(A) at least one compound comprising at least one thiol (–SH), thioether (–SR^1) or thiocarbonyl (>C=S) group, wherein R^1 is alkyl, aryl, alkylaryl or arylalkyl,

(B) at least one sugar alcohol which contains at least three hydroxyl (–OH) groups and does not comprise any carboxylic acid (–COOH) or carboxylate (–COO^-) groups, and

(C) an aqueous medium

was found.

In a first aspect, there is provided a post chemical-mechanical-polishing (post-CMP) cleaning composition comprising:

(A) at least one compound comprising at least one thiol (–SH), thioether (–SR^1) or thiocarbonyl (>C=S) group, wherein R^1 is alkyl, aryl, alkylaryl or arylalkyl,

(B) erythritol, threitol, or a stereoisomer thereof, or a mixture thereof,

(C) ~~an aqueous medium~~water,

wherein the post-CMP cleaning composition has a pH-value in the range of from 4 to not more than 7.

This post-CMP cleaning composition of the disclosure is referred to as (Q1) or composition (Q1) in the following.

According to an embodiment disclosed herein, a post-CMP cleaning composition comprising:

(A) at least one compound comprising at least one thiol (–SH), thioether (–SR^1) or thiocarbonyl (>C=S) group, wherein R^1 is alkyl, aryl, alkylaryl or arylalkyl,

(L) at least one oligomeric or polymeric polycarboxylic acid, and

(C) an aqueous medium

was found.

In an aspect, there is provided the use of the post-CMP cleaning composition as defined above for removing residues and contaminants from the surface of semi-conductor substrates useful for manufacturing microelectronic devices.

In another aspect, there is provided a process for manufacturing microelectronic devices from semiconductor substrates comprising the step of removing residues and contaminants from the surface of the semiconductor substrates by contacting them a least once with the post-CMP cleaning composition as defined above.

In ~~a second aspect~~an embodiment, there is provided a post chemical-mechanical-polishing (post-CMP) cleaning composition comprising:

(D) is cysteine, glutathione, N-acetylcysteine, thiourea or a derivative thereof,

(L) at least one oligomeric or polymeric polycarboxylic acid, and

(C) an aqueous medium.

This post-CMP cleaning composition of the disclosure is referred to as (Q2) or composition (Q2) in the following.

(Q1) and/or (Q2) are generally referred to as (Q) or composition (Q) in the following.

Moreover, the use of the composition (Q) for removing residues and contaminants from the surface of semiconductor substrates useful for manufacturing microelectronic devices was found.

In ~~a third aspect~~an embodiment, there is provided the use of the post-CMP cleaning composition as defined above for removing residues and contaminants from the surface of semiconductor substrates useful for manufacturing microelectronic devices.

In ~~a fourth aspect~~an embodiment, there is provided a process for manufacturing microelectronic devices from semiconductor substrates comprising the step of removing residues and contaminants from the surface of the semiconductor substrates by contacting them at least once with the composition (Q) was found. This process of the embodiments disclosed herein is referred to as the process (P) in the following.

Preferred embodiments are explained in the claims and the specification. It is understood that combinations of preferred embodiments are within the scope of the present disclosure.

Advantages

In view of the prior art discussed above, it was surprising and could not be expected by the person skilled in the art that the objects underlying the embodiments disclosed herein could be solved by the composition (Q) and by the process (P).

It was particularly surprising that the composition (Q) and the process (P) were excellently suited for post-processing substrates useful for fabricating electrical devices, in particular, semiconductor integrated circuits (ICs), more preferably ICs with LSI (large-scale integration) or VLSI (very-large-scale integration). It was even more surprising that the composition (Q) and the pro-

Claims:

1. A post chemical-mechanical-polishing (post-CMP) cleaning composition comprising:
   (A) at least one compound comprising at least one thiol (–SH), thioether (–SR^1) or thiocarbonyl (>C=S) group, wherein R^1 is alkyl, aryl, alkylaryl or arylalkyl,
   (B) is erythritol, threitol, or a stereoisomer thereof, or a mixture thereof,
   (C) water~~an aqueous medium~~,
   wherein the post-CMP cleaning composition has a pH-value in the range of from 4 to not more than 7.

2. A composition according to claim 1, wherein the compound (A) is a compound comprising at least one thiol (–SH), thioether (–SR^1), or thiocarbonyl (>C=S) group and at least one amino (–NH_2, –NHR^2, or –NR^3R^4) group and wherein R^1, R^2, R^3 and R^4 is – independently from each other – alkyl, aryl, alkylaryl or arylalkyl.

3. A composition according to claim 2, wherein the compound (A) is thiourea or a derivative thereof.

4. A composition according to claim 2, wherein compound (A) is an amino acid comprising at least one thiol (–SH) or thioether (–SR^1) group, or a derivative of this amino acid,
   wherein R^1 is alkyl, aryl, alkylaryl or arylalkyl.

5. A composition according to claim 4, wherein the compound (A) is cysteine, cystine, glutathione, N-acetylcysteine, or a derivative thereof.

6. A composition according to anyone of the claims 1 to 5, wherein the composition further comprises (D) at least one metal chelating agent.

7. A composition according to anyone of the claims 1 to 5, wherein the composition further comprises at least one metal chelating agent (D) which is selected from the group consisting of propane-1,2,3-tricarboxylic acid, citric acid, butane-1,2,3,4-tetracarboxylic acid, pentane-1,2,3,4,5-pentacarboxylic acid, trimellitic acid, trimesinic acid, pyromellitic acid, mellitic acid and oligomeric and polymeric polycarboxylic acids.

8. A composition according to anyone of the claims 1 to 8, wherein the composition further comprises (E) at least one surfactant.

9. A composition according to anyone of the claims 1 to 8, wherein the composition further comprises at least one surfactant (E) which is selected from the group consisting of:

(E1) amphiphilic nonionic, water-soluble or water-dispersible surfactants having

(e11) at least one hydrophobic group selected from the group consisting of branched alkyl groups having 5 to 20 carbon atoms; and
(e12) at least one hydrophilic group consisting of oxyethylene monomer units;

(E2) amphiphilic nonionic, water-soluble or water-dispersible surfactants having

(e21) at least one hydrophobic group selected from the group consisting of branched alkyl groups having 5 to 20 carbon atoms; and
(e22) at least one hydrophilic group selected from the group consisting of polyoxyalkylene groups comprising

(e221) oxyethylene monomer units and
(e222) at least one type of substituted oxyalkylene monomer units wherein the substituents are selected from the group consisting of alkyl, cycloalkyl, aryl, alkyl-cycloalkyl, alkyl-aryl, cycloalkyl-aryl and alkyl-cycloalkyl-aryl groups;

the said polyoxyalkylene group of (e22) containing the monomer units (e221) and (e222) in random, alternating, gradient and/or blocklike distribution; and

(E3) amphiphilic nonionic, water-soluble or water-dispersible alkyl polyglucoside surfactants.

10. The use of the post-CMP cleaning composition as defined in anyone of the claims 1 to 9 for removing residues and contaminants from the surface of semiconductor substrates useful for manufacturing microelectronic devices.

~~11. The use according to claim 10, wherein the post-CMP cleaning composition has a pH value in the range of from 4 to 8.~~

~~12.~~11. The use according to claim 10, wherein the residues and contaminants comprise benzotriazole or a derivative thereof and wherein the surface is a copper-containing surface.

~~13.~~12. The use according to claim 10, wherein the cleaning composition is used for removing residues and contaminants from the surface of semiconductor substrates comprising

- electrically conductive layers containing or consisting of copper,
- electrically insulating dielectric layers consisting of low-k or ultra-low-k dielectric materials, and
- barrier layers containing or consisting of tantalum, tantalum nitride, titanium nitride, cobalt, nickel, manganese, ruthenium, ruthenium-nitride, ruthenium-carbide, or ruthenium tungsten nitride

after chemical mechanical polishing.

~~14.~~13. A process for manufacturing microelectronic devices from semiconductor substrates comprising the step of removing residues and contaminants from the surface of the semiconductor substrates by contacting them at least once with the post-CMP cleaning composition as defined in anyone of the claims 1 to 9.

~~15. A process according to claim 14, wherein the cleaning composition has a pH value in the range of from 4 to 8.~~

~~16.~~14. A process according to claim 1~~3~~4, wherein the residues and contaminants comprise benzotriazole or a derivative thereof and wherein the surface is a copper-containing surface.

~~17.~~15. A process according to claim 1~~3~~4, wherein the semiconductor substrates comprise

- electrically conductive layers containing or consisting of copper,
- electrically insulating dielectric layers consisting of low-k or ultra-low-k dielectric materials, and
- barrier layers containing or consisting of tantalum, tantalum nitride, titanium nitride, cobalt, nickel, manganese, ruthenium, ruthenium-nitride, ruthenium-carbide, or ruthenium tungsten nitride.

~~18. A post chemical-mechanical-polishing (post-CMP) cleaning composition comprising:~~

~~(A) is cysteine, glutathione, N-acetylcysteine, thiourea or a derivative thereof,~~

~~(L) at least one oligomeric or polymeric polycarboxylic acid, and~~

(C) an aqueous medium.

19. A composition according to claim 18, wherein (L) is an oligomeric or polymeric polycarboxylic acid containing acrylic acid monomeric units.

20. A composition according to claim 18, wherein (L) is an oligomeric or polymeric polycarboxylic acid having at least 20 carboxylic acid groups.

21. A composition according to claim 18, wherein the weight average molecular weight of the oligomeric or polymeric polycarboxylic acid (L) is more than 2,000 Dalton as determined by gel permeation chromatography.

22. A composition according to claim 18, wherein (L) is an oligomeric or polymeric polycarboxylic acid which is a copolymer containing

(i) acrylic acid monomeric units, and

(ii) monomeric units derived from fumaric acid, maleic acid, itaconic acid, aconitic acid, mesaconic acid, citraconic acid, methylenemalonic acid or maleic anhydride.

23. A composition according to claim 18, wherein (L) is an oligomeric or polymeric polycarboxylic acid which is a maleic acid / acrylic acid copolymer.

24. A composition according to anyone of the claims 18 to 23, wherein the composition further comprises (E) at least one surfactant.

25. A composition according to anyone of the claims 18 to 23, wherein the composition further comprises at least one surfactant (E) which is selected from the group consisting of:

(E1) amphiphilic nonionic, water-soluble or water-dispersible surfactants having

(e11) at least one hydrophobic group selected from the group consisting of branched alkyl groups having 5 to 20 carbon atoms; and

(e12) at least one hydrophilic group consisting of oxyethylene monomer units;

(E2) amphiphilic nonionic, water-soluble or water-dispersible surfactants having

(e21) at least one hydrophobic group selected from the group consisting of branched alkyl groups having 5 to 20 carbon atoms; and

(e22) at least one hydrophilic group selected from the group consisting of polyoxyalkylene groups comprising

(e221) oxyethylene monomer units and

(e222) at least one type of substituted oxyalkylene monomer units wherein the substituents are selected from the group consisting of alkyl, cycloalkyl, aryl, alkyl-cycloalkyl, alkyl-aryl, cycloalkyl-aryl and alkyl-cycloalkyl-aryl groups;

the said polyoxyalkylene group of (e22) containing the monomer units (e221) and (e222) in random, alternating, gradient and/or blocklike distribution; and

(E3) amphiphilic nonionic, water-soluble or water-dispersible alkyl polyglucoside surfactants.

26. The use of the post-CMP cleaning composition as defined in anyone of the claims 18 to 25 for removing residues and contaminants from the surface of semiconductor substrates useful for manufacturing microelectronic devices.

27. The use according to claim 26, wherein the residues and contaminants comprise benzotriazole or a derivative thereof and wherein the surface is a copper-containing surface.

28. The use according to claim 26, wherein the cleaning composition is used for removing residues and contaminants from the surface of semiconductor substrates comprising

- electrically conductive layers containing or consisting of copper,
- electrically insulating dielectric layers consisting of low-k or ultra-low-k dielectric materials, and
- barrier layers containing or consisting of tantalum, tantalum nitride, titanium nitride, cobalt, nickel, manganese, ruthenium, ruthenium-nitride, ruthenium-carbide, or ruthenium tungsten-nitride

after chemical mechanical polishing.

29. A process for manufacturing microelectronic devices from semiconductor substrates comprising the step of removing residues and contaminants from the

surface of the semiconductor substrates by contacting them at least once with the post-CMP cleaning composition as defined in anyone of the claims 18 to 25.

30. A process according to claim 29, wherein the residues and contaminants comprise benzotriazole or a derivative thereof and wherein the surface is a copper-containing surface.

31. A process according to claim 29, wherein the semiconductor substrates comprise

- electrically conductive layers containing or consisting of copper,
- electrically insulating dielectric layers consisting of low-k or ultra-low-k dielectric materials, and
- barrier layers containing or consisting of tantalum, tantalum nitride, titanium nitride, cobalt, nickel, manganese, ruthenium, ruthenium-nitride, ruthenium-carbide, or ruthenium-tungsten nitride.