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 (H₂O₂) from water and air (oxygen) as well as electrochemical CO₂ 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 C₁ 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 CO₂ and water**
- Electrosynthesis of formic acid (formate)
- Production of high-value chemicals (e.g. bifunctional carboxylic acids as polymer building blocks) via electro-/biocatalytic process cascades (e.g. electrosynthesis with subsequent C₁ fermentation)
- Electrosynthesis of ethylene
- Production of value-added chemicals (e.g. ethylene oxide) via combination of electrocatalytic processes and heterogeneously catalyzed processes

**Decentralized production of hydrogen peroxide (H₂O₂) on demand**
- Cathodic H₂O₂ production via reduction of oxygen (air) on gas diffusion electrodes
- Anodic H₂O₂ 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
**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 modeling

**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”
- Fraunhofer Lighthouse Project “Electricity as a Raw Material”
  [www.igb.fraunhofer.de/electricity-as-a-raw-material](http://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
- CO$_2$EXIDE – CO$_2$-based Electrosynthesis of Ethylene Oxide, EU Horizon 2020, Grant agreement n° 768789

**Contact**

Dr. Arne Roth
Phone +49 9421 9380-1030
arine.roth@igb.fraunhofer.de

Dr.-Ing. Carsten Pietzka
Phone +49 711 970-4115
carsten.pietzka@igb.fraunhofer.de

[www.igb.fraunhofer.de](http://www.igb.fraunhofer.de)

**Further information**

[www.igb.fraunhofer.de/electrosynthesis](http://www.igb.fraunhofer.de/electrosynthesis)