NEW FRAUNHOFER IKTS SITES

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Rostock **1**

Smart subsea technologies for the sustainable use of the oceans

The oceans are an important source of life and of the Earth's biodiversity. At the same time, they are used for recreational purposes, transport, as a source of raw materials and energy, as well as for waste disposal. The transition to an efficient and sustainable use of maritime resources has a very high priority and is the focal point of the United Nations Decade of Ocean Science for Sustainable Development (2021–2030). Therefore, the cross-disciplinary research group Smart Ocean Technologies (SOT), in which the Fraunhofer institutes IGD, IGP, IKTS and IOSB participate, is developing forward-looking subsea technologies in Rostock. This includes robust sensor systems and test methods for permanent condition monitoring of subsea structures, as well as wear- and corrosion-resistant ceramic key components ensuring the maintenance-free operation of subsea aggregates. Furthermore, we establish novel analysis methods which allow to characterize the complex aging processes of microplastics in the oceans.

For the purpose of testing our proposed solutions, we will have at our disposal an underwater test rig in the Baltic Sea (Digital Ocean Lab) in the near future. Testing in real conditions is an important contributor to successful development. The versatile underwater test rig close to the shore will be equipped for the most different application scenarios, such as offshore wind energy, aquaculture or unexploded ordnance removal. Its purpose is to serve research and industry alike by allowing to test, evaluate and optimize materials, modules and complete subsea systems under controlled conditions in a real environment.

Areas of research

- Condition monitoring of subsea structures
- Ceramic key components of subsea systems
- Analytics of microplastics

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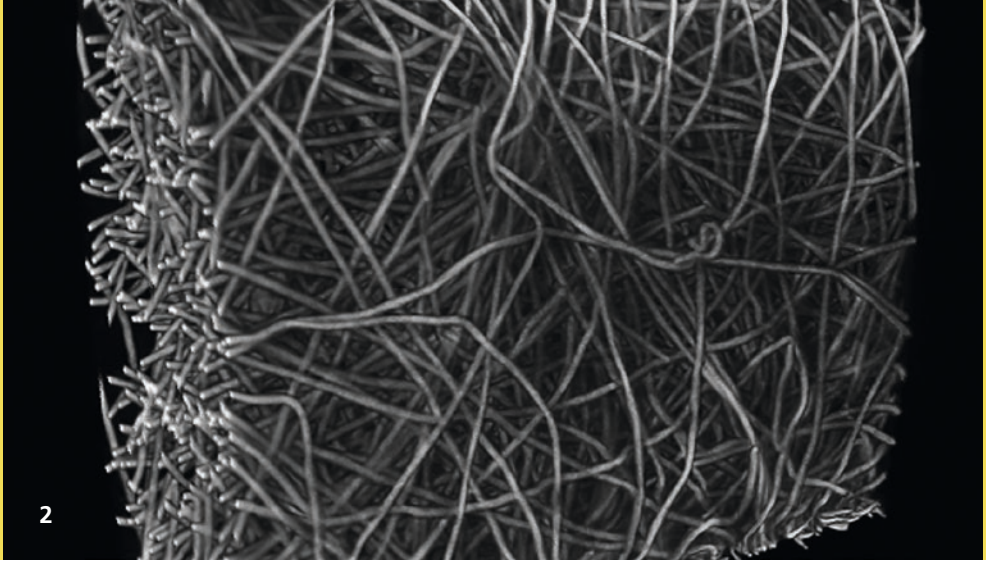

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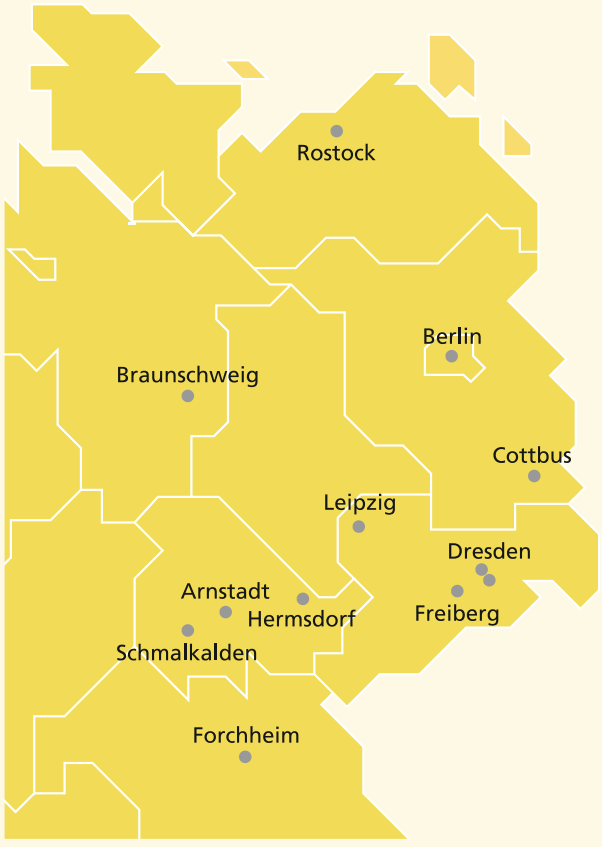
Forchheim 2

Correlative microscopy for bio- and energy materials

More and more frequently, modern material developments, e.g. for medical or energy technology, use composite or nanostructured materials with novel and versatile properties. Their detailed characterization at our Forchheim site can be done with cutting-edge equipment, such as light, electron, ion or X-ray microscopy, as well as the associated spectroscopic measuring methods.

Fraunhofer IKTS sites



Fraunhofer IKTS uses sophisticated methods that allow to analyze material compositions and the associated physical and chemical properties under accurately adjusted environmental conditions. These are recorded correlatively, and examined and described on various dimensional scales. To be able to evaluate and interpret the material data and the complexity of their various combinations, we also develop intelligent and adaptive algorithms.

Areas of research

- Correlative microscopy and spectroscopy across all scales for composites from metallic, ceramic and polymer bio- and energy materials
  - Characterization of materials and components of batteries and fuel cells with different cell concepts and various degrees of technological maturity
  - Characterization of implant materials
- Characterization of complex material composites for material optimization or for the development of efficient, personalized therapies, e.g. bone architecture in the case of osteoporosis
- Examination of micro- and nanoplastic residues in water and water body samples, study of health effects, e.g. on human kidney and lung tissue
- Development of adaptive algorithms for the qualitative and quantitative evaluation of collected correlative data
- Use of machine learning methods to evaluate image data

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Arnstadt **1**

Production research for energy storage solutions

Looking at the transformative processes taking place in the automotive and energy sectors, digital support for the production and quality assurance of battery cells and modules will play an ever greater role in the future. The comprehensive digitization of industrial production is one key to optimizing the complete production chain and thus increase the competitiveness of companies. At our site in Arnstadt – the Battery Innovation and Technology Center BITC – we use industry-adjacent pilot lines to test innovative data-driven approaches for process monitoring, control and quality assurance.

When it comes to manufacturing battery cells and battery modules, scaling – i.e. the production of components in the order of millions while maintaining a high standard of quality – comes as a big challenge. When the aim is to ensure the highest possible quality in battery production with minimal rejects, it is important to detect defects as early as possible in the manufacturing process. The BITC aims to use innovative non-destructive testing and measuring technology to monitor all relevant process parameters. AI-based concepts for intelligent aggregation, structuring, evaluation and storage are used for the data thus collected. This enables detecting defect patterns, optimizing production flows and establishing a holistic production data management approach. It also opens up new quality criteria and standards in battery production.

In addition to specific questions around battery development, we are also engaged with developing fundamental routines for the scalable production of complex energy storage and conversion solutions. Looking forward, we will transfer our experience from battery research to digitally supported production technologies for the hydrogen economy, e.g. for electrolyzers.

The BITC finds its greatest strength in its development-related cooperation with companies and research institutions in Thuringia, such as the Technical University Ilmenau, the universities in Jena and Gera-Eisenach, as well as CATL, one of the largest battery cell producers. This allows to concentrate the know-how directly at the site. This type of production research is enormously important for the expansion of new industrial capacities in Thuringia. Moreover, the BITC will be active in the training and further training of qualified employees from the region and promote Industry 4.0 concepts in battery production and other industrial areas.

Areas of research

- Industrial data concepts
- Test methods for battery production
- Workflow management
- Instrumentation and interlinking of process steps
- Quality control and evaluation of digitally supported production processes

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Freiberg 2

New approaches to battery cell recycling

High-performing lithium-ion batteries are a key component for the successful shift away from fossil fuels. Their economic sustainability and the continuous reduction of manufacturing costs are essential for expanding further the use of lithium-ion batteries for mobile or stationary energy storage in the future. At our Freiberg site, we develop efficient manufacturing processes, test methods and recycling concepts suitable for the industry.

To test new high-performing energy materials and cost-efficient manufacturing technologies for the mass market, we and our industrial clients have various technological facilities for mixing, slurry processing, tape coating, drying and compaction of electrode tapes available in dry-room conditions. Minimizing the number of rejects and scrap is another important contribution to reducing costs. For this purpose, we are working to develop non-destructive in-line test methods that are suitable for the industry and can detect defects or functional changes in the material composition or the cell structure early on. This allows to continuously improve the quality of the slurry and tape production.

However, over the coming years it will not just be lower production costs that will give a competitive edge. New concepts and technologies allowing to refeed recovered materials and raw materials into battery cell production will also play a decisive role. Fraunhofer IKTS is pursuing several initiatives in this regard. First, we aim to increase the yield and purity of economically strategic raw materials in the recycling of battery storage systems. This includes both hydrometallurgical and electrochemical processing methods, as well as the recovery of these products from digesting agents and process waters.

To automate material recycling and make recycling processes more efficient and precise, we use suitable monitoring systems and database solutions. Furthermore, we analyze under which conditions these recycled materials can be used for resynthesis and what their effect is on the electrochemical performance of the battery cells. With regard to the required material and substance quality – purity being the most important aspect – we also develop existing recycling processes further, with a view to resynthesis processes. Furthermore, we also develop guidelines for design geared toward the circular economy and for the recycling-friendly design of lithium-ion cells with liquid electrolyte, as well as for solid-state batteries. This allows to make battery systems more suitable for the circular economy and reduce the negative environmental effect of batteries.

Areas of research

- Transfer of efficient production methods for battery electrodes to the industrial scale
- Industrially suitable in-line test methods for electrode production
- Recirculation of battery components
- Material recycling of battery materials

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