^7 independently is H, C_1-C_{20}-alkyl, phenyl, or C_1-C_{20}-alkyl-substituted phenyl; and "n" has an average value in the range of about 2 to about 1000; and

(d) an aqueous carrier therefor.

2. The composition of claim 1 wherein the secondary film-forming metal-passivating agent comprises an amine-substituted nitrogen heteroaromatic compound.

3. The composition of claim 2 wherein the amine-substituted nitrogen heteroaromatic compound comprises 5-aminotetrazole.

4. The composition of claim 3, wherein the at least one secondary film-forming metal-passivating agent comprises 5-aminotetrazole.

5. The composition of claim 3 wherein the at least one secondary film-forming metal-passivating agent comprises a bis-(nonylphenylpoly(oxyethylene)) phosphate ester.

6. The composition of claim 1, wherein the secondary film-forming metal-passivating agent comprises a bis-(poly(oxyethylene)) phosphate ester.

7. The composition of claim 6 wherein the bis-(poly(oxyethylene)) phosphate ester comprises a bis-(nonylphenylpoly(oxyethylene)) phosphate ester.

8. The composition of claim 1 further comprising 0.01 to 20 percent by weight of an auxiliary metal-chelating agent selected from the group consisting of oxalic acid, an amino-substituted carboxylic acid, a hydroxyl-substituted carboxylic acid, a salt thereof, a partially neutralized form thereof, and a combination of two or more of the foregoing.

9. The composition of claim 1 wherein the auxiliary metal-chelating agent comprises glycine.

10. The composition of claim 1 wherein the particulate abrasive comprises silica.

11. A chemical-mechanical polishing (CMP) composition suitable for polishing a substrate comprising copper and/or silver, the composition comprising:

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

(b) 0.001 to 1 percent by weight of salicylhydroxamic acid, a salt thereof or a partially neutralized form thereof;

(c) 0.005 to 0.5 percent by weight of at least one secondary film-forming metal-passivating agent selected from the group consisting of an amine-substituted nitrogen heteroaromatic compound and a bis-(poly(oxyethylene)) phosphate ester; and

(d) an aqueous carrier therefor.