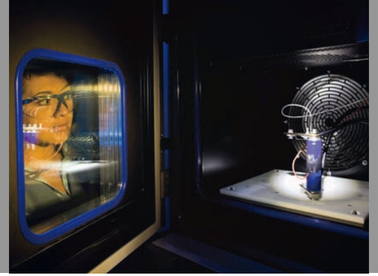
ENERGY STORAGE SYSTEMS BY FRAUNHOFER IKTS

Fraunhofer IKTS

FRAUNHOFER INSTITUTE FOR
CERAMIC TECHNOLOGIES AND SYSTEMS IKTS



SERVICE PORTFOLIO

MATERIALS AND TECHNOLOGIES

Materials
- Synthesis of anode and cathode materials
- Synthesis of solid-state ion conductors (Na-β"-aluminate, Na^+- and Li^+-ion conducting glass ceramics)
- Optimization of the specific surface for increasing the power density
- C-coating of the active materials for increasing conductivity
- Modification of the slurry formula for lithium-ion batteries
- Powder and granule production on the pilot-plant scale

Technologies
- Technology and process development for the manufacture of lithium-ion, sodium-based and metal-air batteries, as well as super capacitors
- Evaluation of active materials in the treatment and manufacturing process, as well as their performance
- Production on the laboratory scale including upscaling to pilot-plant production of lithium-ion cells

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SERVICE PORTFOLIO

CHARACTERIZATION AND SYSTEMS

Characterization
- Characterization of active materials in lithium-ion test cells
- Characterization of materials for $NaNiCl_2$ or NaS cells
- Microscopic, electrochemical and mechanical characterization of thin electrode tapes
- Manufacture of button and pouch cells for materials and technology characterization
- Characterization of performance and aging under climate-controlled conditions
- Characterization of the charging and discharging as well as degradation behavior
- Post-mortem analysis
- Manufacture of high-temperature test cells for planar and tubular electrolyte geometries

System
- Thermal 3D modeling of energy storage systems
- Market analyses and competent consulting for individual questions

FRAUNHOFER IKTS

The Fraunhofer Institute for Ceramic Technologies and Systems IKTS conducts applied research on high-performance ceramics. The institute's three sites in Dresden and Hermsdorf (Thuringia) collectively represent Europe's largest R&D institute dedicated to the study of ceramics.

As a research and technology service provider, the Fraunhofer IKTS develops modern ceramic high-performance materials, customized industrial manufacturing processes and creates prototype components and systems in complete production lines from laboratory scale to pilot plant scale. Furthermore, the institute has expertise in diagnostics and testing of materials and processes.

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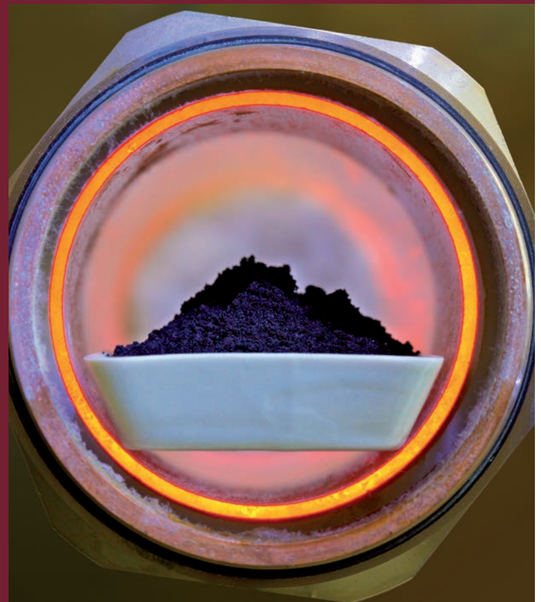
CERAMIC MATERIALS AND TECHNOLOGIES FOR ENERGY STORAGE SYSTEMS



CERAMIC ENERGY STORAGE SYSTEMS

Electrical energy storage systems are an important building block when sustainably shaping the future of the world's energy supply. Most attention in this field is being given to lithium-ion batteries, super capacitors, sodium-based batteries, metal-air batteries and lithium-sulfur batteries.

Fraunhofer IKTS uses its know-how in materials science and technical manufacturing solutions to develop materials, manufacturing methods and innovative battery designs – always with an eye on applicability. In doing so, the complete value-added chain can be covered, from the laboratory scale through to full-scale industrial production. For this purpose, Fraunhofer IKTS has highly modern plants and analytical equipment at its disposal, which are used for examining new cost-efficient processes and acquiring a deeper understanding of the operation and aging of battery storage solutions.

LITHIUM-ION BATTERIES

Lithium-ion batteries are generally considered the key technology in the field of electric mobility. In order to reach optimal performance as well as longer lifetimes and reasonable target costs, both the active materials and the manufacturing process itself need to be optimized. In this regard, Fraunhofer IKTS uses its expertise in ceramic materials and technologies along the complete value-added chain, from powder synthesis to electrode manufacturing. Thus, the institute carries out research on the synthesis and processing of active materials and separator components, as well as their further processing to obtain battery electrodes.

Furthermore, numerous methods are available for characterizing the electrode structure and its electrochemical as well as aging behavior (post-mortem analysis). Our researchers have thus managed to assemble a comprehensive understanding of how the reliability of the battery is related to its manufacturing conditions. Cell assembly, packaging and cell testing are analyzed and performed in cooperation with partners from industry and research.

SODIUM-BASED BATTERIES

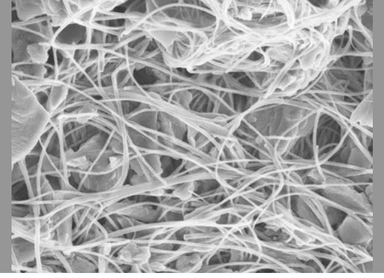
From both an economic and ecological perspective, sodium-sulfur batteries and sodium-nickel-chloride batteries are ideally suited for stationary energy storage. Sodium-nickel-chloride batteries are particularly attractive because of their high energy density and their scalability to large, secure systems. The core component of these batteries is a ceramic electrolyte made of β-aluminate.

At Fraunhofer IKTS, this component is further developed, focusing on materials selection, manufacturing methods and quality assurance. Based on the institute's materials expertise, new electrolyte materials with high β″-phase contents and densities, as well as innovative synthesis routes are investigated. In order to reduce production costs, scientists examine efficient manufacturing methods, including the automated in-line testing and affordable raw materials required for this. In addition, Fraunhofer IKTS works on optimizing the cell design to improve battery performance in the future.

METAL-AIR BATTERIES

Many energy conversion processes are based on electrochemical reactions, which involve a charge transfer process. It is therefore desired for efficient energy conversion systems to have this charge transfer take place at a high rate, i.e. as fast as possible. This can be achieved through electrocatalysts, which contribute significantly to an optimized energy balance of battery systems. For this purpose, Fraunhofer IKTS develops and tests cost-effective and highly efficient electrocatalysts based on mixed metal oxides. These electrocatalysts may, for instance, be used for the oxygen reduction reaction (ORR) in metal-air batteries or for the oxygen evolution reaction (OER) in electrolyzer systems.

Technologies for the manufacture and coating of catalytically active cathodes and anodes are also available at Fraunhofer IKTS. They undergo further development continuously.



SUPER CAPACITORS

So-called super capacitors comprise the group of dual-layer capacitors, pseudo-capacitors and hybrid capacitors. They are characterized by a high power density, short charging and discharging times, and a long lifetime. In particular when combined with lithium-ion batteries, there are numerous interesting applications for mobile and stationary energy storage systems.

Fraunhofer IKTS develops manufacturing methods for these energy storage systems by transforming active powders into thin electrode tapes. Ceramic technologies are used for the dispersion of powders, the manufacture of casting slurries and the deposition of the electrodes in the continuous tape casting process. In the development, the application of environmentally friendly materials that pose no health risks, is important to the institute. Synergies from film battery manufacturing processes are used within the scope of integrated technology development.

PILOT PLANT FOR BATTERY PRODUCTION

The pilot plant for battery production is jointly operated by thyssenkrupp System Engineering and Fraunhofer IKTS. On 350 m² drying room area, Fraunhofer IKTS and its partners develop processes and technologies for the manufacture of lithium-ion batteries, from the discontinuous laboratory scale to the continuous pilot-plant scale.

In addition to the scaling and optimization of coating and other manufacturing technologies, aspects such as film handling within the process, the design of the manufacturing environment and the implementation of efficient process monitoring are also crucial for the efficient, reproducible, environmentally friendly and resource-saving production of batteries. The development of technologies and systems solutions on the pilot-plant scale constitutes an important link between basic research in the lab and the development of industrial processes. Thanks to the complementary competencies of the partners as well as an extensive network of clients and development partners, a comprehensive knowledge base has already been generated.