The challenge:
High-efficiency, real-world fuel

The conversion of Europe’s energy system leads to a stronger dependency on the electric grid, as most renewable energy is harvested in electric form. This also fosters new demands for distributed power sources as back-up systems for the grid. These range from classic back-up power solutions to range extenders on board electric vehicles. For these types of applications bio-ethanol is a very suitable energy carrier as it offers low greenhouse gas emissions combined with the ease of handling and the high energy density of a liquid fuel. The challenge is to develop a converter which achieves high conversion efficiencies and allows for frequent start-stop cycling which is typical for this kind of application.

The solution:
Direct ethanol fuel cells

Fuel cells can achieve high conversion efficiencies. Fuel cells operating in the low temperature regime and directly converting the fuel can also achieve fast start-up times. The drawback is that the complete conversion of ethanol has not yet been achieved in acidic low proton exchange membrane (PEM) fuel cells.

In the project two alternative technologies were therefore evaluated: anion exchange membrane (AEM) based fuel cells and high temperature PEM based fuel cells. In both cases significant efforts were made to improve the materials used in these cells.
Achievements

- significant contribution to the scientific field with more than 30 papers and conference contributions
- manganese dioxide as noble metal free cathode catalyst for AEM direct alcohol fuel cells using fuels other than ethanol
- AEM materials ready for the further development of cost-efficient direct methanol or ethylene glycol fuel cells
- modified PBI membranes with high performance in HT-PEM based DAFCs
- RTIL-doped PFSA membranes with high performance in pressurised DAFC at 120 °C
- Pt alloy catalyst exhibiting high activity and CO₂ current efficiency for the ethanol oxidation at 160 °C
- new set-up to perform differential electrochemical mass spectrometry (DEMS) under HT-PEM conditions
- a demonstration unit with 15 cells is currently in preparation

Opportunities

Though it was found that the AEM-based technology is not suitable for ethanol it can be used for the high-performance conversion of other fuels like methanol or ethylene glycol. The materials developed within EUBECELL should allow more cost-efficient cells than are used in typical DMFCs today. We are therefore looking for partners for the stack and system development e.g. for back-up power solutions.

HT-PEMFCs have proven their potential as direct ethanol fuel cells. Here further research is needed both on the material and the system level. We are looking for partners for a joint research project to further advance this topic.

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