Using electric energy for the production of chemicals is becoming of increasing strategic importance since it addresses two current challenges: First, the trend towards renewable energy sources leads to fluctuations in the availability of electrical energy with periods of excess current and insufficient concepts for storage. Second, many industrial processes require base chemicals, which leads to high efforts and costs for purchase and storage. Further, carbon-based chemicals like ethylene are up to now mainly synthesized from imported fossil resources. To tackle these challenges, Fraunhofer IGB develops electrolytic processes which enable the local on-demand production of base chemicals from water, CO₂ waste streams, or oxygen from air. Core component of the technology is an electrolytic cell with integrated gas diffusion electrode (GDE). At the GDE, oxygen or CO₂ is electrochemically reduced to the desired product. The cell enables also the combination of the typically cathodic electrosynthesis process with anodic reactions, e.g. process water treatment by advanced oxidation processes (AOP).

Apart from the scalable electrolytic cells with currently approx. 130 cm² electrode area, Fraunhofer IGB has developed and built a demonstration unit with fully automatic process control. The unit enables the transfer of results from laboratory scale into a first industry-relevant scale with reliable results on flow-through mode operation and scale-up.
Performance characteristics

- The electrolytic synthesis processes require only electrical energy, water, and pressurized air or CO₂.
- Local on-demand production of the required chemicals: No need for transport or storage.
- Intermittent production enables the use of renewable energy sources and excess current.
- Valorization of exhaust gases, especially CO₂.

Electrolytic cells:
- Electrode area (GDE) currently approx. 130 cm²
- Scalable by electrode area and stacking
- Acid and base resistant: pH 1 – 14
- Gas volume flows up to 300 L/h
- Fluid volume flows up to 100 L/h
- Possible inlet pressure up to 3 bar
- Inlet temperature up to 60°C
- Option for flow-through and semibatch operation

Demonstrator unit:
- Fully automated process control
- Flexible mobile system
- Option for integrated pH control
- Controlled extraction and analysis of products generated in gas and fluid compartment

Application areas

- Synthesis of carbon-based base chemicals from CO₂ and water (e.g. ethylene, formic acid)
- Production of H₂O₂ from air oxygen and water
- Combination with process water treatment (e.g. electro-oxidation for COD removal)

Our equipment

- Electrolytic cells with approx. 130 cm² electrode area
- Mobile, flexible demonstrator unit with fully automatic process control
- Chemical and technical laboratories
- In-house analytical laboratory
- SOLIDWORKS® CAD software for construction of cells and complete units
- COMSOL Multiphysics® simulation software for process modelling

Our service offers

- Conception and development
- Electrolytic cells for a wide range of applications
- Material flow management
- Analytics and characterization
- Customer- and application-specific solutions (process, technology, system)
- Simulation and modelling
- Process analysis and optimization
- Process-, technology- and prototype development
- Design from small up to industrial scale

Reference projects

- Fraunhofer lighthouse project »Electricity as a Raw Material«
  Further information: www.igb.fraunhofer.de/electricity-as-a-raw-material
- CELBICON – Cost-effective CO₂ conversion into chemicals via combination of Capture, ELectrochemical and Biochemical CONversion technologies,
  EU (grant agreement no. 679050)
  Further information: www.igb.fraunhofer.de/en/celbicon