CLAIMS

1. A fire protection and insulation composition comprising:
   encapsulated sodium and/or lithium silicate, and an additional or other filler or binder material including a thermally conductive filler, wherein the composition, when applied to a battery cell, acts as a thermally conductive coating at normal working temperatures of the battery cell, and wherein the sodium and/or lithium silicate undergoes hydrothermal crystallization into amorphous silica when exposed to higher temperatures such that the coating acts as a thermally insulative barrier for the battery cell.

2. A fire protection and insulation composition according to claim 1, wherein the filler material comprises one or more of a pore-forming agent, rheology modifier, thermal insulation filler, and the thermal conductive filler.

3. A fire protection and insulation composition according to claim 2, wherein the pore-forming agent is a starch.

4. A fire protection and insulation composition according to claim 2 or 3, wherein the the pore-forming agent is provided by the sodium and/or lithium silicate.

5. A fire protection and insulation composition according to any one of claims 2 to 4, wherein the rheology modifier is a starch, fumed silica and/or cellulose or cellulose derivatives.

6. A fire protection and insulation composition according to claim 3 or 5, wherein the starch is derived from corn, tapioca, wheat or rice.

7. A fire protection and insulation composition according to any one of claims 2 to 6, wherein the thermal insulation filler is fumed silica and/or aerogel.

8. A fire protection and insulation composition according to any one of claims 2 to 7, wherein the thermal conductive filler is selected from one or more of the following: boron nitride, aluminium nitride, aluminium oxide and magnesium oxide.

9. A fire protection and insulation composition according to any one of the preceding claims, further comprising a UV curing agent.

10. A fire protection and insulation composition according to any one of the preceding claims, further comprising cellulose.

11. A fire protection and insulation composition according to any one of the preceding claims, further comprising a surfactant.

12. A fire protection and insulation composition according to any one of the preceding claims, further comprising gypsum.

13. A fire protection and insulation composition according to any one of the preceding claims, wherein the sodium and/or lithium silicate is in the range of 35-60 Baume.

14. A fire protection and insulation composition according to claim 1, wherein the sodium and/or lithium silicate is in the form of a powder.

15. A fire protection and insulation composition according to claim 2, comprising:
    a) 90-95 wt% of sodium silicate;
    b) 1-5 wt% of corn starch;
    c) 1-5 wt% of cellulose; and
    d) 1-5% of a surfactant.

16. A fire protection and insulation composition according to claim 2, comprising:
    a) 30-50 wt% of sodium silicate;
    b) 5-20 wt% of lithium silicate;

c) 30-50 wt% of aluminium nitride;
d) 1-5 wt% of corn starch;
e) 1-5 wt% of fumed silica; and
f) 1-5 wt% of a surfactant.

17. A fire protection and insulation composition according to claim 2, comprising:
a) 50-65 wt% of sodium silicate;
b) 30-50 wt% of boron nitride;
c) 1-5 wt% of irgacure 819;
d) 1-5 wt% of cellulose; and
e) 1-5 wt% of a surfactant.

18. A fire protection and insulation composition according to claim 2, comprising:
a) 50-60 wt% of sodium silicate;
b) 30-59 wt% of boron nitride;
c) 1-5 wt% of fumed silica;
d) 1-5 wt% of cellulose; and
e) 1-5 wt% of surfactant.

19. A fire protection and insulation composition according to claim 2, comprising:
a) 40-60 wt% of sodium silicate ($SiO_2:Na_2O = 3.22$);
b) 30-50 wt% of boron nitride; and
c) 3-15 wt% gypsum.

20. A fire protection and insulation composition according to claim 1, wherein the sodium and/or lithium silicate is in the form of a sodium and/or lithium metasilicate hydrate.

21. A fire protection and insulation composition according to claim 20, wherein the sodium and/or lithium metasilicate hydrate is in the form of sodium metasilicate pentahydrate, sodium metasilicate nonahydrate, lithium metasilicate, or lithium disilicate.

22. A fire protection and insulation composition according to claim 20 or 21, wherein the binder material is silicone rubber RTV.

23. A fire protection and insulation composition according to claim 20 or 21, wherein the binder material is silane-grafted polyurethane.

24. A fire protection and insulation composition according to claim 20 or 21, wherein the binder material is water-based acrylic.

25. A fire protection and insulation composition according to claim 20 or 21, wherein the binder material is siloxane.

26. A fire protection and insulation composition according to any one of claims 20 to 25, wherein the thermal conductive filler is selected from one or more of the following: boron nitride, aluminium nitride, aluminium oxide and magnesium oxide.

27. A fire protection and insulation composition according to claim 22, comprising:

a) 30-70 wt% of silicone rubber RTV;
b) 20-70wt% of boron nitride; and
c) 10-30 wt% of acid treated encapsulated sodium metasilicate pentahydrate.

28. A fire protection and insulation composition according to claim 22, comprising:

a) 30-70 wt% of silicone rubber RTV;
b) 30-70 wt% boron nitride;
c) 10-30 wt% acid treated encapsulated lithium metasilicate; and
d) 10-30 wt% encapsulated sodium metasilicate nonahydrate;

wherein the sum of the components of the composition are combined to reach 100 wt%.

29. A fire protection and insulation composition according to claim 22, comprising:

a) 30-70 wt% of silicone rubber RTV;

b) 30-70 wt% aluminium nitride; and

c) 10-30 wt% encapsulated sodium metasilicate pentahydrate;

wherein the sum of the components of the composition are combined to reach 100 wt%.

30. A fire protection and insulation composition according to claim 23, comprising:

a) 30-70wt% silane-grafted polyurethane;

b) 20-70wt% boron nitride;

c) 1-5wt% siloxane;

d) 1-3wt% surfactant; and

e) 10-30wt% encapsulated sodium metasilicate pentahydrate;

wherein the sum of the components of the composition are combined to reach 100 wt%.

31. A fire protection and insulation composition according to claim 24, comprising:

a) 30-70wt% water-based acrylic;

b) 20-70wt% boron nitride;

c) 1-3wt% surfactant; and

d) 10-30wt% encapsulated sodium metasilicate pentahydrate;

wherein the sum of the components of the composition are combined to reach 100 wt%.

32. A fire protection and insulation composition according to claim 22, comprising:

a) 30-70wt% silicone rubber RTV;

b) 10-50wt% boron nitride;

c) 20-50wt% siloxane;

d) 1-3wt% surfactant; and

e) 10-30wt% encapsulated sodium metasilicate pentahydrate;

wherein the sum of the components of the composition are combined to reach 100 wt%.

33. A fire protection and insulation composition according to any one of the preceding claims, further comprising 5 to 30 wt% of reinforcement material.

34. A fire protection and insulation composition according to claim 33, wherein the reinforcement material is selected from one or more of the following: glass/ceramic wool, chopped-strands, fibers or whiskers.

35. A composite sheet comprising an inorganic reinforcement layer, to which is applied a layer of the fire protection and insulation composition according to any one of the preceding claims.

36. A composite sheet according to claim 35, wherein the inorganic layer is in the form of a glass/ceramic mat or a fabric.

37. A method of providing fire protection and insulation for a battery cell, comprising coating or covering at least a cathode and/or a vent of the battery cell with a fire protection and insulation coating as claimed in any one of the preceding claims.