Fraunhofer
IKTS

FRAUNHOFER INSTITUTE FOR CERAMIC TECHNOLOGIES AND SYSTEMS IKTS

BUSINESS DIVISION

ENERGY

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ENERGY

With its ‘Energy’ business division, Fraunhofer IKTS provides innovative components, modules and complete energy technology systems, developed, built and tested on the basis of ceramic materials and technologies. Its applications include energy storage and fuel cell systems, solar cells, energy harvesting modules and thermal energy systems, even solutions for bioenergetic and chemical energy sources.

Successfully transforming our energy supply system to make it sustainable is one of the most important tasks facing us in the 21st century. This task requires that we use renewable and conventional energy sources as efficiently as possible while minimizing resulting damaging effects.

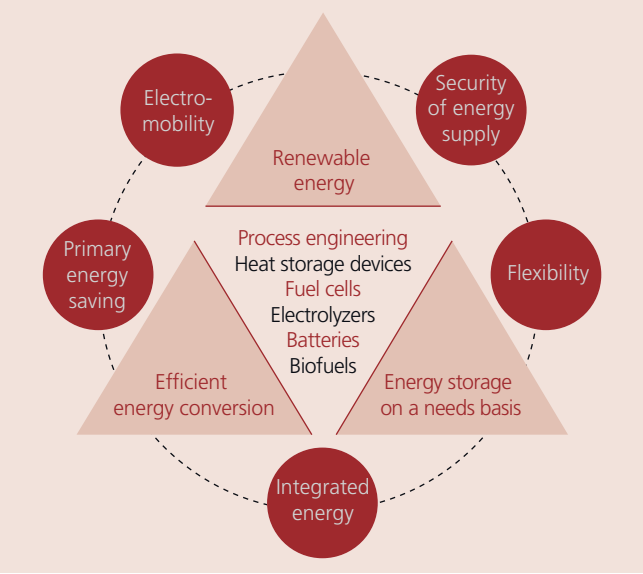
This means that efficient energy transformation, the integration of renewable energies and energy storage solutions that are able to respond to a fluctuating demand are of great importance for our future energy supply. In view of this, fuel cells allow to convert chemical energy into usable electric and thermal energy, thus helping to save primary energy.

High-performing electrical storage solutions, such as batteries, when combined with photovoltaic plants, enable electromobility and allow for a more efficient use of solar energy. The combination of wind energy converters and electrolyzers for the conversion of electric energy into fuels and chemicals allows to connect different energy sectors, making energy systems much more flexible.

When it comes to converting and storing electric and thermal energy, the systems used need to be robust and offer a long service life while being cost-efficient with regard to their manufacture and operation. As a full-service provider, Fraunhofer IKTS has been comprehensively addressing these challenges for several years in order to develop innovative solutions. This approach leads to significant competitive advantages, particularly in the dynamic market segment of energy production and storage.

Careful analysis, often including the modeling and simulation of the most important component within the system, which is often based on ceramic technology, always comes first. It is an indispensable step in order to use specific properties as effectively as possible and integrate the ceramic component optimally into energy converters and systems.

Cooperating with several partners from the industry, IKTS operates several pilot plants, covering the complete process chain for a modern manufacturing of energy system components. This means we are uniquely qualified to test and improve the materials and processes developed at the institute in semi-industrial environments together with our clients.



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AREAS OF APPLICATIONS

Energy storage

Fraunhofer IKTS is working on lithium-ion batteries and their production methods as well as batteries based on ceramic sodium solid-state ion conductors for cost-effective decentralized energy storage solutions. In particular, the work with batteries using solid-state electrolytes and composite materials based on solid-state ion conductors is unique in this area. Other focal points are metal-air batteries and supercapacitors. The available heat storage media are based on zeolites, phase change materials and components for salt storage systems. The research topics cover the complete value chain for energy storage systems and their manufacturing, from the lab to production scale.

Electrolysis and Power-to-X

The electrolysis of water steam and CO_2 at the commercial scale is a key technology for using excess electrical energy from renewable sources. For instance, the energy can be converted to fuels and chemicals, such as hydrogen to be introduced into gas networks and then reconverted into electricity, or transformed into higher-value hydrocarbons by conversion with CO_2 via synthesis gas. The fuel cell stacks of Fraunhofer IKTS are ideal for electrolysis operation. Our experience in the development of cells, interconnectors and joining methods, gained in our work with commercial SOFC technology, enables rapid design and material iterations as well as large-scale modules. Furthermore, Fraunhofer IKTS is working to develop reactor concepts. The institute combines water-selective membranes with catalytic converters in the membrane reactor or membrane contactor. Furthermore, our researchers develop catalytic converter systems and engineer processes, methods and plants for the production of fuels and chemicals using the Fischer-Tropsch synthesis.

Fuel cells

Producing electricity with SOFCs and MCFCs is in its first stage of market introduction. New production methods are investigated for PEM fuel cells with the aim of reducing the platinum content. Other efforts focus on the consistent reduction of manufacturing costs, extending service life, increasing the number of usable fuel types, and on system integration. The IKTS is a leading international partner with decades of experience. Its capabilities cover the full value chain: The IKTS develops cells and stacks, manufactures these on the prototype scale and integrates them in client-specific systems through modular methods, in order to demonstrate compact and energy-efficient solutions for the cogeneration of heat and power. The performance range of such systems includes portable devices in the 50 W range, as well as stationary plants in the MW range. The most varied fuels are used for these systems, such as biogas, LPG and hydrogen.

Bioenergy

The IKTS supplies a large number of process engineering solutions for bioenergy technologies, such as disintegration, mixing and stirring processes. For the treatment of biogas, adsorptive and membrane methods are used to optimize the processes for methane enrichment, gas dehydration, nutrient recovery and process water treatment. The focus is on making biogas plants more flexible in responding to fluctuations in energy demand. Furthermore, bioethanol manufacturing processes are improved through membranes at various points in the production process, e.g. during saccharification, dewatering or substrate treatment. Novel organophile pervaporation membranes and ultrafiltration membranes help to make production processes more efficient.

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Deep geothermics

In deep geothermal plants, extreme conditions, such as high pressures, temperatures and salt content, often cause corrosion and incrustation, affecting their economic viability and operational safety. Based on its long years of experience with incrustation phenomena and its excellent analytical equipment, Fraunhofer IKTS also focuses on developing corrosion-resistant components and plants, and on process design. Experimental and corrosion testing rigs enable real-time on-site monitoring. Electrochemical treatment of the thermal fluids allows toxic substances and geogenic radionuclides to be retained and disposal problems to be avoided. During this process the recovery of strategically important metals is also possible.

Photovoltaics and concentrated solar power

The efficiency of solar cells depends to a large degree on the electric conductivity provided by the metal collector electrodes. Highly efficient thick-film and direct-write techniques enable the cost-efficient metalization of cells. Fraunhofer IKTS develops pastes and inks for existing and novel cell concepts. In the field of concentrated solar power (CSP), Fraunhofer IKTS is working on receiver materials and high-temperature materials for heat exchangers and heat storage systems. The integration of thermal energy storage solutions makes it possible to provide energy when it is needed.

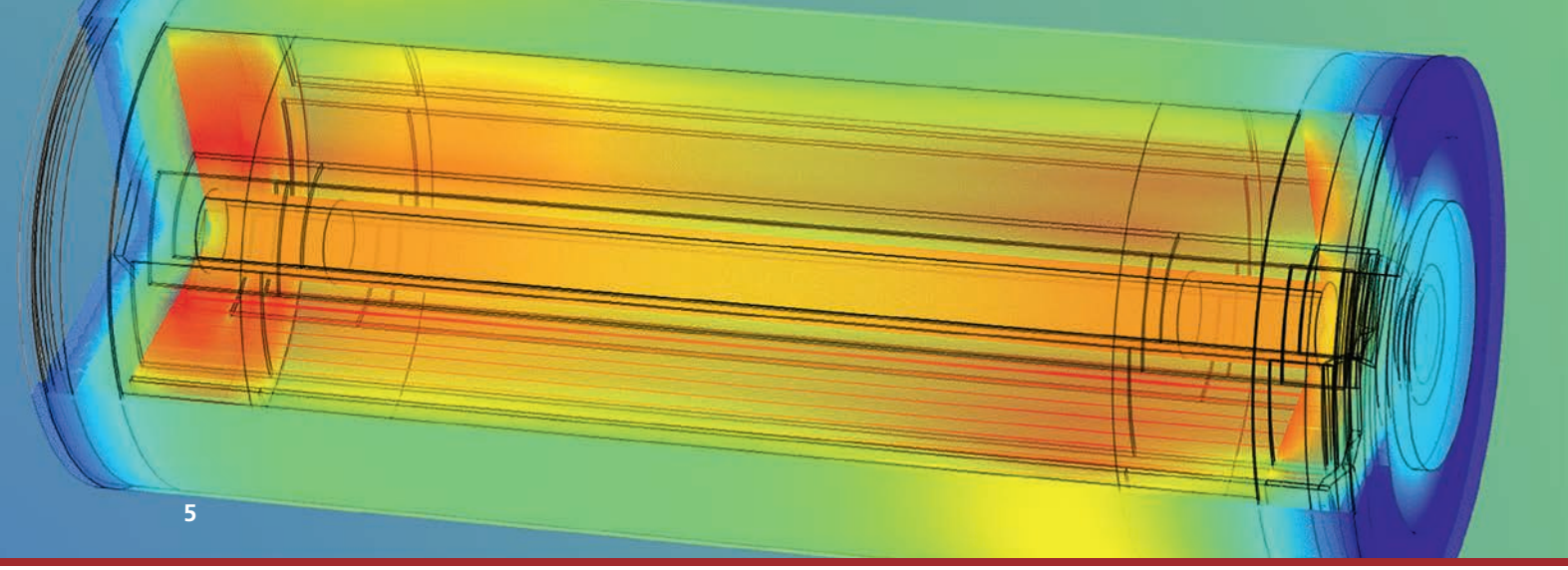
Energy harvesting

For energy supply of decentralized microsystems, such as sensors or medical or consumer devices, it is possible to use energy from the environment such as waste heat or vibration. Based on long years of experience with ceramic active materials (thermoelectric and piezoceramic materials), the Fraunhofer IKTS researchers are developing so-called energy harvesters, e.g. piezo and thermoelectric generators.

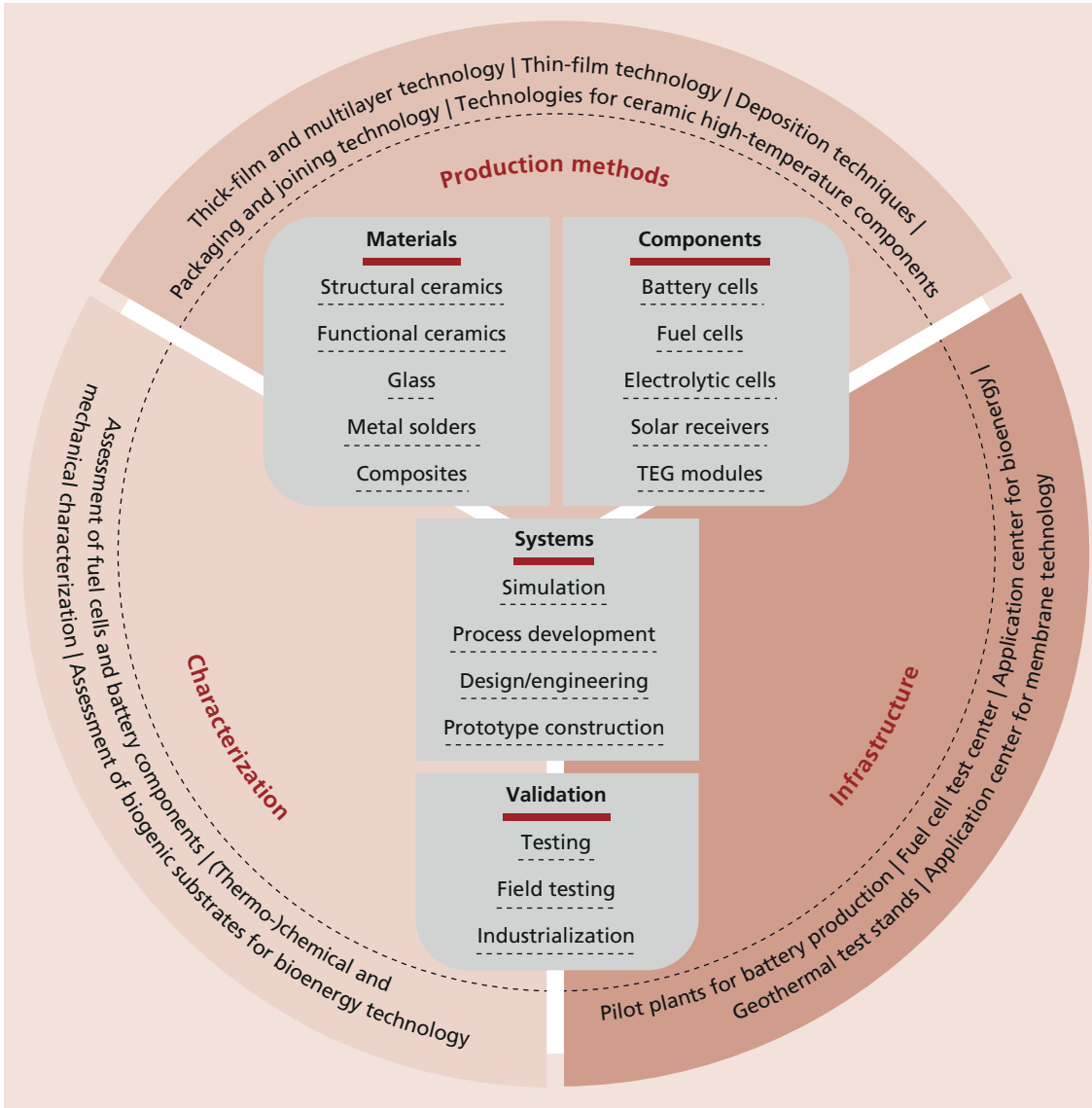
High-temperature gas turbines and thermal energy systems

Increasing the eco-friendliness and efficiency of hot gas turbines and reducing emissions requires higher process temperatures, and therefore materials with high thermal shock resistance. Therefore, monolithic ceramics and ceramic matrix composites (CMC) are an interesting alternative to metals. Beyond this, Fraunhofer IKTS also focuses on environmental barrier coatings based on oxide and non-oxide ceramic systems.

1 *Battery test stand for the characterization of lithium cells.*
2 *High-temperature battery for stationary energy storage.*
3 *Test of thermoelectric generators to produce electric energy from thermal energy.*
4 *Optimizing electric and thermal energy production from biomass.*



COMPETENCES AND INFRASTRUCTURE



5 *Simulation of the temperature distribution inside the coil structure of a lithium-ion battery during pulse loading.*

FRAUNHOFER IKTS IN PROFILE

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

As a research and technology service provider, Fraunhofer IKTS develops modern ceramic high-performance materials, customized industrial manufacturing processes and creates prototype components and systems in complete production lines from laboratory to pilot-plant scale. Furthermore, the institute has expertise in diagnostics and testing of materials and processes. Test procedures in the fields of acoustics, electromagnetics, optics, microscopy and laser technology contribute substantially to the quality assurance of products and plants.

The institute operates in nine market-oriented business divisions to demonstrate and qualify ceramic technologies and components as well as non-destructive test methods for new industries, product concepts and markets beyond the established fields of application. Industries addressed include ceramic materials and processes, mechanical and automotive engineering, electronics and microsystems, energy, environmental and process engineering, bio- and medical technology, non-destructive testing and monitoring, water as well as materials and process analysis.

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COVER *Efficient energy supply with high-temperature fuel cells.*