CLAIMS

1. A negative electrode material, characterized in that the negative electrode material has a core-shell structure, wherein the core comprises a silicon-containing material, the shell comprises an organic lithium salt and a porous carbon film, and at least part of lithium ion is intercalated in the porous carbon film.

2. The negative electrode material of claim 1, wherein the negative electrode material further comprises a phosphorus-containing coating layer, which is between the core and the shell;

preferably, the phosphorus-containing coating layer comprises a polymer having polycyclic aromatic hydrocarbon structural segments;

preferably, the phosphorus-containing coating layer is made from phytic acid.

3. The negative electrode material of claim 1, wherein, based on the total amount of the negative electrode material, the organic lithium salt is present in an amount of 5-34 wt%, the silicon-containing material is present in an amount of 65-90 wt%, and the porous carbon film is present in an amount of 1-10 wt%;

preferably, based on the total amount of the negative electrode material, the organic lithium salt is present in an amount of 10-30 wt%, the silicon-containing material is present in an amount of 68-86 wt%, and the porous carbon film is present in an amount of 1-6 wt%;

preferably, the negative electrode material further comprises graphite;

preferably, the graphite is present in the core and/or the shell;

preferably, the mass ratio of the total amount of the silicon-containing material, the organic lithium salt and the porous carbon film to the amount of graphite is 1:1-10, further preferably 1:1-5.

4. The negative electrode material of claim 1, wherein the negative electrode material has a median particle size of 0.1-20 μm.

5. The negative electrode material of any one of claims 1-4, wherein

the organic lithium salt is at least one selected from the group consisting of lithium polyacrylate, lithium polymethacrylate, lithium polymaleate, lithium polyfumarate, lithium carboxymethylcellulose and lithium alginate;

preferably, the silicon-containing material is at least one selected from the group consisting of elemental silicon, SiO_x wherein $0.6 < x < 1.5$, and silicon-containing alloy; preferably, the silicon-containing alloy is at least one selected from the group consisting of silicon-aluminum alloy, silicon-magnesium alloy, silicon-zirconium alloy and silicon-boron alloy.

6. A method for preparing the negative electrode material of any one of claims 1-5, comprising:

(1) mixing a silicon source and a carbon source, and then calcining the mixture;

(2) mixing the calcined product obtained in the step (1) with an organic lithium salt; and

(3) subjecting the materials obtained in the step (2) of mixing to vacuum freeze-drying.

7. The method of claim 6, wherein the silicon source is at least one selected from the group consisting of elemental silicon, SiO_x wherein $0.6 < x < 1.5$, and silicon-containing alloy; preferably, the silicon-containing alloy is at least one selected from the group consisting of silicon-aluminum alloy, silicon-magnesium alloy, silicon-zirconium alloy and silicon-boron alloy;

preferably, the carbon source is pitch, preferably at least one selected from the group consisting of petroleum pitch, coal tar pitch, natural pitch and modified pitch;

preferably, the mass ratio of the silicon source to the carbon source is 1: (0.04-0.12).

8. The method of claim 6, wherein the step (1) of mixing comprises:

adding the silicon source and the carbon source into an organic solvent, and then stirring ultrasonically, preferably for 10-100min;

preferably, the organic solvent is at least one selected from the group

consisting of N,N-dimethylformamide, N,N-dimethylacetamide and N-methylpyrrolidone;

preferably, the calcining is operated under an inert atmosphere at a temperature of 600-1000 ℃, preferably 700-900 ℃, for 10-240min, preferably 20-60min.

9. The method of any one of claims 6-8, wherein the organic lithium salt is at least one selected from the group consisting of lithium polyacrylate, lithium polymethacrylate, lithium polymaleate, lithium polyfumarate, lithium carboxymethylcellulose and lithium alginate;

preferably, the organic lithium salt is used in an amount of 0.05-0.5 parts by weight, preferably 0.1-0.4 parts by weight in relative to 1 part by weight of the silicon source;

preferably, the step (2) of mixing includes: adding the calcined product obtained in the step (1) and the organic lithium salt into the solvent and stirring for 4-48 h.

10. The method of any one of claims 6-9, wherein the vacuum freeze-drying of the step (3) is operated at a temperature of not higher than -65 ℃ and a vacuum degree of not higher than 120 Pa for a time of 4-48 h.

11. The method of any one of claims 6-10, wherein the method further comprises: adding graphite in the step (1) and/or the step (2);

wherein the method further comprises the step (4) of: mixing the product obtained in the vacuum freeze-drying in the step (3) with graphite;

preferably, graphite is used in an amount of 1-15 parts by weight, preferably 1-5 parts by weight in relative to 1 part by weigh of the product obtained in the vacuum freeze-drying in the step (3).

12. The method of any one of claims 6-10, wherein the method further comprises: forming a phosphorus-containing coating layer before the step (1) by a method comprising the steps of:

(a) contacting the silicon-containing material, a phosphorus source and a solvent at 30-80 ℃ to graft the phosphorus source to the surface of the silicon-containing material; and

(b) subjecting to a temperature programmed calcining to convert the phosphorus source around the silicon-containing material into the phosphorus-containing coating layer comprising the polymer having polycyclic aromatic hydrocarbon structural segments, wherein the temperature programmed calcining comprises:

heating to a first temperature of 400-500 ℃ at a first heating rate,

heating to a second temperature of 600-800 ℃ at a second heating rate, wherein the second heating rate is lower than the first heating rate, and

keeping at the second temperature;

preferably, the phosphorus source is selected from the group consisting of organic polybasic phosphoric acid and its esters or salts, preferably phytic acid;

preferably, the solvent is at least one selected from the group consisting of toluene, N,N-dimethylformamide, N,N-dimethylacetamide and N-methylpyrrolidone;

preferably, the temperature programmed calcining includes: heating to a first temperature of 450-500 ℃, such as 480 ℃, at a first heating rate of 1-10 ℃/min, preferably 5-10 ℃/min; then heating to a second temperature of 600-650 ℃, such as 620 ℃, at a second heating rate of 1-5 ℃/min, preferably 1-3 ℃/min; and keeping at the second temperature for 1-8h, preferably 2-4h.

13. Use of the negative electrode material of any one of claims 1-5 in a lithium ion battery.

14. A lithium ion battery comprising the negative electrode material of any one of claims 1-5, a lithium-containing positive electrode material, a separator and an electrolyte;

preferably, the lithium ion battery is a liquid lithium ion battery, a semi-solid lithium ion battery or a solid lithium ion battery.