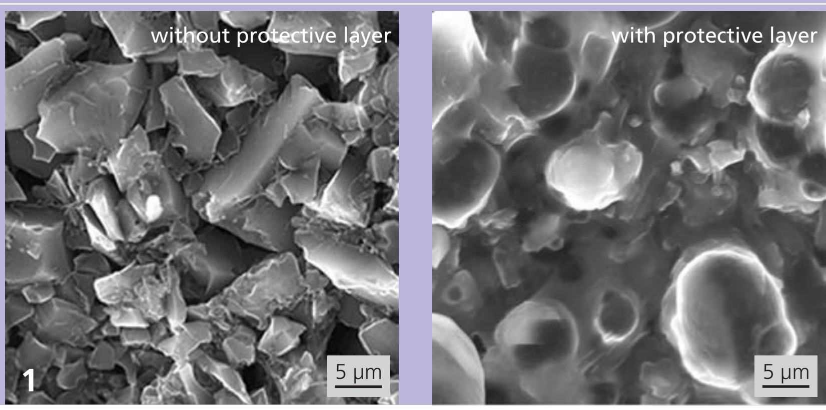


NATRIUM-SULFUR BATTERIES FOR STATIONARY ENERGY CELLS

THE TASK

Renewable energy types, such as wind and photovoltaic energies, are subject to natural variations in quantity. To compensate for these variations, high-temperature sodium-sulfur batteries are employed, for example, as stationary energy cells. Because of the kinetic mechanism of the reaction, only less than 25 percent of the theoretical capacity can be utilized. Furthermore, the high-temperature system has tremendous safety risks due to the use of liquid sodium.

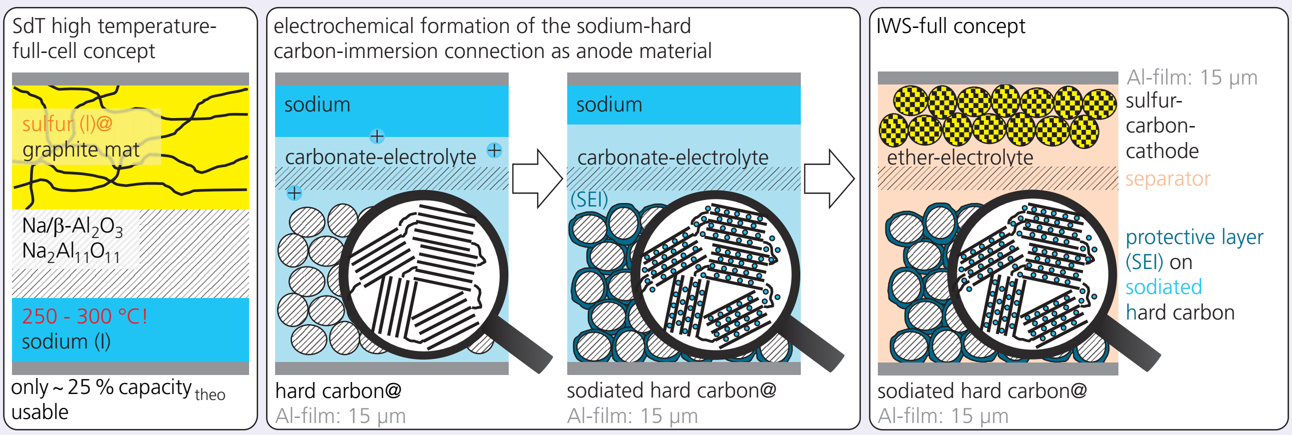
Dresden research institutes are collaborating in the funded project on novel battery components and manufacturing techniques for a room temperature Na-S battery demonstrator. In this project, Fraunhofer IWS Dresden implements the whole process chain to produce Na-S battery cells. The development tasks include material preparation, electrode production, and formation of cell stacks.

OUR SOLUTION

In the joint NaSBattSy project, registered under No. 1002 34957 by the SAB (Saxon Development Bank), the IWS sought to develop a stationary electrochemical energy cell based on sodium-sulfur cell technology. This mode of energy storage can be produced at reasonable costs and works at room temperature. The low price results from the low-cost materials that are available in almost unlimited quantities, without any toxic waste.

The latter demands an innovative, electrochemical step ahead, in which the anode material – a sodium-carbon compound Na_xC – is generated. Customized electrolyte formulation must efficiently eliminate undesirable side effects (polysulfide shuttle) and form protective layers on the anode side (Fig. 1).

Full-cell concept of the Na-S cell, developed at IWS and patented, in comparison with standard concept



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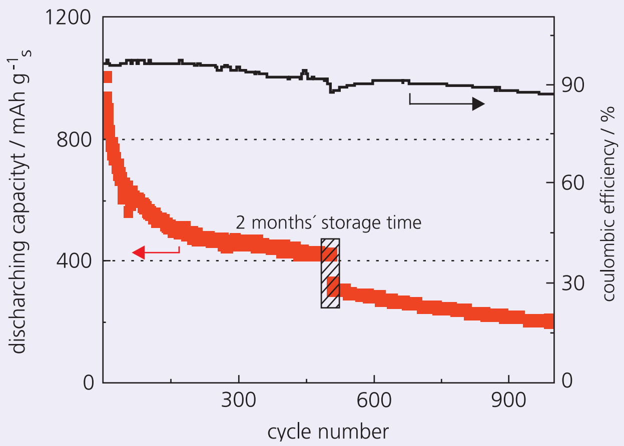
For the anode, non-graphitizable carbons are used; these carbons are presodiated with an adapted electrolyte formulation and simultaneously coated with a sulfidic protective layer (Fig. 2). For the cathode, a paste-based coating technology that has already been established for lithium-ion batteries is used, on the one hand. Alternatively, a solvent-free process is applied, in which a freestanding electrode film is produced from the carbon-sulfur composite and a binder, on the other hand. Both technologies are already common in the fabrication of lithium-ion batteries (Fig. 3) and thus do not demand new equipment.

RESULTS

In the collaboration, the project partners created the electrochemical and technological basics for a new electric storage system for stationary applications. For the first time, a Na-S cell could demonstrate electrochemical stability for more than 1000 cycles at room temperature (Fig. 4). This result is an important milestone towards low-cost energy cells based on available raw materials.

Sulfur discharge capacity versus number of cycles of the developed full-cell concept



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Fraunhofer IWS mainly researches anode formation as an unknown process step. The electrolyte has emerged as a relevant key component in the Na-S cell. Solubility against polysulfides is defined by the composition of the solvents and the salt concentrations and significantly affects specific capacity (sulfur utilization) on the cathode side, as well as degradation and self-discharging on the anode side (due to the polysulfide shuttle effect).

In contrast to lithium, there are no commercially available sodium foils, which are essential for a temporally efficient formation of the sodium-hard carbon intercalation compound. Fraunhofer IWS developed a scalable concept for casting sodium foils. In the future, cyclic life can be further prolonged by adapting the electrolyte formulation.

1 SEM images of the hard carbon anode material, with/without protective layer

3 Roll-to-roll coating system

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