Fraunhofer
BATTERIEN

FRAUNHOFER BATTERY ALLIANCE

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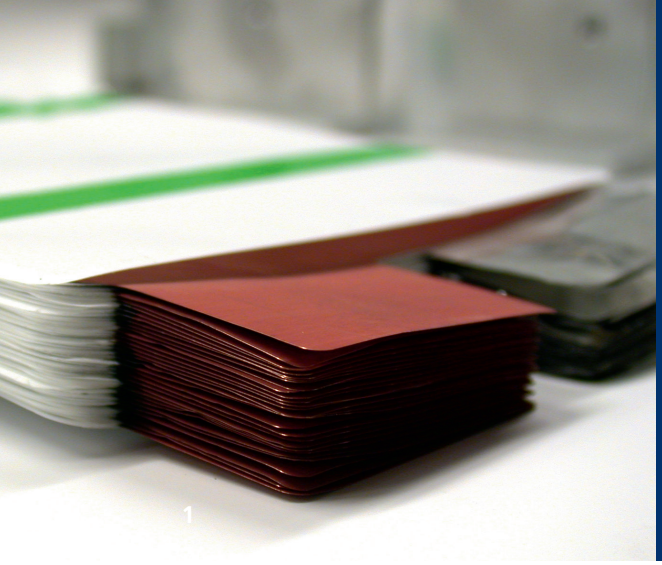


High-performance batteries are key components in mobile and stationary electrically-powered applications, and are also the most complex elements in these systems. Particularly in high energy and output ranges, the durability and reliability of a system must be high, placing significant technical demands on the batteries. Electrical energy storage devices in vehicles must meet a particularly wide range of (sometimes contradictory) requirements, regarding for example their cost, energy and power density, cycle stability, temperature range and safety.

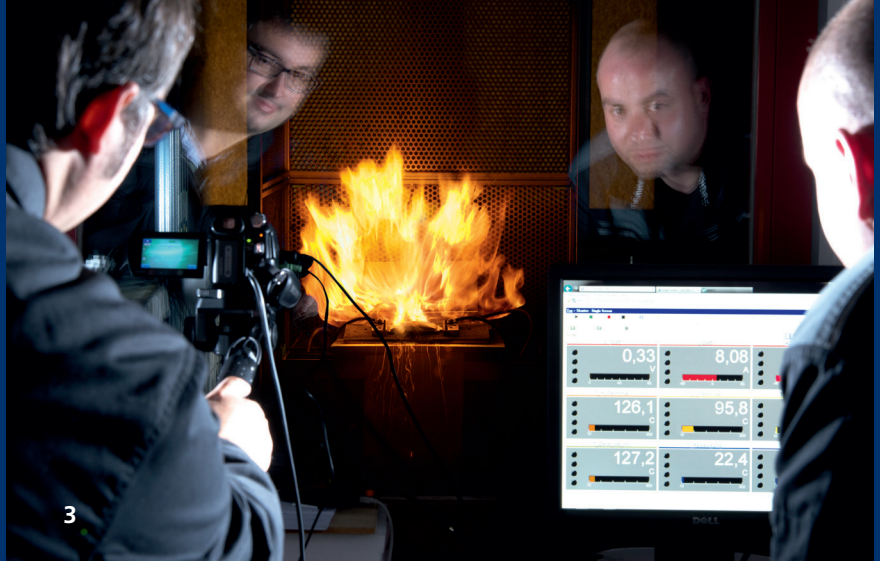
Through research in the field of electrochemical energy storage, the Fraunhofer Battery Alliance develops suitable technologies and conceptual solutions to application level, paying particular attention to their social, economic and ecological impacts. Here optimization is needed across a series of disciplines. The 19 members of the Fraunhofer Battery Alliance have competences in virtually all of these areas.

From the material to the cell

In the area of materials and cells, the members of the Battery Alliance develop, optimize and characterize customer-specific materials and manufacturing processes for batteries. Emphasis is placed on lithium-ion systems and double-layer capacitors. Redox-flow and high-temperature storage (NaS, Na nickel chloride) are also developed. Research and development work aims to increase tolerance to external influences and improve the storage properties and intrinsic safety.

Systems

Within the Fraunhofer Battery Alliance, individual cells based on different technologies are developed for use in tailored battery modules and complete battery systems in a range of applications. Work covers the simulation-based design of the mechanical construction and the cooling system, joining technologies, safety concepts, the development of battery management systems and the accompanying algorithms for measuring charge and aging, and optimized charging and operation management strategies. The interfaces of the modular battery systems are configured to facilitate system integration in terms of both performance and communication.



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COVER PHOTO:
Oscillation laser welding for the safe electrical connection of battery cells. Photo: Fraunhofer ILT.

1 *Multilayered electrode stack. Photo: Fraunhofer IFAM.*
2 *AVTR battery module. Photo: Fraunhofer IISB.*
3 *Abuse test overcharging a lithium ion cell (pouch cell). Photo: Fraunhofer ICT.*

Simulation

The properties of batteries from the atomic scale up to behavior in a power chain are investigated by the Battery Alliance using cutting-edge simulation tools. Research topics in both fundamental and contract research include the simulation of material properties, cell optimization from a thermal and aging perspective, the optimization of battery management systems, network simulations and the crash behavior of cells and batteries.

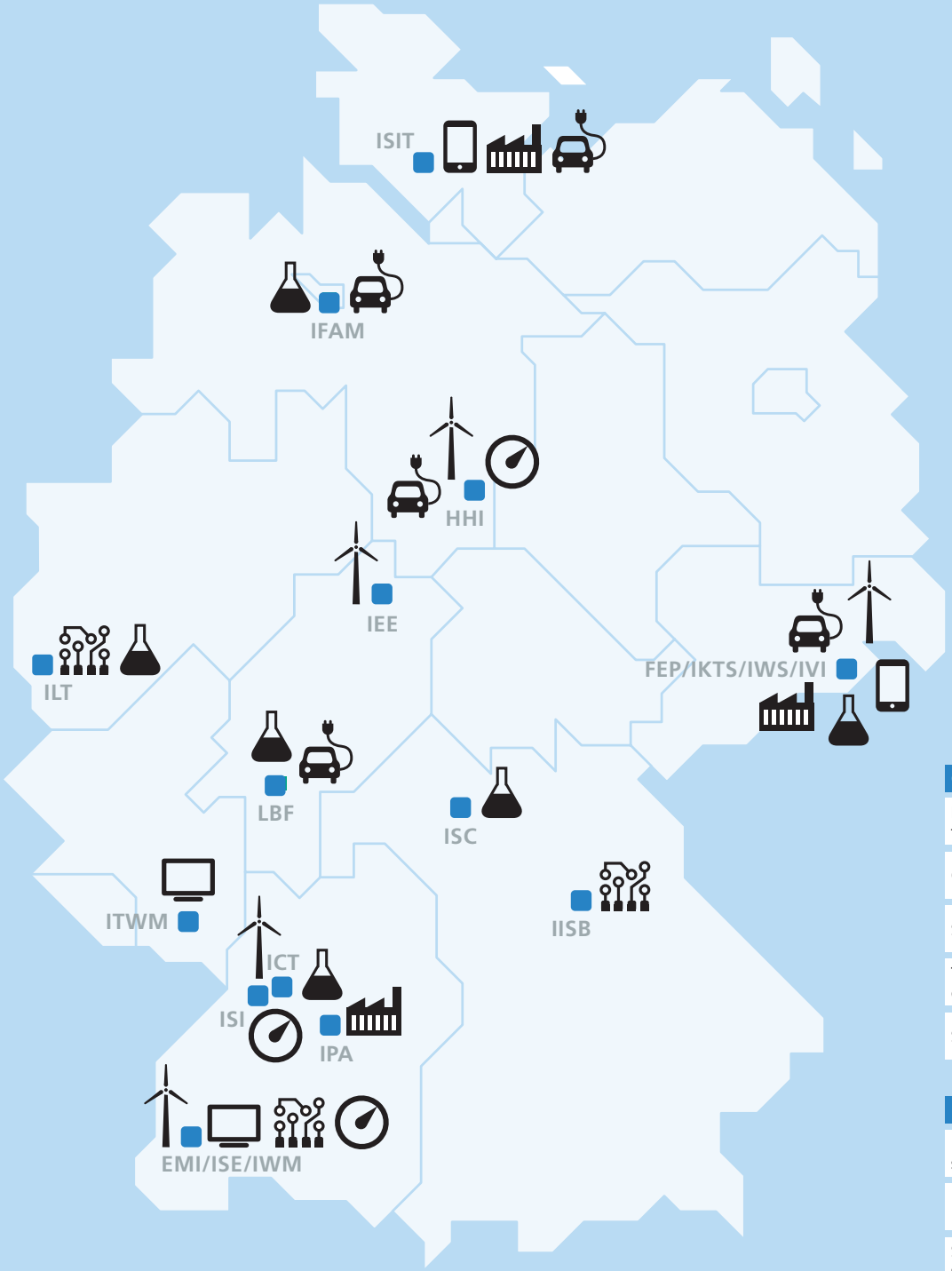
Testing and evaluation

The testing and evaluation of energy storage devices is an important stage in the development chain for automotive applications. Due to the range of challenges involved, a significant number of attributes must be investigated. Beside standard tests, the facilities available within the Fraunhofer Battery Alliance enable specialized and highly scientific tests on specific topics, on a cell, module and system level.

Cell production

Our institutes operate special pilot plants for transferring results obtained in the laboratory to industrial scale. In these plants, all stages of the production of electrochemical cells can be carried out.

THE MEMBERS OF THE BATTERY ALLIANCE



Core competences

- From the material to the cell
- Cell production
- Systems
- Testing and evaluation
- Simulation

Markets and applications

- Mobile energy storage devices
- Electromobility
- Stationary energy storage devices

RESEARCHERS AND DEVELOPERS FROM 19 FRAUNHOFER INSTITUTES HAVE COMBINED THEIR COMPETENCES IN THE FRAUNHOFER BATTERY ALLIANCE.

Fraunhofer EMI | Investigation of strain-rate-dependent effects under mechanical abuse up to module level, and crash modeling of cells and modules.

Fraunhofer FEP | Development of throughput-optimized vacuum thin film technologies in a roll-to-roll modus for current collectors, cathodes, anodes, electrolytes and separators.

Fraunhofer HHI | Development of new safety concepts for batteries based on photonic sensor technology with the objective of cost-effective production and integration in lithium-ion batteries for a wide variety of applications.

Fraunhofer ICT | Safety tests on lithium-ion systems up to module level, gas analytics and other special analysis methods on cell and system level and development of new secondary batteries such as lithium/sulfur, solid-state and redox-flow batteries.

Fraunhofer IEE | Physical electrochemical simulation of cells and battery systems for stationary and automobile applications, identification of parameters for any chosen battery simulation model, development and testing of battery-hardware-in-the-loop systems, aging simulations for cells and battery systems.

Fraunhofer IFAM | Material and process development for future battery technologies such as nanostructured electrodes for lithium-ion batteries, composites for all-solid-state batteries and metal air batteries.

Fraunhofer IISB | Development of battery systems with a battery management system (foxBMS® is used as a free, open and flexible development environment) and integrated power electronics for mobile and stationary applications.

Fraunhofer IKTS | Battery development based on ceramic materials and processes with an emphasis on lithium and sodium systems, conventional cell concepts and solid-state approaches.

Fraunhofer ILT | Laser-based production technology from cell up to pack level, such as drying and functionalization of layers, structuring, manufacturing and connection of electrodes, bonding technology for module production and the investigation of new secondary batteries like thin film or solid-state batteries.

Fraunhofer IPA | Development of production processes and production technology for the manufacture of rechargeable batteries considering Industry 4.0 technologies.

Fraunhofer ISC | Research on sustainable energy storage technologies – material and process development, testing and intelligent recycling of Li-ion, solid-state and lead-acid batteries.

Fraunhofer ISE | Material development, cell production processes, module and system development, battery tests according to conventional norms and standards and quality assurance for energy storage plants.

Fraunhofer ISI | International monitoring of technology and market developments and development of the framework conditions for energy storage devices/batteries for electro-mobility, stationary and (small) mobile applications, as well as national roadmapping for the strategic support of research, industry and politics.

Fraunhofer ISIT | Customer-specific development and manufacture of secondary batteries for special requirements up to system level, based on lithium-ion technology, the development and optimization of manufacturing processes and the development of new secondary batteries such as magnesium sulfur, lithium sulfur and calcium-ion batteries.

Fraunhofer ITWM | Development and application of physical models for the simulation of electrochemical energy storage devices from micrometer scale up to cell scale, with an emphasis on lithium-ion cells.

Fraunhofer IVI | User-oriented battery characterization, remote monitoring and long-term aging diagnostics, from the cell through to the vehicle fleet for current and future battery technologies.

Fraunhofer IWM | Simulation of battery materials on atomic and quantum chemical level, and simulation of the crash behavior of battery systems.

Fraunhofer IWS | Material, surface and laser technologies along the process chain for the development of novel battery cells, with current emphasis on the lithium/sulfur system.

Fraunhofer LBF | Multiphysical testing and verification of traction batteries for electric vehicles according to mechanical, thermal and electrical criteria, and evaluation of system reliability and quantification of insecurity in the field of electromobility.

FRAUNHOFER BATTERY ALLIANCE

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