WHAT IS CLAIMED IS:

1. A preceramic resin for forming a polymer-derived ceramic material, said resin comprising a first functionalised organosilicon monomer having a first ceramic yield of no greater than 50%, and one or more of:

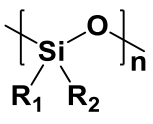
a) a second functionalised organosilicon monomer having a second ceramic yield, wherein the second ceramic yield is greater than the first ceramic yield by at least 5%; and

b) ceramic particles.

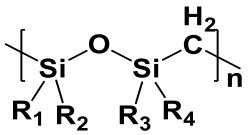
2. The preceramic resin according to claim 1, wherein the first ceramic yield is a ceramic yield which is less than or equal to 30%, and/or wherein the second ceramic yield is greater than the first ceramic yield by 10% or more.

3. The preceramic resin according to claim 1 or 2, wherein the first functionalised organosilicon monomer is based on an organosilicon monomer independently selected from the group consisting of:

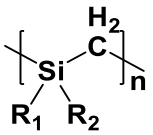
a polysiloxane, polycarbosiloxane, polycarbosilane, polysilylcarbodiimide and a polysilazane having the following chemical structures of Formula 1, Formula 2, Formula 3, Formula 4 and Formula 5, respectively,



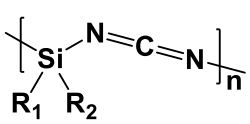
Formula 1



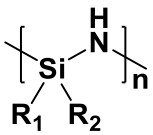
Formula 2



Formula 3



Formula 4



Formula 5

wherein:

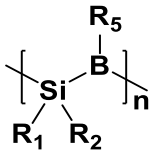
n represents a backbone structure of repeating silicon atom-containing motifs and is independently an integer of from 2 to 15; and

R_1, R_2, R_3 and R_4 are independently selected from the group

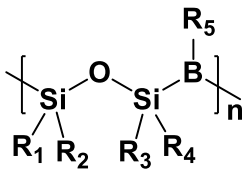
consisting of H, a C_1-C_{18} substituted or unsubstituted alkyl, a C_1-C_{18} substituted or unsubstituted alkyl ether, a phenyl and a halide, independently for each integer of n, with the proviso that the pairs of R_1 and R_2 and R_3 and R_4 are not both H, alkyl ether or halide for every integer of n, preferably wherein the pairs of R_1 and R_2 and R_3 and R_4 are not both H, alkyl ether or halide for any integer of n, and preferably wherein each of R_1 and R_2 and R_3 and R_4 are identical for every integer of n;

a polysilsesquioxane, polysilsesquicarbodiimide and a polysilsesquiazane substituted with one or more groups selected from the group consisting of a C_1-C_{18} substituted or unsubstituted alkyl, a C_1-C_{18} substituted or unsubstituted alkyl ether, a phenyl and a halide; and

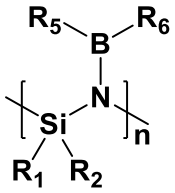
a polyborosilane, a polyborosiloxane and a polyborosilazane having the following chemical structures of Formula 6, Formula 7 and Formula 8, respectively,



Formula 6



Formula 7



Formula 8

wherein:

n represents a backbone structure of repeating silicon atom-containing motifs and is independently an integer of from 2 to 15;

R_1, R_2, R_3 and R_4 are as defined above; and

R_5 and R_6 are independently selected from the group consisting of H, OH, a C_1-C_{18} substituted or unsubstituted alkyl, a C_1-C_{18} substituted or unsubstituted alkyl ether and a phenyl, independently for each integer of n, and preferably wherein R_5 and R_6 are identical for every integer of n.

4. The preceramic resin according to any one of claims 1 to 3, wherein the first functionalised organosilicon monomer is functionalised with a thermal- and/or photopolymerisable functional group.

5. The preceramic resin according to any one of claims 1 to 4, wherein the first

functionalised organosilicon monomer is a polysiloxane methacryloxypropyl terminated polydimethylsiloxane.

6. The preceramic resin according to any one of claims 1 to 5, wherein the second functionalised organosilicon monomer is present and contains a polymerisable functional group that is different from, though complementary to, a polymerisable functional group of the first functionalised organosilicon monomer.

7. The preceramic resin according to any one of claims 1 to 6, wherein the second functionalised organosilicon monomer is present and is a polysiloxane (mercaptopropyl) methylsiloxane homopolymer.

8. The preceramic resin according to any one of claims 1 to 7, wherein the second functionalised organosilicon monomer is present, and wherein the first functionalised organosilicon monomer and the second functionalised organosilicon monomers are present in the preceramic resin in a 1:1 to 1:2 ratio in respect of their polymerisable functional groups.

9. The preceramic resin according to any one of claims 1 to 8, wherein the second functionalised organosilicon monomer is present, and wherein one of the first functionalised organosilicon monomer and the second functionalised organosilicon monomer is functionalised with an acrylate polymerisable functional group and the other is functionalised with a thiol polymerisable functional group.

10. The preceramic resin according to any one of claims 1 to 9, wherein the ceramic particles are present, preferably wherein at least 90% of the ceramic particles have a size of between about 1 nm to about 1 mm, as determined using TEM.

11. A polymer-derived ceramic material formed from a preceramic resin according to any one of claims 1 to 10.

12. The polymer-derived ceramic material according to claim 11, formed by pyrolysis of a green body, characterised by a linear shrinkage of greater than or equal to 30% and a volumetric shrinkage of greater than or equal to about 66%.

13. The polymer-derived ceramic material according to claim 11 or 12, wherein the polymer-derived ceramic material comprises silica, formed by pyrolysis of a green body, characterised by a linear shrinkage of greater than or equal to 20% and a volumetric shrinkage of greater than or equal to about 49%.

14. The polymer-derived ceramic material according to any one of claims 11 to 13, wherein the polymer-derived ceramic material comprises a glass-ceramic material.

15. A method for forming a polymer-derived ceramic material, said method comprising:

a) subjecting a preceramic resin according to any one of claims 1 to 10 to polymerising conditions to form a preceramic polymer; and
b) subjecting the preceramic polymer to pyrolytic conditions to form a polymer-derived ceramic material.

16. The method according to claim 15, wherein formation of the polymer-derived ceramic material from the preceramic polymer proceeds through a porous phase, and wherein the pyrolytic conditions comprise a temperature ramp-up rate of no greater than 10 ºC/minute for a period within the porous phase.

17. The method according to claim 15 or 16, wherein the pyrolytic conditions comprise a temperature ramp-up rate of no greater than 10 ºC/minute for a period within the temperature range of 200 to 900 ºC.

18. The method according to any one of claims 15 to 17, wherein the pyrolytic conditions comprise a maximum temperature of less than a porosity transition temperature of the polymer-derived ceramic material.

19. The method according to any one of claims 15 to 18, wherein the pyrolytic conditions comprise a minimum temperature of no less than the porosity transition temperature.

20. The method according to any one of claims 15 to 19, further comprising a preliminary step of shaping the preceramic resin using a 3D printer.