



Fraunhofer

IKTS

FRAUNHOFER INSTITUTE FOR CERAMIC TECHNOLOGIES AND SYSTEMS IKTS



BUSINESS DIVISION

ENVIRONMENTAL AND PROCESS ENGINEERING





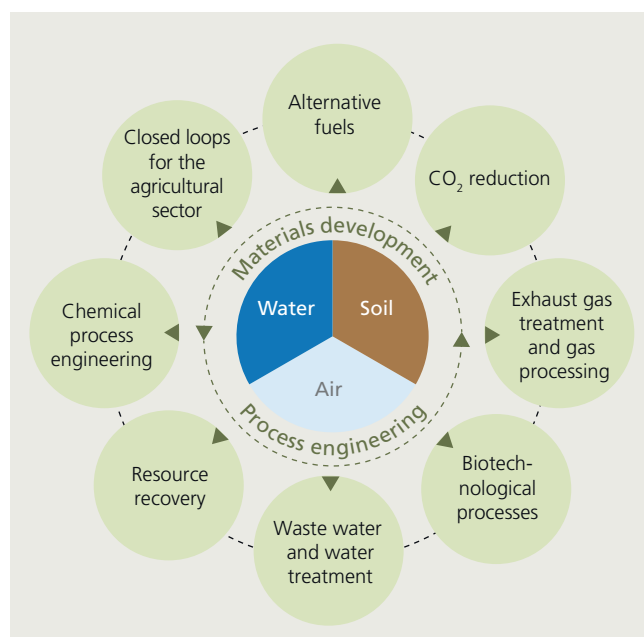
ENVIRONMENTAL AND PROCESS ENGINEERING

With its “Environmental and Process Engineering” business division, Fraunhofer IKTS provides materials, technologies and systems to make the conversion of materials and energy safe, efficient, environmentally and climate-friendly. The focus is on processes in the field of conventional and bioenergies, strategies and methods for keeping the soil, water and air clean and for recovering valuable raw materials from residual waste materials. Many approaches aim for closed material cycles.

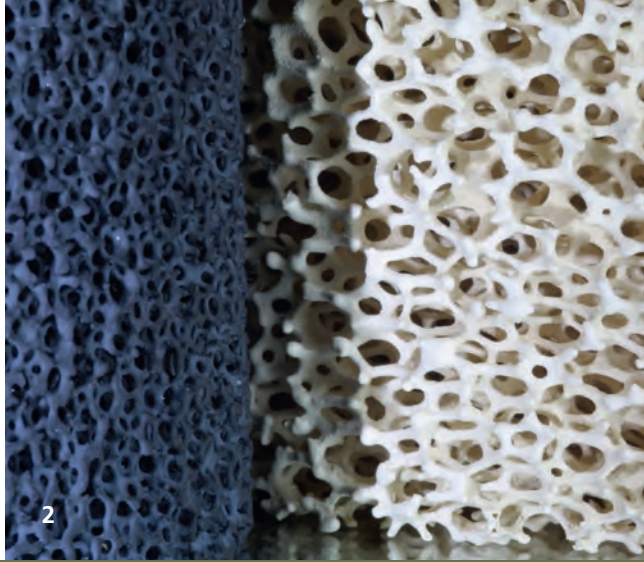
Fraunhofer IKTS is one of the leading research institutions worldwide with regard to material separation technology using ceramic materials. Material, technology, and process expertise are all intertwined, thus enabling the development of complex process engineering systems for energy-efficient separation processes, chemical conversion and the recovery of valuable materials. Ceramic membranes, filters, adsorbents and catalysts of Fraunhofer IKTS play a vital role in gas processing and water treatment. Furthermore, ceramic membrane methods are combined with innovative materials to produce novel reactor concepts to make process engineering methods more efficient.

Process engineering know-how regarding the comminution, disintegration and mixing of biogenic substrates is another core competence of Fraunhofer IKTS in the field of biochemical and thermochemical biomass conversion. It allows to convert agricultural residual waste materials to solid, liquid and gaseous energy carriers. It also makes it possible to process nutrients from liquid manure, dung and fermentation products to retain transportable and storable fertilizer products with defined properties.

Numerous lab and pilot plants are used to model, validate and optimize fluidic, electrochemical and thermomechanical characteristics for material transport processes and reactions.



With the high number of labs and technical centers, as well as the application centers for membrane technology and bioenergy, the business division possesses the ideal infrastructure for realizing projects of the most varied volumes and scales. The results are used directly in demonstration plants, which can be built at the clients’ sites and operated by Fraunhofer IKTS.



AREAS OF APPLICATION

Waste water and water treatment

Keeping water clean, in particular by purifying waste water, is a central tenet of environmental protection. In this area, Fraunhofer IKTS focuses on methods free from chemical and biological agents, as well as on integrated reactor systems for the treatment of waste and process waters. With ceramic membranes or electrochemical and photocatalytic oxidation processes, potable water, municipal and industrial process water, mining water and geothermal deep water can be processed.

Exhaust gas treatment and gas processing

Many engineering processes produce gaseous mixtures containing extremely fine particles and gaseous pollutants that are hazardous to humans and damaging to the environment. Fraunhofer IKTS provides open-porous, cellular ceramic bodies and membranes for hot gas dedusting and particle filtration. Nanoporous membranes, for instance, enable separating individual components from gaseous mixtures. Another focus is on ceramic catalyst supports and catalysts for exhaust gas purification. As an alternative to precious metals, ceramic catalysts exhibit higher thermal stability. Furthermore, they tolerate common catalyst poisons, which critically affect precious metals, much better.

CO₂ reduction

Various strategies for preventing (CDA), as well as using and storing (CCU) CO₂ offer significant potential with a view to meeting the defined climate targets. Ceramics-based technologies for electrolysis, CO₂ capture and for the synthesis of higher-value products (Fischer-Tropsch) can become a game-changing contribution to this effort. In particular in carbon-intensive industries, such as the steel industry, it is possible to reduce emissions significantly by up to 95 % by

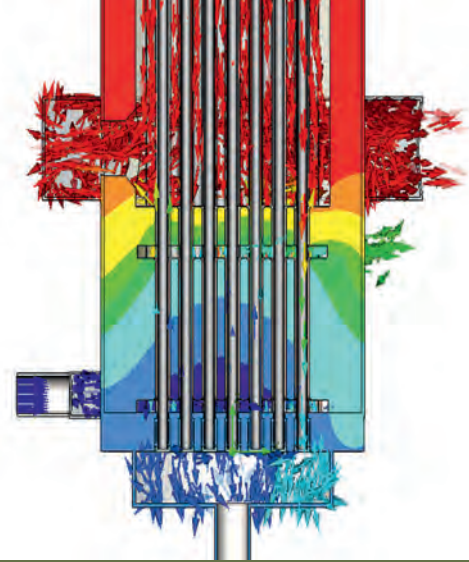
producing hydrogen in a highly efficient solid-oxide electrolysis process and using it for the reduction of ferrous oxide. Another approach for reducing CO₂ emissions is to optimize industrial combustion and oxidation processes. The consumption of fossil energy carriers, and thus CO₂ emissions, can be reduced by adding oxygen. To produce oxygen cost-efficiently, Fraunhofer IKTS is developing oxygen-selective membranes and oxygen generators.

Chemical process engineering

Material separation with durable ceramic membranes is energy-efficient and thus often more economically viable than the thermal separation techniques, extraction and adsorption methods typically used in chemical process engineering. The use of chemicals for regenerating adsorbents or extracting agents decreases when using membranes. In reaction engineering, educts can be dosed accurately and products can be removed with precision thanks to ceramic membranes. In this field, Fraunhofer IKTS works with catalytically active membranes, combining them with catalysts in the membrane reactor or membrane contactor.

Alternative fuels

On account of their high energy density and easy storage, liquid fuels will retain significance for mobility in the short and medium term. Fraunhofer IKTS shows ways to replace oil as the basic ingredient for fuel production by using alternative carbon-containing raw materials and compounds. This includes catalyst systems as well as process engineering methods and plants for the production of fuels and recyclable materials using chemical syntheses, such as the Fischer-Tropsch synthesis while taking hydrogen technologies into account. Powerful modeling and simulation allow for the development and supply of novel concepts in chemical reaction engineering.



Resource recovery

Resource recovery from waste waters and liquid process media, and their provision plays an important role in the efficient use of resources. Fraunhofer IKTS is able to cover the full wet chemical process chain, starting with the extraction from solids, to enriching using membrane-supported extraction processes, through to the target product. In this regard, electrochemical processes are preferred, but process combinations are also used. We have extensive experience in recovering rare earth concentrates from secondary raw material sources, preparing rare earth compounds in a pure state, as well as in recovering special and precious metals from scrap metal and dump materials. Hypolimnetic water is a non-conventional source, allowing the extraction of many important raw materials, depending on the specific site.

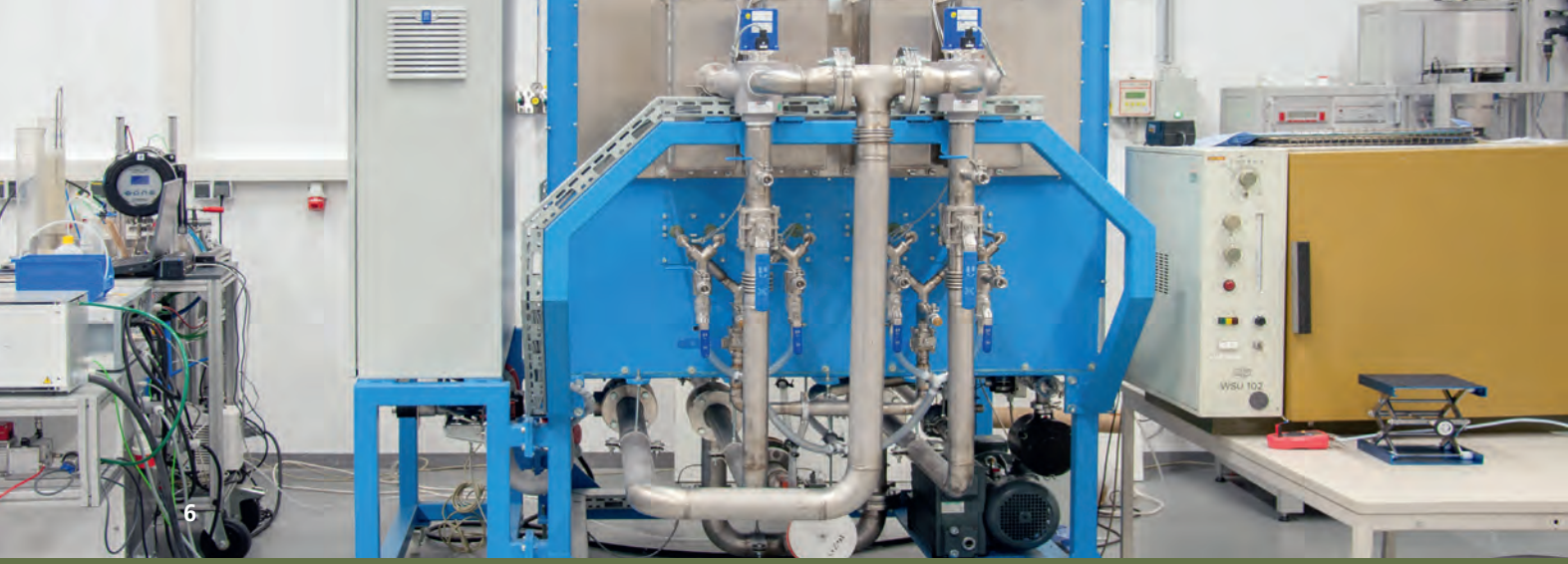
Biotechnological processes

Fraunhofer IKTS provides a wide range of process engineering solutions for bioenergy technologies, such as disintegration, mixing and stirring processes, with the aim of using substrates containing lignocellulose, among other substances, for the purpose of biogas production. The treatment of biogas is optimized through adsorptive and membrane processes, which improve methane enrichment, biogas dehydration, nutrient recovery and process water treatment. With regard to the production of bioethanol, the IKTS relies on organophile pervaporative separation and ultrafiltration membranes for the purpose of saccharification, dewatering and substrate preparation. Many of these extremely efficient methods can be transferred to other biotechnological recovery and treatment processes.

Agriculture

Resource efficiency, the effectiveness of antibiotics, sustainability of soil properties, or quality of ground water: These aspects are becoming more and more important for the agricultural systems of today. Sustainable economic management of resources must be based on the treatment and use of biomass- and nutrient-containing residual waste materials which are produced in agriculture as by-products. These materials are prepared in such a way that they can be re-introduced into the production cycle in the form of fertilizer, water and energy. In this context, material cycles are not seen as isolated systems. Rather, sensor systems automatically detect and analyze the complex interactions between cycles in order to increase productivity through optimized processes while at the same time improving sustainability. In this endeavor, Fraunhofer IKTS offers ceramic membranes, filters, adsorbents, catalysts, sensors and energy storage solutions.

- 1 *Photocatalytic waste water treatment.*
- 2 *Open-cell ceramic foams for waste water treatment and exhaust gas purification.*
- 3 *Ceramic-supported catalysts for industrial exhaust gas purification.*
- 4 *Ceramic membranes in various geometries.*
- 5 *Simulation of material and heat transfer within a membrane module.*



COMPETENCES AND INFRASTRUCTURE

Ceramic membranes

- Porous substrates in tubular and planar geometry
- Membranes from macroporous to nanoporous
- Dense, conductive and mixed-conductive membranes

Porous and cellular ceramics

- Grain ceramics and extrudates with narrow pore size distributions
- Open-cell ceramic foams with high pore volumes > 90 %

Adsorbents and storage materials

- Layered and framework silicates based on natural raw materials
- Synthesis of zeoliths and mixed oxides

Catalysts and catalyst substrates

- Catalyst development, screening, production and characterization
- In the form of extruded honeycombs, ceramic foams, membranes, bulk materials

Electrodes

- Testing of electrode materials
- Development of functional layers for corrosion protection

Membrane process engineering and particle filtration

- Membrane and filter testing
- Development and prototype production of plants
- Process configuration and pilot testing

Process engineering for biogenic substrates

- Process development and configuration for biomass treatment
- Processes for the production of solid, liquid and gaseous energy sources
- Engineering of biogas plants

Chemical process engineering

- Modeling, validation, and optimization of material transport and reaction
- Development and optimization of catalytic processes
- Automation of process engineering systems

Electrochemical process engineering

- Process development for the separation of pollutants and resource recovery
- Development and production of specific electrolysis cells and test equipment
- Set-up and operation of test plants, up to technical pilot scale

Infrastructure

Test facilities for the testing of membranes, filters, adsorbents and catalysts (incl. mobile systems for tests at clients' site)

ATEX-compliant membrane systems for solvent filtration and vapor permeation

Center for Smart Agriculture and Water Management

Mobile test stand for exposure testing and electrochemical in-situ analyses in deep geothermics

Membrane Technology Applications Center

Bioenergy Applications Center

6 Plant for the decentralized production of oxygen (10 Nm³ O₂/h).

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.

www.ikts.fraunhofer.de



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COVER *Pilot plant for the testing of ceramic membranes for the purification and treatment of water, solvents and gaseous mixtures.*