CLAIMS:

1. A dielectric polymer film comprising a cured gap-fill material forming composition, comprising a polymer obtained by polymerization of monomers having formula I

$$R^1R^2R^3\ Si\text{-}X^1\text{-}SiX^2_nR^4_{3-n} \qquad I$$

wherein

each X^1 is selected from the group of oxygen, optionally substituted bridging linear or branched bivalent hydrocarbyl groups, such as alkylene having 1 to 6 carbon atoms and arylene having 6 to 10 carbon atoms;

each X^2 is selected from the group of hydrogen, organic or inorganic hydrolyzable groups;

each R^1 and R^2 and R^3 is independently selected from alkyl groups having 1 to 6 carbon atoms and aryl groups having 6 to 18 carbon atoms, such as phenyl or benzyl groups, said groups optionally being substituted;

each R^4 is selected from alkyl groups having 1 to 6 carbon atoms and aryl groups having 6 to 18 carbon atoms, such as phenyl or benzyl groups, said groups optionally being substituted;

n is an integer of 1 to 3; and

wherein the gap-fill material forming composition comprises polymer material having a weight average molecular weight of 1000 to 10 000 g/mol, formulated in organic solvent or solvents, and

wherein the dielectric polymer film has a thickness of less than 1 μm and a shrinkage between soft bake and cure less than 5%.

2. The dielectric polymer film according to claim 1, wherein the gap-fill material forming composition comprises at least 10 mol%, such as 10-20 mol-%, more preferably about 15 mol-%, of a polymer according to formula I.

3. The dielectric polymer film according to claim 1 or 2, wherein the gap-fill material forming composition is obtained by copolymerization of compounds of formula I with silane monomers, wherein the compounds of formula I amount to at least 5 mol% of the total amount of monomers of the polymer composition.

4. The dielectric polymer film according to any of the preceding claims, the gap-fill material forming composition being obtained by copolymerization of a compound of formula I with a compound of formula II

$$(X^3)_m(R^5)_{3-m}Si\text{-}R^6\text{-}Si(X^4)_m(R^7)_{3-m} \qquad \text{II}$$

wherein

each X^3 and X^4 is independently selected from the group of hydrogen, organic or inorganic hydrolyzable groups;

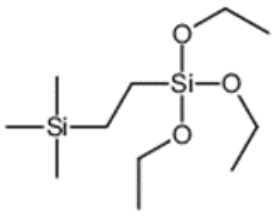
each R^5 and R^7 is independently selected from alkyl groups having 1 to 6 carbon atoms and aryl groups having 6 to 18 carbon atoms, such as phenyl or benzyl groups, said groups optionally being substituted;

each R^6 is selected from the group of optionally substituted bridging linear or branched bivalent hydrocarbyl groups, such as alkylene having 1 to 6 carbon atoms and arylene having 6 to 10 carbon atoms; and

m is an integer of 1 to 3.

5. The dielectric polymer film according to any one of the preceding claims, wherein each X^1 and R^6 is independently selected from alkylene having 1 to 4, in particular 2 carbon atoms.

6. The dielectric polymer film according to any one of the preceding claims, wherein the monomers according to formula I are selected from monomers having formula Ia



Ia.

7. The dielectric polymer film according to any one of claims 4–5, wherein the compounds of formula I amount to at least 10 mol-% and the compounds of formula II amount to at least 40 mol-% of the total amount of monomers of the gap-fill material forming composition.

8. The dielectric polymer film according to any of the preceding claims, the gap-fill material forming composition being obtained by copolymerization of a compound of formula I with a compound of formula III

$$(X^4)_{4-n}SiR^{14}{}_n \qquad \text{III}$$

wherein
each X^4 is selected from the group of hydrogen, organic or inorganic hydrolyzable groups;
each R^{14} is selected from alkyl groups having 1 to 6 carbon atoms and aryl groups having 6 to 18 carbon atoms, such as phenyl or benzyl groups, said groups optionally being substituted; and
n is an integer of 1 to 3.

9. The dielectric polymer film according to any one of the preceding claims, wherein each X^2, X^3 and X^4 is independently selected from the group of hydrogen and R^9O-, wherein R^9 stands for an alkyl having 1 to 6 carbon atoms.

10. The dielectric polymer film according to any one of the preceding claims, wherein each R^1, R^2, R^3, R^5, R^6, R^7, R^8 and R^{14} is independently selected from alkyl groups having 1 to 4 carbon atoms and phenyl groups.

11. The dielectric polymer film according to any one of the preceding claims, the gap-fill material forming composition comprising a polymer formulated in organic solvent or solvents having a curing catalyst selected from a thermally labile curing catalyst, a photobase-containing curing catalyst, and a photoacid-containing curing catalyst.

12. The dielectric polymer film according to any one of the preceding claims, wherein said gap-fill material forming composition is capable to fill dimensions of 10-20 nm or less, particularly when deposited by spin-coating.

13. The dielectric polymer film according to any one of the preceding claims, having an electric breakdown voltage of at least 4.0 MV/cm.

14. The dielectric polymer film according to any one of the preceding claims, having a dielectric constant at 1 MHz of 2.9 or less.

15. The dielectric polymer film according to any one of the preceding claims, having a refractive index of at least 1.37 measured at a wavelength of 633 nm and an elastic modulus of 8.5 GPa or more.

16. The dielectric polymer film according to any one of the preceding claims having a shrinkage between soft bake and cure less than 1% and a thickness of 50 to 350 nm.

17. A method of forming a gap-fill dielectric polymer film, comprising:

- hydrolysing a first silicon compound having the formula I

$$R^1R^2R^3\ Si\text{-}X^1\ \text{-}SiX^2{}_nR^4{}_{3\text{-}n} \qquad I$$

wherein R^1, R^2, R^3, X^1, R^4, X^2 and n have the same meanings as in claim 1; and

- polymerizing the first silicon compound, optionally with at least one second silicon compound obtained by hydrolysing a compound having the formula II

$$(X^3)_m(R^5)_{3\text{-}m}Si\text{-}R^6\text{-}Si(X^4)_m(R^7)_{3\text{-}m} \qquad II$$

wherein R^5, R^6, R^7, X^3, X^4 and m have the same meanings as in claim 4,
and/or a compound having the formula III

$$(X^4)_{4\text{-}n}SiR^{14}{}_n \qquad III$$

wherein R^{14}, X^4 and n have the same meanings as in claim 8,
to provide a gap-fill coating composition; said gap-fill coating composition comprising polymer material having a weight average molecular weight of 1000 to 10 000 g/mol, in organic solvent system;

- depositing the gap-fill coating composition in liquid form on a substrate, preferably by spin coating; and

– curing the composition to form the gap-fill dielectric polymer film.

18. The method according to claim 17, wherein the substrate is a semiconductor substrate or an optical element or optically active device substrate.

19. A method for producing a semiconductor device or an optical element or optically active device, the method comprising:

- providing a substrate;
- applying a gap-fill material forming composition as defined in any one of claims 1 to 16 onto the substrate; and curing the composition to provide a gap-fill dielectric film according to any one of claims 1–16 on the substrate, wherein curing optionally comprises combining thermal and UV curing.

20. A semiconductor device or optical element comprising a dielectric polymer film according to any one of claims 1-16.