Karlsruher Institut für Technologie

Division III – Mechanical and Electrical Engineering

Division I – Biology, Chemistry, and Process Engineering

Institute for Applied Materials – Electrochemical Technologies (IAM-ET)

Institute of Organic Chemistry (IOC)

Max Planck Institute for Chemical Energy Conversion (MPI-CEC)

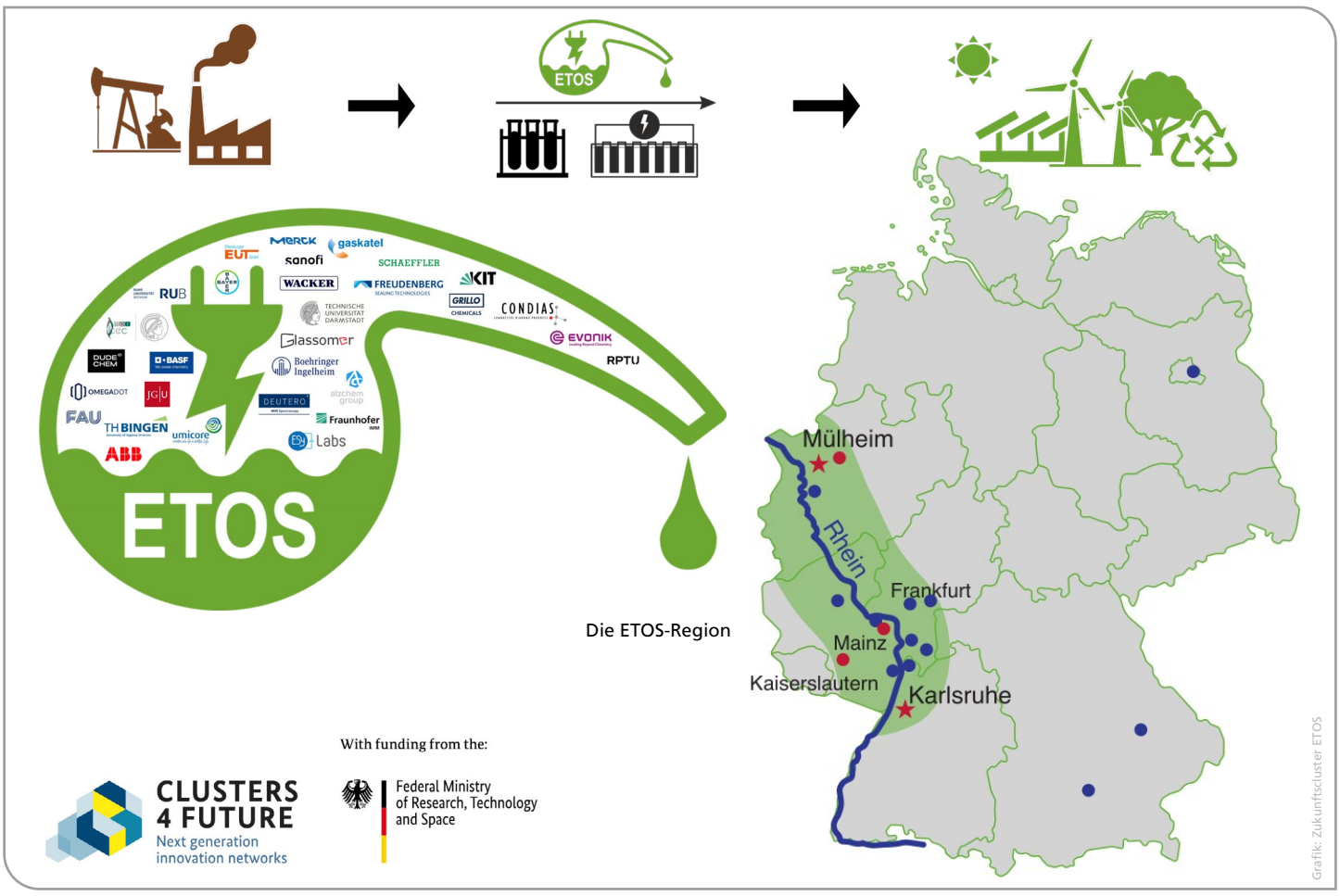
Open Flow Electrolysis Cell

Using Electrical Energy for the Sustainable Production of Chemicals

Universities, research institutions, and companies have established the ETOS innovation network to work on new processes making chemical production more sustainable. The focus lies on the power-to-chemicals concept, i.e., on using electrical energy, ideally from renewable sources, to produce chemicals. This will enhance the cost efficiency, safety, and ecological compatibility of chemical production processes. The open flow electrolysis cell exemplifies electrochemical synthesis processes under flow conditions. A reaction solution continuously flows through the cell and passes two electrodes. The electrical power applied there triggers the desired chemical reaction. Flow reactors ensure continuous, scalable production and, hence, are of particular interest for the transfer of electrochemical processes from the lab to industrial applications.

Fine Chemicals – Invisible, but Omnipresent

Fine chemicals are omnipresent. The are used as dyes, fragrances, medicinal product constituents, or food additives and contained in many products used in our everyday life. Most fine chemicals are being produced by classical chemical synthesis methods. Often, these methods require toxic and costly reactants, fossil raw materials, and energy-consuming reactions. Hence, they are associated with a high energy consumption, CO_2 emissions, and partly problematic by-products.



Die ETOS-Region

The ETOS innovation network with the research institutions and companies involved.

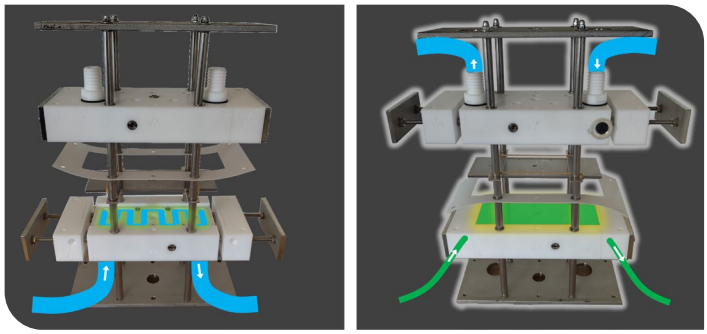
Electro-organic Synthesis – Power as a Chemical Reactant (Power-to-Chemicals)

Electro-organic synthesis is a promising approach to solving several of the problems mentioned above. Electrical power is used directly for the chemical reactions, classical chemical reagents can be significantly reduced.

This method offers a number of advantages:

- Electrical energy is used directly for chemical reactions
- Significantly reduced need for toxic chemicals
- Less by-products and waste
- Milder and safer reaction conditions
- Use of renewable energies in times of high availability or low costs
- Reduced production costs

As a result, cost efficiency, safety, and environmental compatibility of chemical production processes are enhanced.



Open flow electrolysis cell with cooling channel (colored blue, left) and flow path of the reaction solution (colored green, right).

Open Flow Electrolysis Cell

Today, innovative reactor concepts and modern electrode materials allow for electrochemical reactions that have been considered difficult to implement for a long time. These innovations open up new perspectives for electrification of the chemical industry.

The open flow electrolysis cell displayed here illustrates the functioning principle of electrochemical synthesis processes under flow conditions. The reaction solution continuously flows through the cell and passes two electrodes. The power applied there triggers the desired chemical reaction.

Flow reactors enable continuous and scalable production and, hence, are of particular interest for the transfer of electrochemical processes from the lab to industrial applications. Electrosynthesis is a key element for the energy transition and sustainable production of chemicals and opens up new pathways for the green transformation of the chemical industry.

ETOS Clusters4Future Initiative

ETOS (Electrifying Technical Organic Syntheses) is one of the Cluster4Future initiatives funded by the Federal Ministry of Research, Technology and Space (BMFTR). It forms a big innovation network of universities, research institutions, and chemical industry companies along the river Rhine from Freiburg to the Ruhr area. The network pools expertise from chemistry, process engineering, and engineering sciences to push the transformation of the chemical industry towards the use of more climate-friendly and resource-efficient processes and accelerate the transfer of research findings to industrial application.

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