PATENTCLAIMS

1. Process for the manufacturing of semiconductor devices, characterized in that patterned or structured SiO_2-layers or SiO_2-lines are generated with high resolution by use of SiO_2 precursor compositions, which are inkjet printed.

2. Process according to claim 1, characterized in that patterned or structured SiO_2-layers or SiO_2-lines are generated by inkjet printing SiO_2 precursor compositions, comprising at least one high boiling alcohol as solvent, with high resolution on substrate surfaces, drying and treating at high temperature for converting the precursor into solid SiO_2.

3. Process according to one or more of the claims 1 to 2, characterized in that the SiO_2 precursor compositions are inkjet printed at temperatures in the range from room temperature up to 300° C, preferably in the range between room temperature up to 150° C, most preferably in the range from room temperature up to 70° C, and dried at temperatures in the range of 80 – 400 °C, preferably in the range of 100 – 200 °C.

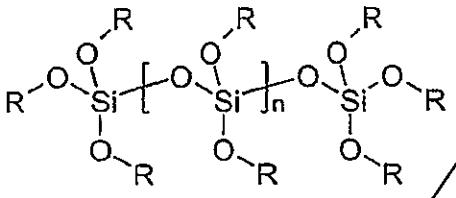
4. Process according to one or more of the claims 1 to 3, characterized in that after printing the inkjet printed and dried SiO_2 precursor compositions are converted to a barrier film consisting of SiO_2 at a temperature higher than 500 °C and less than 1000 °C.

5. Process according to one or more of the claims 1 to 4, characterized in that dried SiO_2 precursor compositions are converted to a barrier film consisting of SiO_2 at a temperature higher than 650 °C and less than 900 °C.

6. Process according to one or more of the claims 1 to 4, characterized in that the temperature for drying and subsequently converting is elevated

by slow degrees in order to save the treated wafers but also in order to evaporate the solvents smoothly.

7. SiO_2 precursor compositions, comprising
(A) a SiO_2 precursor or precursor mixture of the general formula (I)



(I)

wherein independently from each other
R A, AOA, Ar, AAr, AArA, AOAr, AOArA, AArOA,
wherein A is linear or branched $C_1 - C_{18}$-alkyl, or substituted or unsubstituted cyclic C_3-C_8 alkyl; Ar is a substituted or unsubstituted aromatic group having 6 – 18 carbon atoms,
and,
n = 1 – 100
and wherein R may build a further direct bond to Si or to neighbouring Groups R
and
(B) a high boiling solvent or homogeneous solvent mixture with a boiling temperature >100 °C and <400 °C, which is at least an alcohol or a homogeneous mixture of alcohols or a homogeneous mixture of at least one alcohol and at least one organic co-solvent or a homogeneous mixture of co-solvents and at least one alcohol.

8. SiO_2 precursor compositions according to claim 7, comprising a SiO_2 precursor or precursor mixture of the general formula (I), wherein R is methyl, ethyl, i- or n-propyl, most preferably ethyl.

9. SiO_2 precursor compositions according to claim 7 or 8, comprising at least an alcohol selected from the group

tetraethylene glycol, glycerol, dipropylene glycol, 4-methoxybenzyl alcohol,
tripropylene glycol, dipropylene glycol butyl ether, 2-phenoxyethanol, diethanolamine, triethylene glycol, ethylene glycol, 2-undecanol, ethylene glycol 2-ethylhexyl ether, diethylene glycol propyl ether, ethylene glycol hexyl ether, diethylene glycol, 1-decanol, a-terpineol, lactic acid, hexylene glycol, propylene glycol, 1-nonanol, dipropylene glycol methyl ether, diethylene glycol butyl ether, 1,3-butanediol, benzyl alcohol, 1-octanol,
2-methyl-2-heptanol, 2-octanol, 2,2-dimethyl-1-pentanol, 1-heptanol, ethylene glycol butyl ether, 4-heptanol, 3-heptanol, diethylene glycol ethyl ether, tetrahydrofurfuryl alcohol, propylene glycol butyl ether, furfuryl alcohol, diacetone alcohol, 2-heptanol, ethanolamine, 5-methyl-2-hexanol,
diethylene glycol methyl ether, ethylene glycol butyl ether, 1-hexanol, cyclohexanol, 3-methylcyclohexanol, 2,2-dimethyl-1-butanol, 4-methyl-1-pentanol, ethylene glycol propyl ether, ethyl lactate, 2-hexanol, 2-methyl-1-pentanol, 2-ethyl-1-butanol, 3-hexanol, 3-methyl-2-pentanol 1-pentanol, cyclopentanol, 4-methyl-2-pentanol, 2-methyl-3-pentanol, 3-methyl-1-butanol, ethylene glycol ethyl ether, 3,3-dimethyl-1-butanol, 2-methyl-1-butanol, 2-pentanol, ethylene glycol methyl ether, 3-pentanol, propylene glycol methyl ether, 1-butanol, 2-methyl-1-propanol.

10. SiO_2 precursor compositions according to one or more of the claims 7 to 9, comprising at least an alcohol selected from the group methyl alcohol, ethyl alcohol, *n*-propyl alcohol, lisopropyl alcohol, *n*-butyl alcohol, 2-ethyl-1 butanol, *sec*-butyl alcohol, *tert*-butyl alcohol, isobutyl alcohol, iso-amyl alcohol, *n*-amyl alcohol, t-amyl alcohol, *n*-hexyl alcohol, heptanol, octanaol, allyl alcohol, crotyl alcohol, ethylene glycol, propylene glycol, trimethylene glycol, glycerol, ,methyl isobutyl carbinol, 2-ethyl-1-hexanol, diacetone alcohol, nonyl alcohol, decyl alcohol, cetyl alcohol, cyclohexanol, furfuryl alcohol, tetrahydrofurfuryl alcohol, benzyl alcohol and, phenyl ethyl alcohol.

11. SiO_2 precursor compositions according to one or more of the claims 7 to 10, comprising at least one organic co-solvent, which is selected

from the aromatic or heteroaromatic hydrocarbons, like toluene, xylene (all isomers), tetralin, indan, or mono, di, tri, tetra, penta and hexa alkyl benzenes, naphthalene, alkyl naphthalene, alkylthiazoles, alkylthiophenes, or which is selected from the aliphatic hydrocarbons in form of linear or branched alkanes like n-octane or from the cycloalkanes, like methylcyclohexane or decalin which is a mixture thereof.

12. SiO_2 precursor compositions according to one or more of the claims 7 to 11, comprising at least one organic co-solvent selected from the group toluene, xylene (all isomers), tetralin, indan, benzene, naphthalene n-octane methylcyclohexane and decalin.

13. SiO_2 precursor compositions according to one or more of the claims 7 to 12, comprising at least one aromatic and aliphatic fluoro solvent, like FC43, FC70, methyl nonafluorobutyl ether, 3-ethoxy-1,1,1,2,3,4,4,5,5,6,6,6-dodecafluoro-2-trifluoromethyl-hexane, perfluorodecane or at least one ether, like ethylene glycol diethyl ether, or ester, like amyl acetate , or lactone, like gamma-butyrolactone, or ketone, or amide, like NMP or DMF, suplhoxides (DMSO), sulphones, etc.

14. SiO_2 precursor compositions according to one or more of the claims 7 to 13, comprising the precursor in a concentration in the range of > 0.1% to < 90% by weight, based on the composition as a whole, more preferably > 0.5% to < 50%, and most preferably > 1% to < 20%.

15. SiO_2 precursor compositions according to one or more of the claims 7 to 14, comprising the high boiling solvent or homogeneous solvent mixture in an amount of >10 % up to <99, 9 % by weight, based on the composition as a whole, preferably in an amount >50 % up to <99,5 %, most preferably >80 % up to <99 %, with the proviso that about 90% by weight of the comprising carrier solvent has a boiling point higher than 100 °C and less than 400 °C and that at least 5 % by weight of the solvent mixture is an high boiling alcohol.

16. SiO_2 precursor compositions according to one or more of the claims 7 to 15, having a viscosity in the range >2 and < 20 cps at printing temperature.

17. SiO_2 precursor compositions according to one or more of the claims 7 to 15, having a surface tension in a range between >20 dyne/cm and <60 dyne/cm.

18. Use of the SiO_2 precursor compositions according to one or more of the claims 7 to 17 for the generation of patterned or structured SiO_2-layers or of SiO_2-lines during the manufacturing process of semiconductor devices.

19. Use of the SiO_2 precursor compositions according to one or more of the claims 7 to 17 for micro-stamping / soft lithography, flexo or gravure process steps.

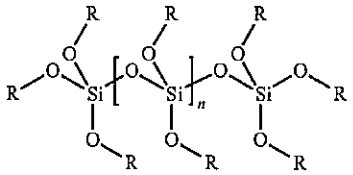
20. Use of SiO_2 diffusion barrier against Phosphorous diffusion in silicon.

21. A semiconductor device fabricated using the inks and processes from claims 1-18.

Patent Claims:

1. A process for the manufacturing of a semiconductor device, comprising generating SiO_2-layers or SiO_2-lines on a substrate surface by applying a precursor composition comprising

(A) a SiO_2 precursor or precursor mixture of the general formula (I)



(I)

wherein independently from each other

R A, AOA, Ar, AAr, AArA, AOAr, AOArA, AAROA,

wherein A is linear or branched C_1-C_{18}-alkyl, or substituted or unsubstituted cyclic C_3-C_8 alkyl; Ar is a substituted or unsubstituted aromatic group having 6-18 carbon atoms, and,

n=1−100

and wherein R may build a further direct bond to Si or to neighboring groups R and

(B) a high boiling solvent or homogeneous solvent mixture with a boiling temperature >100° C. and <400° C., which is at least an alcohol or a homogeneous mixture of alcohols or a homogeneous mixture of at least one alcohol and at least one organic co-solvent or a homogeneous mixture of co-solvents and at least one alcohol,
wherein said precursor composition is ink jet printable.

2. A process according to claim 1, wherein patterned or structured SiO_2-layers or SiO_2-lines are generated with high resolution by use of SiO_2 precursor compositions, which are inkjet printed.

3. A process according to claim 2, wherein patterned or structured SiO_2-layers or SiO_2-lines are generated with a resolution of from 1 to 80 μm.

4. A process according to claim 1, wherein patterned or structured SiO_2-layers or SiO_2-lines are generated by inkjet printing an SiO_2 precursor composition, comprising at least one high boiling alcohol as solvent, with high resolution on a substrate surface, drying and treating at high temperature for converting the precursor into solid SiO_2.

5. A process according to claim 4, wherein patterned or structured SiO_2-layers or SiO_2-lines are generated with a resolution of from 1 to 80 μm.

6. A process according to claim 1, wherein the SiO_2 precursor composition is inkjet printed at temperatures from room temperature up to 300° C. and dried at temperatures of 80-400° C.

7. A process according to claim 6, wherein the SiO_2 precursor compositions are inkjet printed at temperatures in the range from room temperature up to 150° C. and dried at temperatures in the range of 100-200° C.

8. A process according to claim 7, wherein the SiO_2 precursor compositions are inkjet printed at temperatures in the range from room temperature up to 70° C. and dried at temperatures in the range of 100-200° C.

9. A process according to claim 1, wherein after printing the SiO_2 precursor composition is dried at a temperature higher than 500° C. and less than 1000° C. and converted to a barrier film consisting of SiO_2.

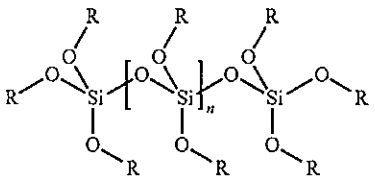
10. A process according to claim 1, wherein the SiO_2 precursor composition is dried at a temperature higher than 650° C. and less than 900° C. and converted to a barrier film consisting of SiO_2.

11. A process according to claim 1, wherein the temperature for drying and subsequently converting is elevated by slow degrees in order to save the treated wafers but also in order to evaporate the solvents smoothly.

12. A semiconductor device fabricated according to the process of claim 1.

13. A SiO_2 precursor composition, comprising

(A) a SiO_2 precursor or precursor mixture of the general formula (I)



(I)

wherein independently from each other

R A, AOA, Ar, AAr, AArA, AOAr, AOArA, AAROA,

wherein A is linear or branched C_1-C_{18}-alkyl, or substituted or unsubstituted cyclic C_3-C_8 alkyl; Ar is a substituted or unsubstituted aromatic group having 6-18 carbon atoms,
and,

n=1−100

and wherein R may build a further direct bond to neighbouring Groups R and

(B) a high boiling solvent or homogeneous solvent mixture with a boiling temperature >100° C. and <400° C., which is at least an alcohol or a homogeneous mixture of alcohols or a homogeneous mixture of at least one alcohol and at least one organic co-solvent or a homogeneous mixture of co-solvents and at least one alcohol.

14. A SiO_2 precursor composition according to claim 13, comprising a SiO_2 precursor or precursor mixture of the general formula (I), wherein R is methyl, ethyl, i- or n-propyl.

15. A SiO_2 precursor composition according to claim 14, wherein R is ethyl.

16. A SiO_2 precursor composition according to claim 13, comprising at least an alcohol selected from the group tetraethylene glycol, glycerol, dipropylene glycol, 4-methoxybenzyl alcohol, tripropylene glycol, dipropylene glycol butyl ether, 2-phenoxyethanol, diethanolamine, triethylene glycol, ethylene glycol, 2-undecanol, ethylene glycol 2-ethylhexyl ether, diethylene glycol propyl ether, ethylene glycol hexyl ether, diethylene glycol, 1-decanol, a-terpineol, lactic acid, hexylene glycol, propylene glycol, 1-nonanol, dipropylene glycol methyl ether, diethylene glycol butyl ether, 1,3-butanediol, benzyl alcohol, 1-octanol, 2-methyl-2-heptanol, 2-octanol, 2,2-dimethyl-1-pentanol, 1-heptanol, ethylene glycol butyl ether, 4-heptanol, 3-heptanol, diethylene glycol ethyl ether, tetrahydrofurfuryl alcohol, propylene glycol butyl ether, furfuryl alcohol, diacetone alcohol, 2-heptanol, ethanolamine, 5-methyl-2-hexanol, diethylene glycol methyl ether, ethylene glycol butyl ether, 1-hexanol, cyclohexanol, 3-methylcyclohexanol, 2,2-dimethyl-1-butanol, 4-methyl-1-pentanol, ethylene glycol propyl ether, ethyl lactate, 2-hexanol, 2-methyl-1-pentanol, 2-ethyl-1-butanol, 3-hexanol, 3-methyl-2-pentanol 1-pentanol, cyclopentanol, 4-methyl-2-pentanol, 2-methyl-3-pentanol, 3-methyl-1-butanol, ethylene glycol ethyl ether, 3,3-dimethyl-1-butanol, 2-methyl-1-butanol, 2-pentanol, ethylene glycol methyl ether, 3-pentanol, propylene glycol methyl ether, 1-butanol, 2-methyl-1-propanol.

17. A SiO_2 precursor composition according to claim 13, comprising at least an alcohol selected from the group

methyl alcohol, ethyl alcohol, n-propyl alcohol, lisopropyl alcohol, n-butyl alcohol, 2-ethyl-1 butanol, sec-butyl alcohol, tert-butyl alcohol, isobutyl alcohol, iso-amyl alcohol, n-amyl alcohol, t-amyl alcohol, n-hexyl alcohol, heptanol, octanaol, allyl alcohol, crotyl alcohol, ethylene glycol, propylene glycol, trimethylene glycol, glycerol, methyl isobutyl carbinol, 2-ethyl-1-hexanol, diacetone alcohol, nonyl alcohol, decyl alcohol, cetyl alcohol, cyclohexanol, furfuryl alcohol, tetrahydrofurfuryl alcohol, benzyl alcohol and, phenyl ethyl alcohol.

18. A SiO_2 precursor composition according to claim 13, comprising at least one organic co-solvent that is an aromatic or heteroaromatic hydrocarbon, or which is a linear or branched aliphatic hydrocarbon or a mixture thereof.

19. A SiO_2 precursor composition according to claim 18, wherein said aromatic or heteroaromatic hydrocarbon is toluene, xylene, a xylene isomer, tetralin, indan, a mono, di, tri, tetra, penta or hexa alkyl benzene, naphthalene, alkyl naphthalene, alkylthiazoles or an alkylthiophene.

20. A SiO_2 precursor composition according to claim 18, wherein said linear or branched alkane is n-octane, a cycloalkane, a methylcyclohexane, decalin or a mixture thereof.

21. A SiO_2 precursor composition according to claim 13, comprising at least one organic co-solvent that is toluene, xylene (all isomers), tetralin, indan, benzene, naphthalene n-octane methylcyclohexane or decalin.

22. A SiO_2 precursor composition according to claim 13, wherein said solvent is an aromatic and aliphatic fluoro solvent, an ether, an ester, a lactone, a ketone, a amide or a sulphone or a solvent mixture thereof.

23. A SiO_2 precursor composition according to claim 22, wherein said solvent is FC43, FC70, methyl nonafluorobutyl ether, 3-ethoxy-1,1,1,2,3,4,4,5,5,6,6,6-dodecafluoro-2-trifluoromethyl-hexane, perfluorodecane, ethylene glycol diethyl ether, amyl acetate gamma-butyrolactone, NMP, DMF, DMSO, or a mixture thereof.

24. A SiO_2 precursor composition according to claim 13, comprising the precursor in a concentration in the range of >0.1% to <90% by weight, based on the composition as a whole.

25. A SiO_2 precursor composition according to claim 24, comprising the precursor in a concentration in the range of >0.5% to <50% by weight, based on the composition as a whole.

26. A SiO_2 precursor composition according to claim 24, comprising the precursor in a concentration in the range of >1% to <20% by weight, based on the composition as a whole.

27. A SiO_2 precursor composition according to claim 13, comprising the high boiling solvent or homogeneous solvent mixture in an amount of >10% up to <99, 9% by weight, based on the composition as a whole, with the proviso that about 90% by weight of the comprising carrier solvent has a boiling point higher than 100° C. and less than 400° C. and that at least 5% by weight of the solvent mixture is an high boiling alcohol.

28. A precursor composition according to claim 27 comprising >50% up to <99.5% by weight of the high boiling solvent or homogeneous solvent mixture, based on the composition as a whole.

29. A precursor composition according to claim 27 comprising >80% up to <99% by weight of the high boiling solvent or homogeneous solvent mixture, based on the composition as a whole.

30. A SiO_2 precursor composition according to claim 13, having a viscosity in the range >2 and <20 cps at printing temperature.

31. A SiO_2 precursor composition according to claim 13, having a surface tension in a range between >20 dyne/cm and <60 dyne/cm.

32. A SiO_2 precursor composition according to claim 13, wherein the composition is inkjet printable.

33. A method comprising using a SiO_2 precursor composition according to claim 13 for the generation of patterned or structured SiO_2-layers or of SiO_2-lines during the manufacturing process of semiconductor devices,

comprising generating said layers or lines by applying a SiO2 precursor according to claim 8 to a substrate.

34. A method comprising using a SiO_2 precursor composition according to claim 13 for micro-stamping/soft lithography, flexo or gravure process steps comprising generating said layers or lines by applying a SiO2 precursor according to claim 8 to a substrate.

35. A method to prevent boron or phosphorus diffusion on a silicon substrate comprising applying a SiO2 precursor according to claim 13 to a substrate to create a SiO_2 diffusion barrier on said silicon substate.