*Electrolysis stack of Fraunhofer IKTS.*

# Services offered

Support in design, evaluation and large-scale testing of CDA and CCU strategies for:

- Mechanical and plant engineering
- $CO_2$ intensive industries
- Energy industry
- Manufacturers of hydrocarbon containing products

## Competences:

- Design, modeling and long-term testing of effective processing concepts
- Development of reactor concepts using advanced ceramic components
- Integration strategies for natural gas, renewable energies and power-to-X energy sources
- Construction and operation of demonstration plants
- Technical and economic assessment
- Feasibility studies, consulting services and networking

## 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), Germany, collectively represent Europe's largest R&D institute dedicated to the study of ceramics.

As a research and technology service provider, Fraunhofer IKTS develops advanced high-performance ceramic materials, industrial manufacturing processes as well as prototype components and systems in complete production lines up to the pilot-plant scale. In addition, the research portfolio also includes materials diagnostics and testing.

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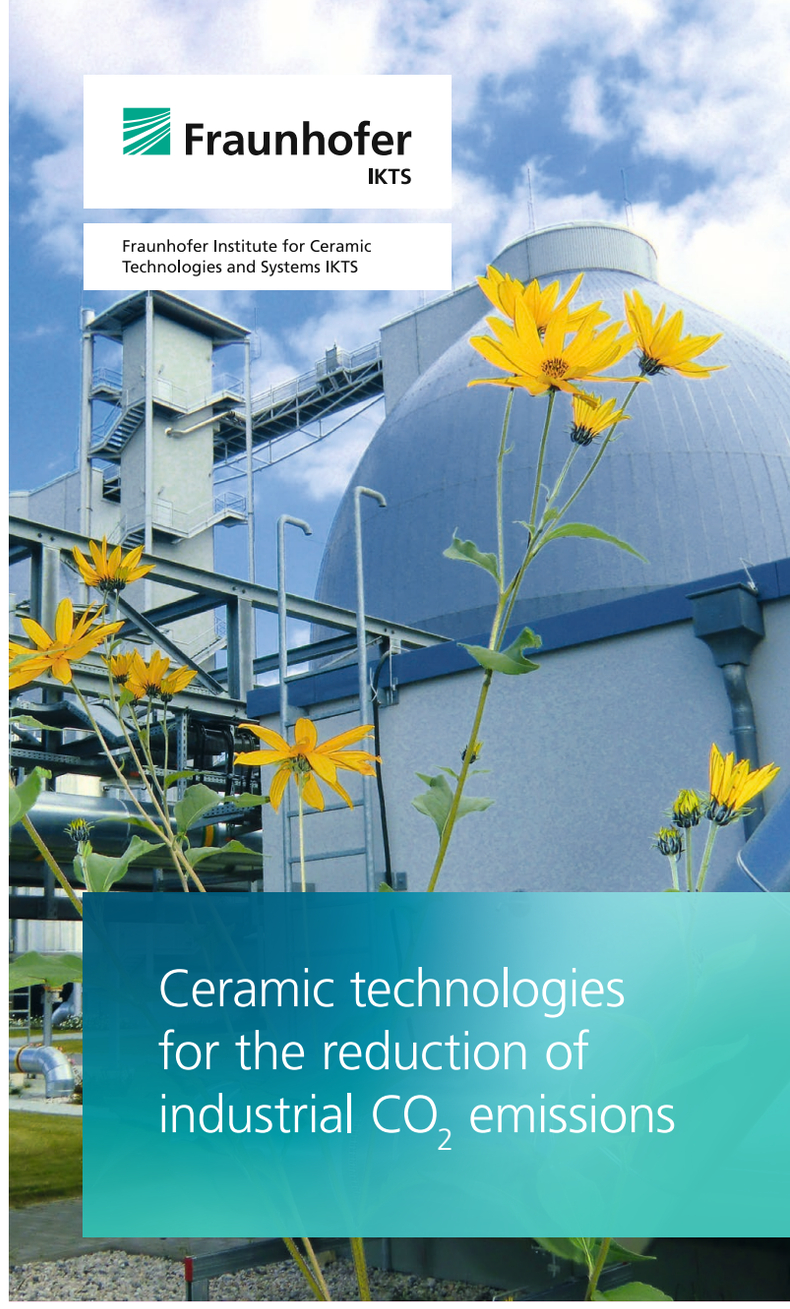

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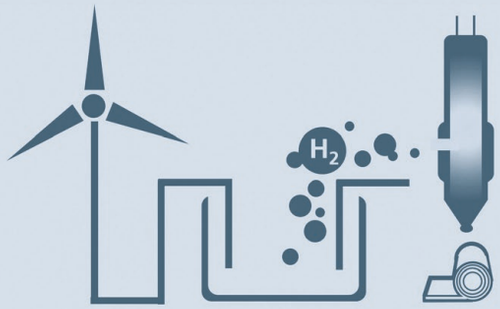
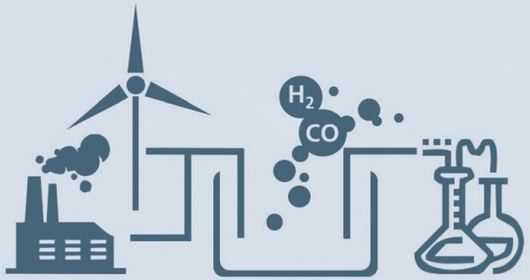
Technologies and Systems IKTS

# Ceramic technologies for the reduction of industrial $CO_2$ emissions

**www.ikts.fraunhofer.de**




*Use of $H_2$ for direct reduction in steel industry.*




*High-value products from $CO_2$ and $H_2O$.*

# Motivation

To achieve the Paris Agreement climate goals a fundamental change in energy and process industry will be necessary. Different strategies for Carbon Direct Avoidance (CDA) as well as Carbon Capture and Utilization (CCU) of $CO_2$ offer great potential to undergo this structural change in an ecological and economical way. Focus is on avoiding emissions, where it is possible, and the efficient use of $CO_2$ resources, which cannot be avoided. Special attention is also paid to the integration of renewable energies as well as new value-added contributions by coupling different sectors.

Ceramic-based technologies for electrolysis, $CO_2$ separation and synthesis of high-value products (Fischer-Tropsch) are well suited to make a significant contribution. Due to high investment needs Fraunhofer IKTS includes cost-benefit analyses at an early stage in its technology and demonstration projects.

# Application scenarios

## $CO_2$-Avoidance (Carbon Direct Avoidance CDA)

In $CO_2$ intensive industry sectors, in particular, innovative technologies for Carbon Direct Avoidance can significantly contribute to reduce emissions. In steel industry, for example, emissions can be considerably reduced by up to 95 % using natural gas and hydrogen from renewable resources for the reduction of iron oxide. For this process coal has been used so far. As approx. 7 % of the German $CO_2$ emissions are caused by steel industry, this approach has a great potential for emission reduction.

With the participation of the steel manufacturer Salzgitter AG and two other Fraunhofer Institutes (ISI and Umsicht), IKTS has carried out a feasibility study on the use of the direct reduction process in a steel mill as part of the BMBF-funded MACOR project (funding code: 03EK3044A) project. Since heat is available at a high temperature level during steel production, a highly efficient solid oxide electrolysis process is well suited for the provision of hydrogen and synthesis gas. As part of the preliminary research at IKTS, a long-term stability of more than 4500 hours has already been demonstrated with the ceramic-based high-temperature electrolysis stacks.

## $CO_2$-Usage (Carbon Capture and Utilization CCU)

Where $CO_2$ emissions cannot be avoided, innovative processes help to guarantee an efficient and economical use of $CO_2$ generated in the production process. At Fraunhofer IKTS focus of research is put on ceramic-based technologies for $CO_2$ separation and co-electrolysis as well as on selective ceramic-based catalysts for the production of high-value products. For lime and cement industry, for example, Fraunhofer IKTS develops a membrane-assisted $CO_2$ separation process as well as a two-step process for $CO_2$ utilization. In the first step, synthesis gas is produced from water vapor and $CO_2$ using co-electrolysis. In the second step, this gas is converted into waxes or long-chain alcohols. Biogas produced from biological waste and renewables raw materials also contains a high amount of $CO_2$ which is currently not utilized. To evaluate new value-added contributions for existing biogas plants, Fraunhofer IKTS develops processes for the production of waxes from biogas. Besides the patented processing concept, Fraunhofer IKTS has tremendous experience in modular reactor concepts for the Fischer-Tropsch synthesis based on ceramic catalysts supports.