Sector / areas of application:
• e-mobility
• shipbuilding
• stationary, temporary storage (solar and wind power installations)

Key terms:
• silicon anode
• sulphur cathode
• inline processing
• porous materials
• light-weight electrodes

Status of patent process:
• patent issued (DE, EU, USA)

Project:
• Title: Development and characterisation of large, porous Si film anodes for lithium-sulphur-silicon energy storage (PorSSi)
• Head: Kiel University (battery development)
• Project partner: RENA Technologies GmbH
• BMBF funding line: “Battery materials for future electric mobile and stationary applications (Batteries 2020)”
• Funding amount: € 1 million
• Duration of funding: 01.09.2017 – 31.08.2020

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Silicon
Storage material for the batteries of the future
Background information

Longer life times, larger ranges and faster recharging – developments such as electric mobility or the miniaturisation of electronics require new storage materials for batteries. With its enormous storage capacity, silicon would potentially have decisive advantages over the materials used in conventional lithium-ion batteries.

But due to its mechanical instability, so far, it was nearly impossible to use silicon for storage applications. During charging, lithium ions move back and forth between the battery’s anode and cathode. As silicon can take up a particularly large number of lithium ions, its volume when charging expands by 400%. Consequently, it would break in the long run.

Project objective: anodes made from 100% silicon

At the Institute for Materials Science at Kiel University, research on silicon has been ongoing for more than 20 years. In the project "Development and characterisation of large, porous Si film anodes for lithium-sulphur-silicon energy storage" (PorSSI), a research team is working together with the company RENA Technologies GmbH on developing high-performance silicon anodes, sulphur cathodes and a strategy for manufacturing them on an industrial scale.

Method

The storage potential of silicon can be fully exploited through structuring the surface at the micro level. Another material with very high storage potential forms the counterpart with a sulphur cathode. Traditional NMC cathodes are compatible with the developed silicon anodes, too.

Thanks to the cooperation with industry, the research results flow directly into the development of new etching systems.

Silicon behaves much more flexibly when it is produced in the form of a thin wire. As a result, it is better at withstanding the high volume expansion when charging. The free volume of porous silicon should further reinforce this effect. Up to 500 cycles have been successfully tested so far.

Benefits

of silicon anodes compared to conventional graphite anodes in lithium-ion batteries:

- 2 to 3 times higher energy density
- shorter charging time (up to around 90%)
- 5 to 10% lower weight
- flame retardant

Opportunities for cooperation with companies and science

Order development

- carry out time resolved measurements
- characterization of microstructure of electrodes
- Production of tailor-made batteries for different applications

R&D cooperation

- joint development of batteries for individual requirements
- upscaling/prototype manufacturing of silicon anodes and sulphur cathodes

We offer

- many years of experience and current research findings in material production, characterisation and structuring
- current research on lithium-ion alternatives

We are looking for

- more project partners, for example from the field of power electronics, with, among other things, expertise and infrastructure on electrolyte systems for sulphur-air, lithium-sulphur, lithium-air and lithium-ion technology and for the development of full cell concepts