Fraunhofer IGB

Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB

Electrochemical synthesis cell

Electrosynthesis of basic chemicals

Clean, resource-efficient and sustainable

Utilization of electric energy for the production of basic chemicals is gaining increasing economic relevance. The electrosynthesis of essential chemical products can solve two current challenges: First, the ongoing energy transition leads to a massive expansion of renewable energy and therefore to an increasing but fluctuating supply of electric energy, which requires new storage and utilization concepts. Second, many industrial processes depend on basic chemicals that are currently produced from fossil and mainly imported resources, entailing substantial costs and effort for purchasing, transport and storage.

To tackle these challenges, Fraunhofer IGB develops electrochemical processes for the decentralized on-site synthesis of basic chemicals. The focus lies on two processes: Production of hydrogen peroxide (H_2O_2) from water and air (oxygen) as well as electrochemical CO_2 conversion to carbon-based platform chemicals, such as formic acid (formate). Fraunhofer IGB has also extended this approach and combines the electrochemical production of formic acid with subsequent fermentative conversion of the generated C_1 intermediate (formic acid) into value-added chemicals, thus linking Power-to-X processes to industrial biotechnology.

The technical and scientific activities of Fraunhofer IGB range from the component development (gas diffusion electrodes, catalyst materials) and the process development to the design of electrochemical modules and demonstrators.

Electrochemical processes and applications

Synthesis of carbon-based platform chemicals from CO_2 and water

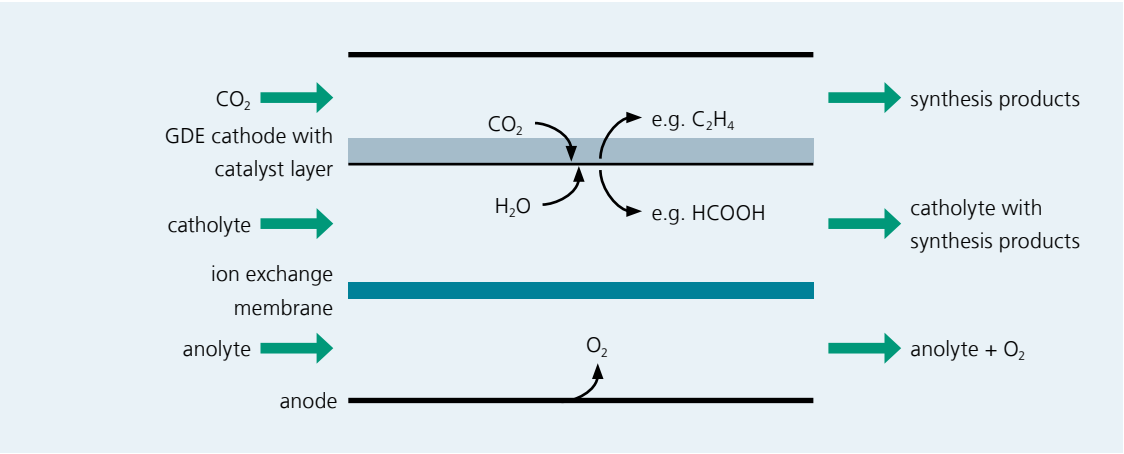
- Electrosynthesis of formic acid (formate)
- Production of high-value chemicals (e.g. bifunctional carbonic acids as polymer building blocks) via electro-/biocatalytic process cascades (e.g. electrosynthesis with subsequent C_1 fermentation)
- Electrosynthesis of ethylene
- Production of value-added chemicals (e.g. ethylene oxide) via combination of electrocatalytic processes and heterogenously catalytized processes

Decentralized production of hydrogen peroxide (H_2O_2) on demand

- Cathodic H_2O_2 production via reduction of oxygen (air) on gas diffusion electrodes
- Anodic H_2O_2 production via water oxidation on boron-doped diamond electrodes

Electrosynthesis of value-added chemicals from biogenic precursors from biomass processing

- Examples of relevant precursors: 5-HMF, lignin



Schematic representation of the electrosynthesis of platform chemicals from CO_2 and water. Products of CO_2 reduction at the cathode leave the electrolysis cell via the outgoing gas flow or the catholyte.

Our equipment

- Electrolytic flow cells with electrode areas between 10 cm^2 and 130 cm^2
- Two mobile, automated demonstrator units for continuous operation
- Chemical/physical laboratories and technical centers
- Electrode characterization methods (REM, XRD, FTIR, etc.)
- Chemical analytics (GC, HPLC, NMR)
- SolidWorks® CAD software for the construction of modules and demonstrator units
- COMSOL Multiphysics® simulation software for process modelling

Automated, mobile demonstrator unit

Our service offers

- Conceptual development, analysis and characterization of electrochemical synthesis processes
- Development and optimization of electrocatalysts, electrodes, and electrolytic cells for a wide range of applications
- Customer- and application-specific development of processes, technologies and prototypes
- Modelling and simulation
- Scale-up, design of processes and systems
- Ecologic and economic evaluation

Reference projects

- Fraunhofer Lighthouse Project "ShaPID – Shaping the Future of Green Chemistry by Process Intensification and Digitalization" *www.igb.fraunhofer.de/en/shapid*
- Fraunhofer Lighthouse Project "Electricity as a Raw Material" *www.igb.fraunhofer.de/electricity-as-a-raw-material*
- CELBICON – Cost-effective CO_2 conversion into chemicals via combination of Capture, ELectrochemical and BIochemical CONversion technologies, EU Horizon 2020, Grant agreement n° 679050 *www.igb.fraunhofer.de/en/celbicon*
- CO_2EXIDE – CO_2-based Electrosynthesis of Ethylene Oxide, EU Horizon 2020, Grant agreement n° 768789 *www.igb.fraunhofer.de/en/co2exide*

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Further information

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electrosynthesis