CLAIMS

1. A chemical-mechanical polishing (CMP) composition comprising:

(a) colloidal silica;

(b) at least one onium compound selected from the group consisting of a phosphonium salt, a sulfonium salt, and a combination thereof;

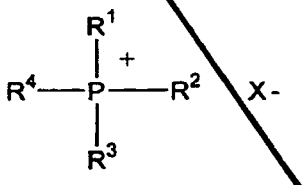
(c) an aqueous carrier therefor;

the composition having a pH of 5 or less.

2. The CMP composition of claim 1 wherein the colloidal silica is present in the composition in an amount in the range of 0.05 to 35 percent by weight.

3. The CMP composition of claim 1 wherein at least one onium salt is present in the composition in an amount in the range of 0.04 to 200 micromoles per gram of composition.

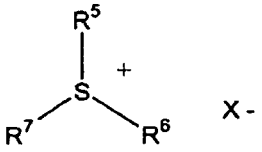
4. The CMP composition of claim 1 wherein the at least one onium compound comprises a phosphonium salt having the following formula:



wherein each R^1, R^2, R^3 and R^4 independently is a substituted or unsubstituted hydrocarbon radical selected from the group consisting of linear C_1-C_{16} alkyl, branched C_3-C_{16} alkyl, C_6-C_{10} aryl, linear C_1-C_{16} alkyl-substituted C_6-C_{10} aryl, and branched C_3-C_{16} alkyl-substituted C_6-C_{10} aryl, wherein the hydrocarbon radical optionally can be substituted with one or more functional substituent selected from the group consisting of a hydroxyl substituent, a halo substituent, an ether substituent, an ester substituent, a carboxy substituent, and an amino substituent;

optionally, R^1 and R^2 together can form a saturated, unsaturated, or aromatic heterocyclic ring with the phosphorus, P, with the proviso that when the heterocyclic ring is aromatic, R^4 is absent; and X- is the conjugate base of an inorganic acid or an organic acid.

5. The CMP composition of claim 1 wherein the at least one onium compound comprises a sulfonium salt having the following formula:



wherein each R^5, R^6, and R^7 independently is a substituted or unsubstituted hydrocarbon radical selected from the group consisting of linear C_1-C_{16} alkyl, branched C_3-C_{16} alkyl, C_6-C_{10} aryl linear C_1-C_{16} alkyl-substituted C_6-C_{10} aryl, and branched C_3-C_{16} alkyl-substituted C_6-C_{10} aryl, wherein the hydrocarbon radical optionally can be substituted with one or more functional substituent selected from the group consisting of a hydroxy, substituent, a halo substituent, an ether substituent, an ester substituent, a carboxy substituent, and an amino substituent;
optionally, R^5 and R^6 together can form a saturated, unsaturated, or aromatic heterocyclic ring with the sulfur, S, with the proviso that when the heterocyclic ring is aromatic, R^7 is absent; and X- is the conjugate base of an inorganic acid or an organic acid.

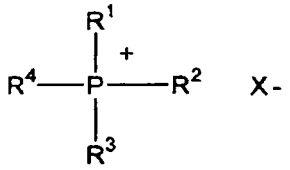
6. The CMP composition of claim 1 wherein the pH is in the range of 2 to 5.

7. A chemical-mechanical polishing (CMP) composition comprising:
(a) 0.1 to 10 percent by weight of colloidal silica;
(b) 0.4 to 20 micromoles per gram of at least one phosphonium salt;
(c) an aqueous carrier therefor;
the composition having a pH of 5 or less.

8. The CMP composition of claim 7 wherein the colloidal silica is present in the composition in an amount in the range of 1 to 6 percent by weight.

9. The CMP composition of claim 7 wherein at least one phosphonium salt is present in the composition in an amount in the range of 1 to 10 micromoles per gram of composition.

10. The CMP composition of claim 7 wherein the at least one phosphonium salt has the following formula:



wherein each R^1, R^2, R^3 and R^4 independently is a substituted or unsubstituted hydrocarbon radical selected from the group consisting of linear C_1-C_{16} alkyl, branched C_3-C_{16} alkyl, C_6-C_{10} aryl, linear C_1-C_{16} alkyl-substituted C_6-C_{10} aryl, and branched C_3-C_{16} alkyl-substituted C_6-C_{10} aryl, wherein the hydrocarbon radical optionally can be substituted with one or more functional substituent selected from the group consisting of a hydroxyl substituent, a halo substituent, and an amino substituent; and X- is the conjugate base of an inorganic acid or an organic acid.

11. The CMP composition of claim 7 wherein the pH is in the range of 2 to 5.

12. A chemical-mechanical polishing (CMP) method for polishing a substrate, the method comprising abrading a surface of the substrate with a CMP composition of claim 1, wherein optionally the at least one onium compound comprises at least one phosphonium salt.

13. A chemical -mechanical polishing (CMP) method for polishing a substrate, the method comprising abrading a surface of the substrate with a CMP composition of claim 7.

14. A chemical-mechanical polishing (CMP) method for polishing a semiconductor substrate, the method comprising the steps of:

(a) contacting a surface of a semiconductor substrate with a polishing pad and an aqueous CMP composition according to any one of claims 1 to 6; 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 at least a portion of the semiconductor surface, wherein optionally the substrate comprises silicon dioxide.

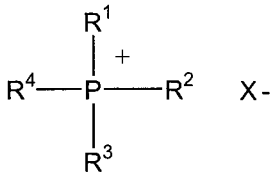
15. The CMP method of claim 14 wherein when the aqueous CMP composition is according to claim 1, the at least one onium compound comprises a sulfonium salt.

CLAIMS

1. A chemical-mechanical polishing (CMP) composition consisting essentially of:

(a) colloidal silica;

(b) at least one onium compound selected from the group consisting of a phosphonium salt, a sulfonium salt, and a combination thereof, wherein the phosphomium salt is selected from the group consisting of tetraphenylphosphonium bromide, methyltriphenylphosphonium bromide, ethyltriphenylphosphonium bromide, butyltriphenylphosphonium bromide, hexyltriphenylphosphonium bromide, benzyltriphenylphosphonium bromide, tetrabutylphosphonium bromide, tetraphenylphosphonium chloride, and tetrabutylphosphonium hydroxide; and the sulfonium salt is selected from a group consisting of trimethylsulfonium bromide, methyldiphenylsulfonium bromide, triphenylsulfonium bromide, dibutyl-2,3-dihydroxypropylsulfonium lactate, and bis-(2-hydroxyethyl)-2,3-dihydroxypropylsulfonium lactate;



(c) an aqueous carrier therefor; the composition having a pH of about 5 or less; wherein the colloidal silica is present in the composition in an amount in the range of about 0.05 to about 35 percent by weight and at least one onium salt is present in the composition in an amount in the range of about 0.04 to about 200 micromoles per gram of composition.

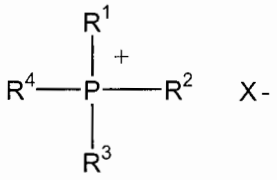
2. The CMP composition of claim 1 wherein the pH is in the range of about 2 to about 5.

3. A chemical-mechanical polishing (CMP) composition comprising:

(a) about 0.1 to about 10 percent by weight of colloidal silica;

(b) about 0.4 to about 20 micromoles per gram of at least one phosphonium salt, wherein the at least one phosphonium salt is selected from the group consisting of tetraphenylphosphonium bromide, methyltriphenylphosphonium bromide, ethyltriphenylphosphonium bromide, butyltriphenylphosphonium bromide, hexyltriphenylphosphonium bromide, benzyltriphenylphosphonium bromide,

tetrabutylphosphonium bromide, tetraphenylphosphonium chloride, and tetrabutylphosphonium hydroxide;



(c) an aqueous carrier therefor;

the composition having a pH of about 5 or less.

4. The CMP composition of claim 3 wherein the colloidal silica is present in the composition in an amount in the range of about 1 to about 6 percent by weight.

5. The CMP composition of claim 3 wherein at least one phosphonium salt is present in the composition in an amount in the range of about 1 to about 10 micromoles per gram of composition.

6. The CMP composition of claim 3 wherein the pH is in the range of about 2 to about 5.

7. A chemical-mechanical polishing (CMP) method for polishing a substrate, the method comprising abrading a surface of the substrate with a CMP composition of claim 1.

8. The CMP method of claim 7 wherein the at least one onium compound comprises at least one phosphonium salt.

9. A chemical-mechanical polishing (CMP) method for polishing a substrate, the method comprising abrading a surface of the substrate with a CMP composition of claim 3.

10. A chemical-mechanical polishing (CMP) method for polishing a semiconductor substrate, the method comprising the steps of:

(a) contacting a surface of a semiconductor substrate with a polishing pad and an aqueous CMP composition according to claim 1; 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 at least a portion of the semiconductor surface.

11. The CMP method of claim 10 wherein the colloidal silica is present in the composition in an amount in the range of about 0.05 to about 35 percent by weight.

12. The CMP method of claim 10 wherein at least one phosphonium salt is present in the composition in an amount in the range of about 0.04 to about 200 micromoles per gram of composition.

13. The CMP method of claim 10 wherein the pH of the CMP composition is in the range of about 2 to about 5.

14. The CMP method of claim 10 wherein the substrate comprises silicon dioxide.