RESEARCH NEWS

The Thuringian Forest battery

Sustainable Batteries Made From Wood Industry By-Products

In light of the growing demand for energy storage for the energy transition, there is an urgent need for cost-effective, safe and resource-efficient battery technologies. Sodium-ion batteries based on locally available and environmentally friendly materials offer a promising approach. Fraunhofer researchers and their project partners are working on a sodium-ion battery system based on lignin, a by-product of the wood and pulp industry.

Lignin, a biopolymer, is a key component of wood, giving it its stability. As a by-product of the paper industry, it is usually burned to generate energy. Researchers from the Fraunhofer Institute for Ceramic Technologies and Systems IKTS and the Friedrich-Schiller-University Jena — both partners of the Center for Energy and Environmental Chemistry Jena (CEEC) — have come up with a better idea.: In the ThüNaBsE (Thuringia Sodium-Ion Battery for Scalable Energy Storage) project, funded by the Free State of Thuringia and the European Social Fund, the researchers are developing and evaluating a new type of sodium-ion battery based on lignin — from raw materials to a 1-Ah full cell. The project aims to support increasing independence from critical raw materials while fostering the transition to cheaper, more sustainable and safe batteries. It is being supported by an industrial advisory board consisting primarily of regional companies, including the Thuringia-based companies Mercer Rosenthal GmbH, Glatt Ingenieurtechnik GmbH, IBU-tec advanced materials AG and EAS Batteries GmbH, as well as Petrochemical Holding GmbH based in Vienna. Another goal of the project is to support junior researchers in Thuringia. This is why several up-and-coming research scientists, who are currently completing their doctorates in the fields of energy and battery research, are involved in the ThüNaBsE project.

Lignin: Turning a by-product into a recyclable

Lignin consists mainly of hydrocarbon building blocks, which can be used for a variety of chemical applications, including electrode material for batteries. In the project, the bio-based raw material is set to be used for the negative electrode. “We want to avoid critical metals such as lithium, cobalt and nickel in the battery value chain. We also aim to minimize the fluorine content in the electrodes and electrolytes, and we are testing to which degree we can eliminate it. However, the project mainly focuses on processing locally available, high-quality lignin into high-performance electrodes for our

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sodium-ion batteries," says Lukas Medenbach, research scientist at Fraunhofer IKTS in Arnstadt, the gateway to the Thuringian Forest.

The lignin used in the project is provided by Mercer Rosenthal GmbH. Under inert conditions, it is thermally converted into carbon, which is then further processed into electrodes. "Our project partners from the Institute for technical chemistry and environmental chemistry at the Friedrich-Schiller-University, led by Prof. Martin Oschatz, use thermal processes to turn the lignin into what we call hard carbon. The structure of this hard carbon is very suitable for the reversible storage of sodium ions. Hard carbon boasts high electrochemical performance, good cycle stability and low acquisition costs, especially if obtained from sustainable raw materials," explains Medenbach's colleague, Cornelius Dirksen. Prussian Blue analogs, non-toxic iron compounds, are to be used as the material for the positive electrode. First used as a pigment around 200 years ago, this substance is characterized by good raw material availability, environmental compatibility and sodium-ion storage properties.

The first small demonstrator cells are currently being built and tested at the Fraunhofer IKTS battery test center in Arnstadt, at Fraunhofer IKTS in Hermsdorf and at the Friedrich Schiller University in Jena. Realistic, multi-physical simulations complement the lab work. The results are promising: "After 100 charging and discharging cycles, the lab cell shows no significant degradation. The aim is to demonstrate 200 charging and discharging cycles for the 1-Ah full cell by the end of the project," says Medenbach.

Once fully developed, the battery could be used for stationary or mobile storage applications where fast charging is not required. The lignin-based sodium-ion batteries are suitable for mobile applications with lower power requirements, including, for example, microcars (speed limit of 45 km/h) or warehouse logistics vehicles such as forklifts. Once the project has been completed, the project partners intend to further scale the technology and take the path to the next technology maturity levels with the help of an even larger consortium.

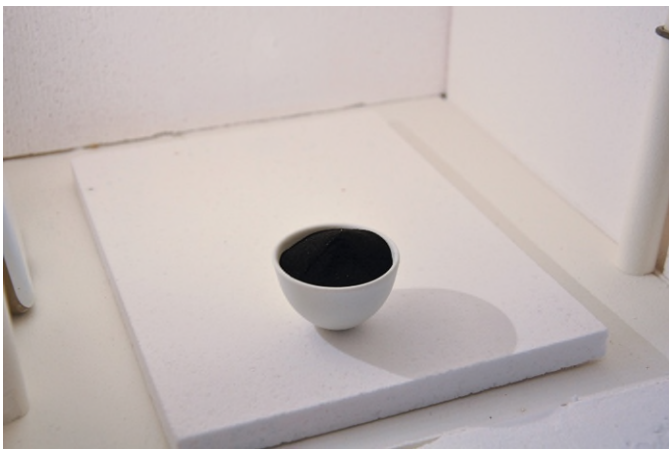

Fig. 1 Hard carbon, obtained from lignin, a by-product from the wood industry, forms the basis for the electrode of the Thuringian Forest battery.

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Fig. 2 Contacting a pouch cell with electrode materials from the ThüNaBsE project.

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