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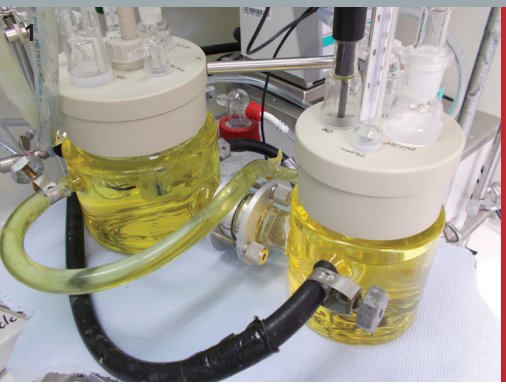
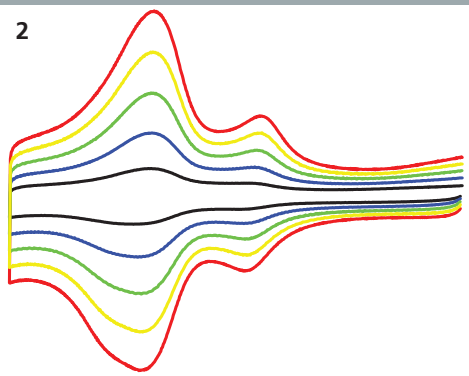
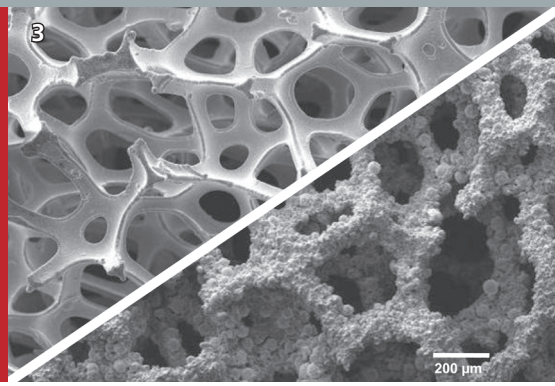
FRAUNHOFER INSTITUTE FOR MANUFACTURING TECHNOLOGY
AND ADVANCED MATERIALS IFAM, BRANCH LAB DRESDEN







1 *Two-compartment cell for electrode testing*
2 *Multi cycle voltammogram*
3 *Catalyst-coated nickel foam electrodes with multi-hierarchy porosity*

ELECTROLYSIS TECHNOLOGY

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Electrodes for Energy Conversion

The electrodes are key components of any electrochemical reactor.
At Fraunhofer IFAM, we develop, manufacture and test electrodes for various applicatios, e.g. hydrogen production or CO_2 conversion. Tailored selectivity and high activity of the electrocatalyst improve the efficiency of the energy conversion process. In this regard, 3D electrodes with a multi-hierarchy porosity are our specialty. The 3D structure provides a huge active surface area for the electrochemical reaction and also maximizes the product turnover.

Electrode Production

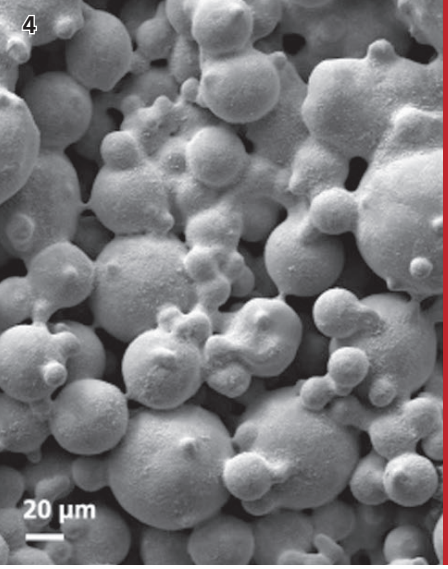
An appropriate production process is crucial to minimize the costs of the electrodes. At Fraunhofer IFAM, different methods (e.g. powder metallurgy, electrodeposition, spraying, printing) can be applied to produce highly efficient and robust electrodes.
In cooperation with our industrial partners, the process is scaled up in order to obtain a high output at yield.

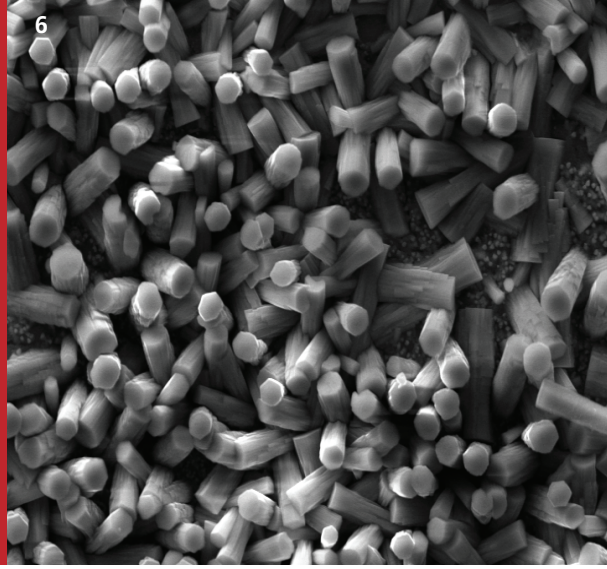
Hydrogen Production

Hydrogen can be produced directly from renewable energy sources by water electrolysis. At Fraunhofer IFAM, new electrode materials are fabricated and tested regarding their hydrogen and oxygen evolution activity and long-term stability. Electrodes are tested in small (cm^2) and large (several dm^2) test cells.

Electrochemical CO_2 Conversion

Fraunhofer IFAM develops electrocatalysts for the electrochemical reduction of carbon dioxide (ERC) to produce valuable chemicals (e.g. formic acid, carbon monoxide).





Electrochemical and Structural Evaluation

For the development and improvement of high-performance electrode materials it is mandatory to elucidate the structure-property relationships of the materials. At Fraunhofer IFAM Dresden, state-of-the-art electrochemical analysis equipment, e.g. electrochemical scanning tunneling microscopy (EC-STM), are available in order to investigate the electrochemical properties and the surface morphology of the electrode materials.

Analysis techniques:

- Electrochemical analysis
  - Cyclic voltammetry (CV)
  - Impedance spectroscopy (EIS)
  - Polarization methods
- Scanning tunneling microscopy (STM)
- Electrochemical STM (EC-STM) and scanning electrochemical potential mapping (SECPM) for *in situ* experiments

Electrode Testing under Real Operation Conditions

All electrode materials can be tested under realistic operation conditions to demonstrate their applicability (e.g. at 80 °C and 30 wt.%-KOH). For this purpose, lab-scale electrolyzer cells are available in which the electrical energy consumption per generated hydrogen volume is determined. Due to the simplicity of the system different electrode configurations can be easily realized.

Lab-scale electrolyzer cells:

- Single cell or short-stack design
- Operating conditions
  - Up tp 80 °C
  - Up to 30 wt.%-KOH
  - Atmospheric pressure
- *In situ* gas quality monitoring

4 *Sintered electrode*
5 *Electrochemical test cell*
6 *Advanced electrodes with nanowhisker electrocatalysts*

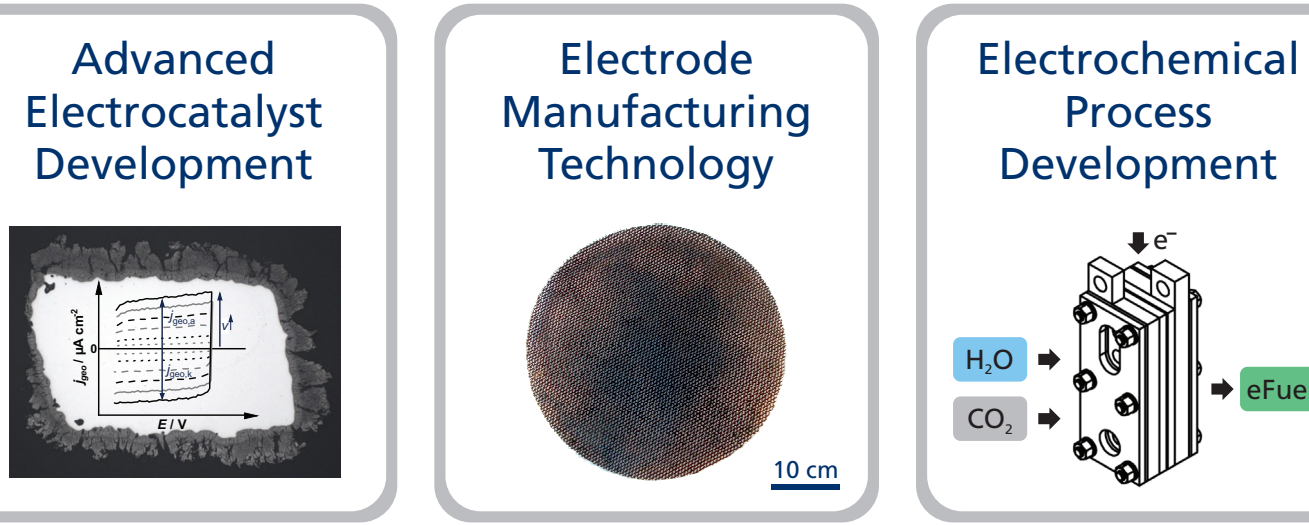


Fig. 1: Schematic description of Fraunhofer IFAM's R&D offer to customers