

THE CLAIMS

What is claimed is:

1. A method for selectively removing a silicon germanide material relative to a germanium-containing material and a silicon-containing material from the surface of a microelectronic device, comprising:

contacting a composition which includes 30 to 99% by weight ('wt.%) of at least one diol compound, 0.01 to 5 wt.% of at least one fluoride species and 0.01 to 10 wt.% of at least one oxidized species with the surface of a microelectronic device, so as to selectively remove the silicon germanide material relative to the germanium-containing material and the silicon-containing material.

2. The method according to claim 1, wherein the composition further includes water.

3. The method according to claim 1, wherein a selection ratio of a silicon germanium material to the germanium-containing material at 25°C (SiGe:Ge) exceeds 5:1.

4. A composition for selectively removing a silicon germanide material relative to a germanium-containing material and a silicon-containing material, comprising:

30 to 99 wt.% of at least one diol compound, 0.01 to 5 wt.% of at least one fluoride species, 0.01 to 10 wt.% of at least one oxidized species, optionally, at least one buffer species and at least one germanium passivation species, as well as water.

5. The composition according to claim 4, wherein pH is in a range from 1 to 5.

6. The composition according to claim 4, wherein the at least one diol species includes any species selected from a group consisting of,

ethylene glycol, neopentyl glycol, propylene glycol, 1,3-propanediol, 1,2-butanediol, 1,3-butanediol, 1,4-butanediol, 1,2-pentanediol, 1,3-pentanediol, 1,4-pentanediol, 2,3-butanediol, 3-methyl-1,2-butanediol, 1,5-pentanediol, 2-methyl-1,3-pentanediol, 2,4-pentanediol, 2-methyl-2,4-pentanediol, 2,3-pentanediol, 1,2-hexanediol, 2-ethyl-1,3-hexanediol, 2,5-dimethyl-2,5-hexanediol, 1,2-octanediol, and a combination thereof.

7. The composition according to claim 4, wherein the at least one fluoride species includes any species selected from a group consisting of,

hydrofluoric acid, hexafluorotitanic acid, hexafluorosilicic acid, hexafluorozirconic acid, tetrafluoroboric acid, tetrabutylammonium trifluoromethane sulfonate, tetraalkylammonium tetrafluoroborate ($\text{NR}_1\text{R}_2\text{R}_3\text{R}_4\text{BF}_4$), tetraalkylammonium hexafluorophosphate ($\text{NR}_1\text{R}_2\text{R}_3\text{R}_4\text{PF}_6$), tetraalkylammonium fluoride ($\text{NR}_1\text{R}_2\text{R}_3\text{R}_4\text{F}$), ammonium bifluoride, ammonium fluoride, and a combination thereof, (wherein R_1 , R_2 , R_3 , R_4 may be the same or different from one another, and are selected from a group consisting of hydrogen, linear or branched C_1 - C_6 alkyl, C_1 - C_6 alkoxy, or substituted or unsubstituted aryl group).

8. The composition according to claim 4, wherein the at least one oxidized species includes any species selected from a group consisting of,

hydrogen peroxide, FeCl_3 , FeF_3 , $\text{Fe}(\text{NO}_3)_3$, $\text{Sr}(\text{NO}_3)_2$, CoF_3 , MnF_3 , oxone ($2\text{KHSO}_5\text{KHSO}_4\text{K}_2\text{SO}_4$), periodic acid, iodic acid, vanadium (V) oxide, vanadium (IV,V) oxide, ammonium vanadate, ammonium peroxomonosulfate, ammonium chloride, ammonium chlorate, ammonium iodate, ammonium nitrate, ammonium perborate, ammonium perchlorate, ammonium periodate, ammonium persulfate, ammonium hypochlorite, ammonium hypobromite, ammonium tungstate, sodium persulfate, sodium hypochlorite, sodium perborate, sodium hypobromite, potassium iodate, potassium permanganate, potassium persulfate, nitric acid, potassium persulfate, potassium hypochlorite, tetramethylammonium chlorite, tetramethylammonium chlorate, tetramethylammonium iodate, tetramethylammonium perborate, tetramethylammonium perchlorate, tetramethylammonium periodate, tetramethylammonium persulfate, tetrabutylammonium peroxomonosulfate, peroxomonosulfuric acid, iron (II) nitrate, urea hydrogen peroxide, peracetic acid, methyl-1,4-benzoquinone (MBQ), 1,4-benzoquinone (BQ), 1,2-benzoquinone, 2,6-dichloro-1,4-benzoquinone (DCBQ), toluquinone, 2,6-dimethyl-1,4-benzoquinone (DMBQ), chloranil, alloxane, N-methylmorpholine N-oxide, trimethylamine N-oxide, and a combination thereof.

9. The composition according to claim 4, further comprising at least one buffer species selected from a group consisting of,

methane sulfonic acid, oxalic acid dihydrate, citric acid, tartaric acid, picolinic acid, succinic acid, acetic acid, lactic acid, sulfosuccinic acid, benzoic acid, propionic acid, formic acid, pyruvic acid, maleic acid, malonic acid, fumaric acid, malic acid, ascorbic acid, mandelic acid, heptanoic acid, butyric acid, valeric acid, glutaric acid, phthalic acid, hypophosphorous acid, salicylic acid, 5-sulfosalicylic acid, hydrochloric acid, ethane sulfonic acid, butane sulfonic acid, p-toluene sulfonic acid, dichloroacetic acid, difluoroacetic acid, monochloroacetic acid, monofluoroacetic acid, hydrochloric acid, trichloroacetic acid, trifluoroacetic acid, hydrobromic acid (62 wt%), sulfuric acid, ammonium

acetate, sodium acetate, potassium acetate, tetramethylammonium acetate and other tetraalkylammonium acetates, phosphonium acetate, ammonium butyrate, ammonium trifluoroacetate, phosphoric acid, diammonium monohydrogen phosphate, ammonium dihydrogen phosphate, bis(tetramethylammonium) monohydrogen phosphate, disodium monohydrogen phosphate, sodium dihydrogen phosphate, dipotassium monohydrogen phosphate, potassium dihydrogen phosphate, ditetraalkylammonium monohydrogen phosphate, ditetraalkylammonium dihydrogen phosphate, diphosphonium monohydrogen phosphate, phosphonium dihydrogen phosphate, ammonium phosphonate, tetraalkylammonium phosphonate, sodium phosphonate, potassium phosphonate, phosphonium phosphonate, salts thereof, and a combination thereof.

10. The composition according to claim 4, further comprising at least one passivation agent selected from a group consisting of,

ascorbic acid, L(+)-ascorbic acid, isoascorbic acid, ascorbic acid derivatives, boric acid, ammonium baborate, borate salts (for example, ammonium pentaborate, sodium tetraborate, and ammonium baborate), alanine, arginine, asparagine, aspartic acid, cysteine, glutamic acid, glutamine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, proline, serine, threonine, tryptophan, tyrosine, valine, sodium bromide, potassium bromide, rubidium bromide, magnesium bromide, calcium bromide, ammonium bromide represented by Formula $NR^1R^2R^3R^4Br$ (wherein R^1 , R^2 , R^3 and R^4 may be the same or different from one another, and are selected from a group consisting of hydrogen and branched or linear C_1 - C_6 alkyl).