Claims

1. Silicon carbon composite particles, characterized in that the particles comprising the components
85 to 99.63 wt.-% silicon content,
0.3 to 15 wt.-% carbon content, and
at least 0.04 wt.-% hydrogen content and optionally 0 to 1 wt.-% oxygen content,
wherein the components sum up to 100 wt.-%, and wherein the carbon content in the area beneath the surface of the particles starting with the surface and reaching up to 30 nm from the surface in direction to the centre of the particles is at least
3 wt.-% higher than in the area of the centre of the particles, wherein the area of the centre is the remaining part of the particles and is directly joined to the area beneath the surface, characterized in that
the silicon carbon composite particles possess an amorphous content of more than 98 %.

2. Silicon carbon composite particles according to claim 1, characterized in that the particles are free from a chlorine content, in particular the chlorine content is below 0.7 ppm-wt.

3. Silicon carbon composite particles according to claim 1 or 2, characterized in that the average particles size of the primary particles is less than 300 nm, in particularly less than 250 nm.

4. Particles according to any of claims 1 to 3, characterized in that the particles have a content of amorphous silicon comprising hydrogen, SiH-species and/or
(poly-[SiH_2]-).

5. Particles according to any of claims 1 to 4, characterized in that the silicon content of the particles is at least 0.5 wt.-% to 30 wt.-%, particularly from 0.5 wt.-% to 20 wt.-%, higher in the area of the centre of the particles than in the area beneath the surface of the particles, and wherein the area of the centre is joined to the area beneath the surface, wherein the area beneath the surface of the particles starts with the surface and reaches up to 30 nm from the surface in direction to the centre of the particles.

6. Particles according to claim 5, characterized in that the silicon content of the particles is at least 2.0 to 15 wt.-% higher in the area of the centre of the particles than in the area beneath the surface of the particles, and, wherein the area of the centre is joined to the area beneath the surface, wherein the area beneath the surface of the particles starts with the surface and reaches up to 30 nm from the surface in direction to the centre of the particles.

7. Particles according to any of claims 1 to 6, characterized in that the carbon content of the particles is at least 3 wt.-% to 30 wt.-%, higher in the area beneath the surface of the particles than in the area of the centre of the particles, and wherein the area of the centre is joined to the area beneath the surface, wherein the area beneath the surface of the particles starts with the surface and reaches up to 30 nm from the surface in direction to the centre of the particles.

8. Particles according to any of claims 1 to 7, characterized in that the carbon content of the particles is from 2 wt.-% to 15 wt.-%.

9. Particles according to any of claims 1 to 8, characterized in that the particles have a content of aliphatic carbon-hydrogen compounds.

10. Particles according to any of claims 1 to 9, characterized in that the particles possess differential capacity (dQ/dV) versus voltage curves with a peak corresponding to the crystalline $Li_{15}Si_4$ (c-$Li_{15}Si_4$) formation, whereby the ratio of the area of this peak to the area of the differential capacity (dQ/dV) in the range between 0.38 and 0.8 V is in the range of 0 to 0.1 during at least the first cycle, and in particular until at least the twentieth cycle, more preferred during at least 100 cycles.

11. Process for the production of silicon carbon composite particles, in particular to any of claims 1 to 10, comprising the steps of

(i) reacting

a) a gaseous stream comprising precursor silane of at least one precursor silane comprising monosilane, disilane, trisilane, tetrasilane, pentasilane, hexasilane, heptasilane, octasilane, iso-tetrasilane, iso-pentasilane, neo-pentasilane, cyclopentasilane, cyclohexasilane and/or a fully hydrogenated organosilane comprising 1 to 8 silicon atoms and 1 to 10 carbon atoms or a mixture of at least two of the aforementioned silanes, and

b) a gaseous stream comprising precursor hydrocarbon selected from olefinic hydrocarbons, alkines and a mixture of at least two of the aforementioned hydrocarbons,

(ii) within a tubular reactor at a reaction temperature of 400 to 700 °C, preferred at 490 °C to 645 °C,

(iii) wherein the reaction takes place within a heated tubular inert gas stream during a time frame of 500 milliseconds to 20 seconds, and optionally

(iv) the reaction mixture is quenched with an inert gas possessing a lower temperature than the reaction mixture, and optionally collecting the silicon carbon composite particles.

12. Process according to claim 11, wherein in (b) the precursor hydrocarbon is an olefinic hydrocarbon of at least one precursor olefinic hydrocarbon selected form alkenes and cycloalkenes comprising 1 to 10 carbon atoms or a mixture of at least two of the aforementioned olefinic hydrocarbons.

13. Process according to claim 11 or 12, wherein in (iii) the reaction takes place within a reaction zone that is located within the heated tubular inert gas stream during a time frame of 500 milliseconds to 20 seconds, and optionally wherein the heated tubular inert gas stream possesses an outer circumference and an inner circumference, wherein the inner circumference is joined with the reaction zone which is within the heated tubular inert gas stream, wherein the radial distance from the inner circumference to the outer circumference of the tubular inert gas stream has a ratio of 2 : 1 to 1 : 10 in relation to the radius of the reaction zone within the tubular inert gas stream.

14. Process according to one of claims 11 to 13, wherein in (iii) the reaction takes place within a reaction zone that is located within the heated tubular inert gas stream during a time frame of 500 milliseconds to 20 seconds, and wherein the heated tubular inert gas stream possesses a temperature of about 400 to 520 °C when the precursor silane, the precursor olefinic hydrocarbon or a mixture thereof is injected into the reaction zone of the tubular reactor.

15. Process according to one of claims 11 to 14, wherein the inert gas is selected from Argon, Helium, Neon and Nitrogen, in particular the inert gas stream is selected from Argon and/or the inert gas for quenching is selected from Nitrogen and Argon.

16. Process according to one of claims 11 to 15, wherein the heated tubular inert gas stream has a volume flow of 1 to 10 Nm^3/h.

17. Anode, in particular anode for use in a cell in a secondary lithium ion battery (LIB) comprising silicon carbon composite particles according to any of previous claims 1 to 11 or obtainable according to any of claims 12 to 16 and optionally comprising a binder.

18. Battery, in particular secondary battery, more preferably for use in a lithium ion battery (LIB) comprising at least one anode according to claim 17.