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) 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.

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 sugar alcohol (B) contains at least four hydroxyl (–OH) groups.

7. A composition according to anyone of the claims 1 to 5, wherein the sugar alcohol (B) is a saturated sugar alcohol.

8. A composition according to anyone of the claims 1 to 5, wherein the sugar alcohol (B) is a saturated sugar alcohol which contains at least four hydroxyl (–OH) groups.

9. A composition according to anyone of the claims 1 to 5, wherein the sugar alcohol (B) is selected from the group consisting of
   (B1) an alditol selected from the group consisting of tetritol, pentitol, hexitol, heptitol, and octitol, or dimers or oligomers thereof, or

(B2) a cyclitol, or dimers or oligomers thereof, or

(B3) pentaerythritol, or dimers or oligomers thereof,

or a mixture thereof.

10. A composition according to anyone of the claims 1 to 5, wherein the sugar alcohol (B) is erythritol, threitol, arabitol, xylitol, ribitol, mannitol, sorbitol, galactitol, iditol, isomalt, maltitol, lactitol, or a stereoisomer thereof, or a mixture thereof.

11. A composition according to anyone of the claims 1 to 5, wherein the sugar alcohol (B) is erythritol, threitol, or a stereoisomer thereof, or a mixture thereof.

12. A composition according to anyone of the claims 1 to 11, wherein the composition further comprises (D) at least one metal chelating agent.

13. A composition according to anyone of the claims 1 to 11, 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.

14. A composition according to anyone of the claims 1 to 13, wherein the composition further comprises (E) at least one surfactant.

15. A composition according to anyone of the claims 1 to 13, 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.

16. The use of the post-CMP cleaning composition as defined in anyone of the claims 1 to 15 for removing residues and contaminants from the surface of semiconductor substrates useful for manufacturing microelectronic devices.

17. The use according to claim 16, wherein the post-CMP cleaning composition has a pH value in the range of from 4 to 8.

18. The use according to claim 16, wherein the residues and contaminants comprise benzotriazole or a derivative thereof and wherein the surface is a copper-containing surface.

19. The use according to claim 16, 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.

20. 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 15.

21. A process according to claim 20, wherein the cleaning composition has a pH value in the range of from 4 to 8.

22. A process according to claim 20, wherein the residues and contaminants comprise benzotriazole or a derivative thereof and wherein the surface is a copper-containing surface.

23. A process according to claim 20, 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.

24. 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,
(L) at least one oligomeric or polymeric polycarboxylic acid, and
(C) an aqueous medium.

25. A composition according to claim 24, 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.

26. A composition according to claim 25, wherein the compound (A) is thiourea or a derivative thereof.

27. A composition according to claim 25, 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.

28. A composition according to claim 27, wherein the compound (A) is cysteine, cystine, glutathione, N-acetylcysteine, or a derivative thereof.

29. A composition according to anyone of the claims 24 to 28, wherein (L) is an oligomeric or polymeric polycarboxylic acid containing acrylic acid monomeric units.

30. A composition according to anyone of the claims 24 to 28, wherein (L) is an oligomeric or polymeric polycarboxylic acid having at least 20 carboxylic acid groups.

31. A composition according to anyone of the claims 24 to 28, 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.

32. A composition according to anyone of the claims 24 to 28, 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.

33. A composition according to anyone of the claims 24 to 28, wherein (L) is an oligomeric or polymeric polycarboxylic acid which is a maleic acid / acrylic acid copolymer.

34. A composition according to anyone of the claims 24 to 33, wherein the composition further comprises (E) at least one surfactant.

35. A composition according to anyone of the claims 24 to 33, 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.

36. The use of the post-CMP cleaning composition as defined in anyone of the claims 24 to 35 for removing residues and contaminants from the surface of semiconductor substrates useful for manufacturing microelectronic devices.

37. The use according to claim 36, wherein the residues and contaminants comprise benzotriazole or a derivative thereof and wherein the surface is a copper-containing surface.

38. The use according to claim 36, 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.

39. 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 24 to 35.

40. A process according to claim 39, wherein the residues and contaminants comprise benzotriazole or a derivative thereof and wherein the surface is a copper-containing surface.

41. A process according to claim 39, 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.

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) an aqueous medium,

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

17. A process according to claim 14, 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.