

What is claimed:

1. A composition comprising:
a silica-based aerogel including hydrophobic-bound silicon, greater than 50% of the hydrophobic-bound silicon bonded to no more than one alkyl group.
2. A composition comprising:
an intrinsically hydrophobic silica-based aerogel, the composition having a heat of combustion of less than 717 cal/g.
3. The composition of claim 1 or claim 2, wherein the silica based aerogel having surface groups, the surface groups consisting essentially of hydrophobic groups of the formula Si-R, where R is a single methyl group.
3. The composition of claim 1, wherein the silica-based aerogel is not surface-treated by a hydrophobizing agent.
4. The composition of claim 1 or claim 2, wherein the composition has a water uptake in the range of about 5 wt % or less, 3 wt% or less, 2 wt% or less, or about 1 wt% or less.
5. The composition of claim 1, wherein the composition has a heat of combustion less than 717 cal/g.
6. The composition of claim 1 or claim 2, wherein the composition has a heat of combustion in the range of about 700 cal/g or less, 650 cal/g or less, 600 cal/g or less, 575 cal/g or less, about 550 cal/g or less, about 500 cal/g or less, about 450 cal/g or less, about 400 cal/g or less, about 350 cal/g or less, about 300 cal/g or less, about 250 cal/g or less, about 200 cal/g or less, about 150 cal/g or less, about 100 cal/g or less, about 50 cal/g or less, about 25 cal/g or less, or about 10 cal/g or less.

7. The composition of any of claim 1, claim 2, claim 3, or claim 4, wherein the composition has a heat of combustion between 250 cal/g and 600 cal/g.
8. The composition of any preceding claim, wherein the composition has an onset of thermal decomposition of hydrophobic organic materials of 350°C or higher.
9. The composition of any preceding claim, wherein the composition has an onset of thermal decomposition of hydrophobic organic materials of 400°C or higher.
10. The composition of any preceding claim, wherein the composition has an onset of thermal decomposition of hydrophobic organic materials of 500°C or higher.
11. The composition of any preceding claim, wherein the silica-based aerogel has a content of ammonium salts in the range of about 2000 ppm or less.
12. The composition of claim 11, wherein the silica-based aerogel has a content of ammonium salts in the range of about 1000 ppm or less, 500 ppm or less, 200 ppm or less, or 100 ppm or less.
13. The composition of any preceding claim, wherein the silica-based aerogel has a content of ammonium salts in the range of about 0.2 wt % or less.
14. The composition of any preceding claim, wherein the silica-based aerogel has a content of ammonium salts in the range of about 0.1 wt % or less.
15. The composition of any preceding claim, wherein the silica-based aerogel has a water uptake in the range of about 10 wt % or less, about 8 wt % or less, about 3 wt % or less, about 2 wt % or less, about 1 wt % or less, or about 0.1 wt % or less.
16. The composition of any preceding claim, wherein the silica-based aerogel has a thermal conductivity less than about 45 mW/M*K.

17. The composition of claim 16, wherein the silica-based aerogel has a thermal conductivity in the range of about 45 mW/M*K or less, about 40 mW/M*K or less, about 35 mW/M*K or less, about 30 mW/M*K or less, about 25 mW/M*K or less, about 20 mW/M*K or less, about 18 mW/M*K or less, about 16 mW/M*K or less, about 15 mW/M*K or less, about 14 mW/M*K or less, about 13 mW/M*K or less, about 12 mW/M*K or less, or about 5 mW/M*K to 50 mW/M*K.
18. The composition of any preceding claim further comprising a reinforcement material.
19. The composition of claim 18, wherein the reinforcement material comprises a fiber reinforcement material or a foam reinforcement material.
20. The composition of any preceding claim further comprising an opacifying or fire-class additive.
21. The composition of claim 20, wherein the opacifying or fire-class additive is present in a range of about 0.1 wt% to about 10 wt%.
22. The composition of claim 20, wherein the opacifying or fire-class additive is present in a range of about 0.5 wt% to about 3.0 wt%.
23. The composition of claim 20, wherein the opacifying or fire-class additive is selected from the group consisting of boron carbide, diatomite, manganese ferrite, manganese oxide, nickel oxide, tin oxide, silver oxide, bismuth oxide, titanium carbide, tungsten carbide, carbon black, titanium oxide, iron titanium oxide, zirconium silicate, zirconium oxide, iron oxide, iron (II) oxide, iron (III) oxide, manganese dioxide, iron titanium oxide, chromium oxide, silicon carbide, phyllosilicate clay, kaolin or kaolinite, metakaolin, halloysite, meta-halloysite, endellite, mica, diaspore, gibbsite, boehmite, montmorillonite, beidellite, pyrophyllite, nontronite, bravaisite, smectite, leverrierite, rectorite, celadonite, attapulgite, chloropal, volkonskoite, allophane, racewinite, dillnite, severite, miloschite, collyrite, cimolite and newtonite, sodium bicarbonate, magnesium hydroxide, magnesium dihydroxide, alumina trihydrate, gypsum,

barringtonite, nesquehonite, lansfordite, hydromagnesite, dolomite, lithium carbonate or mixtures thereof.

24. The composition of any preceding claim further comprising at least about 0.1 wt % strong base or strong base derivative.

25. The composition of any preceding claim comprising at most about 2 wt % strong base or strong base derivative.

26. The composition of claim 24 or claim 25, wherein the strong base or strong base derivative includes cations selected from the group consisting of lithium, calcium, sodium, potassium, rubidium, barium, strontium, and guanidinium.

27. A composition comprising a silica-based aerogel, the composition including at least about 0.1 wt % of strong base or strong base derivative.

28. The composition of claim 27 comprising at most about 2 wt % strong base or strong base derivative.

29. The composition of claim 27 or claim 28, wherein the strong base or strong base derivative includes cations selected from the group consisting of lithium, calcium, sodium, potassium, rubidium, barium, strontium, and guanidinium.

30. The composition of any of claim 27, claim 28 or claim 29, wherein the silica-based aerogel includes hydrophobic-bound silicon, greater than 50% of the hydrophobic-bound silicon bonded to a single alkyl group.

31. The composition of any of claim 27, claim 28, claim 29 or claim 30, wherein the composition has a water uptake in the range of about 15 wt % or less, a heat of combustion less than 717 cal/g, and an onset of thermal decomposition of hydrophobic organic materials of 400°C or higher.

32. A method comprising:

- providing a precursor solution comprising silica gel precursor materials and a solvent;
- providing a basic catalyst solution with a pK_b less than about 4;
- combining the precursor solution and the basic catalyst solution;
- allowing the silica precursor materials to transition into a gel composition;
- extracting at least a portion of the solvent from the gel composition to obtain a silica-based aerogel composition.

33. The method of claim 32, wherein the precursor solution includes at least one silica gel precursor material having at least one hydrophobic group.

34. The method of any of claim 32 or claim 33, wherein the precursor solution includes greater than 30% of at least one silica gel precursor material having a single alkyl group attached to silicon.

35. The method of any of claim 32 or claim 33, wherein the precursor solution includes greater than 30% of at least one silica gel precursor material having a single methyl group attached to silicon.

36. The method of any of claim 32, claim 33, claim 34, or claim 35, wherein the gel composition is not surface-treated by a hydrophobizing agent.

37. The method of any of claim 32, claim 33, claim 34, claim 35, or claim 36, wherein the basic catalyst includes a catalytic amount of a strong base selected from the group consisting of sodium hydroxide, lithium hydroxide, calcium hydroxide, potassium hydroxide, strontium hydroxide, barium hydroxide, guanidine hydroxide, sodium hydroxide, tetrabutylammonium hydroxide, tetramethylammonium hydroxide, choline hydroxide, phosphonium hydroxide, DABCO, DBU, guanidine derivatives, amidines, and phosphazenes.

38. The method of any of claim 32, claim 33, claim 34, claim 35, claim 36 or claim 37, further comprising incorporating a reinforcement material into the silica-based aerogel composition.

39. The method of any of claim 32, claim 33, claim 34, claim 35, claim 36, claim 37, or claim 38, further comprising incorporating an additive into the silica-based aerogel composition.

40. The method of claim 39, wherein the additive is present in a range of about 0.1 wt% to about 10 wt% of the silica-based aerogel composition.

41. The method of claim 39, wherein the additive is present in a range of about 0.5 wt% to about 3 wt%.

42. The method of claim 39, claim 40, or claim 41, wherein the additive is selected from the group consisting of boron carbide, diatomite, manganese ferrite, manganese oxide, nickel oxide, tin oxide, silver oxide, bismuth oxide, titanium carbide, tungsten carbide, carbon black, titanium oxide, iron titanium oxide, zirconium silicate, zirconium oxide, iron oxide, iron (II) oxide, iron (III) oxide, manganese dioxide, iron titanium oxide (ilmenite), chromium oxide, silicon carbide, phyllosilicate clay, kaolin or kaolinite, metakaolin, halloysite, meta-halloysite, endellite, mica, diaspore, gibbsite, boehmite, montmorillonite, beidellite, pyrophyllite, nontronite, bravaisite, smectite, leverrierite, rectorite, celadonite, attapulgite, chloropal, volkonskoite, allophane, racewinite, dillnite, severite, miloschite, collyrite, cimolite and newtonite, sodium bicarbonate, magnesium hydroxide, magnesium dihydroxide, alumina trihydrate, gypsum, barringtonite, nesquehonite, lansfordite, hydromagnesite, dolomite, lithium carbonate or mixtures thereof.