Institute of Technical Thermodynamics

Selected hydrogen production activities at the Institute of Technical Thermodynamics of DLR focused on the electrodes and stack design

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The Institute of Technical Thermodynamics started developing various kinds of electrolysers for a large range of applications approx. in 1985. The main topics are the development of stabilized electrodes for applications with drastical load changes and high durability as well as the understanding of mechanisms and degradation effects.

Unitized Regenerative Fuel Cells

Unitized regenerative fuel cells (URFC) in combination with photo-voltaic modules are attractive systems for space missions because they enable extended operation times and low weight. The URFC uses only one stack for both fuel cell and electrolysis mode.

Different strategies can be adopted:

- Use of single layered electrodes with a bifunctional catalyst (IrO_2+Pt) (option1)
- Use of separate electrodes for O_2 evolution (IrO_2) and consumption (Pt) (option 2)
- Use of a multi layered electrode with separate layers (option3)

The MEAs were prepared with DLR dry powder spraying method.

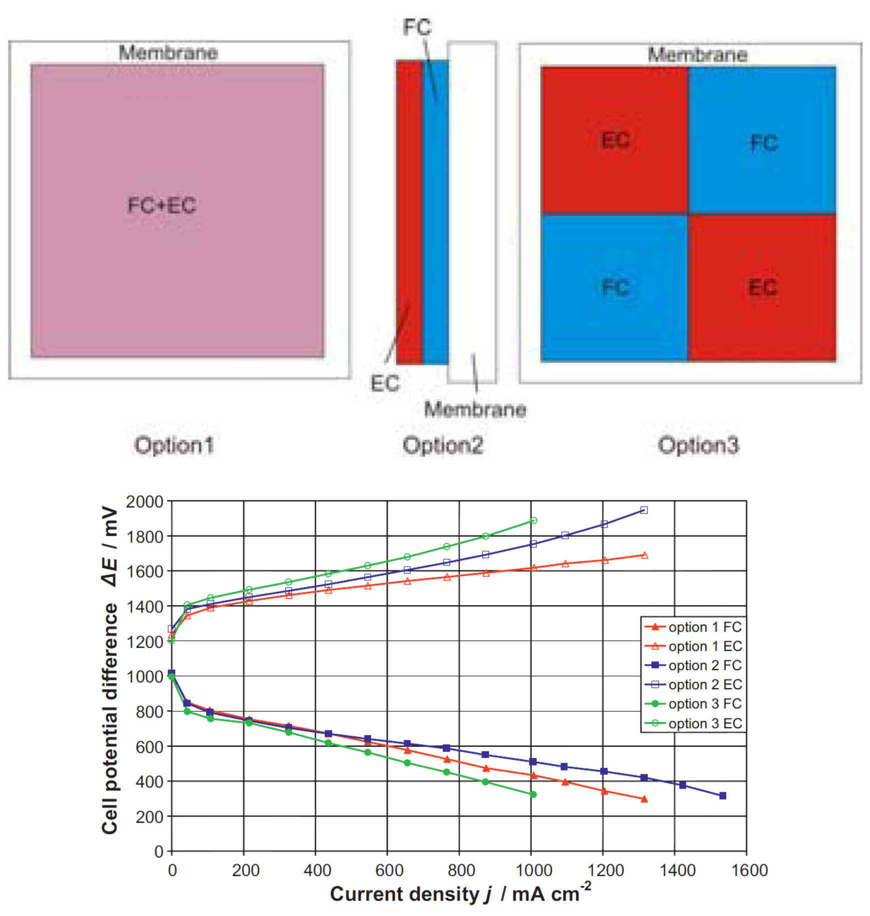

Fig 1: Fuel Cell (FC) and Electrolysis (EC) IV-curves of single cell URFC with different electrode options

25 cm², T_{cell}= 80°C for the fuel cell mode (hydrogen and pure oxygen) and T_{cell}= 90°C for the electrolysis mode providing water vapour, atmospheric pressure.

Electrode Development for Alkaline Water Electrolysis and Cell Tests

DLR has developed coatings for anodes and cathodes on the basis of Raney-nickel that are efficient, low-prized with long life. The coating is done by vacuum plasma spraying (VPS) on nickel sheets or nickel-plated steel sheets. Furthermore for these electrodes an excellent long-term stability during several years was demonstrated in intermittent operation using a solar power profile without potential control during off-times.

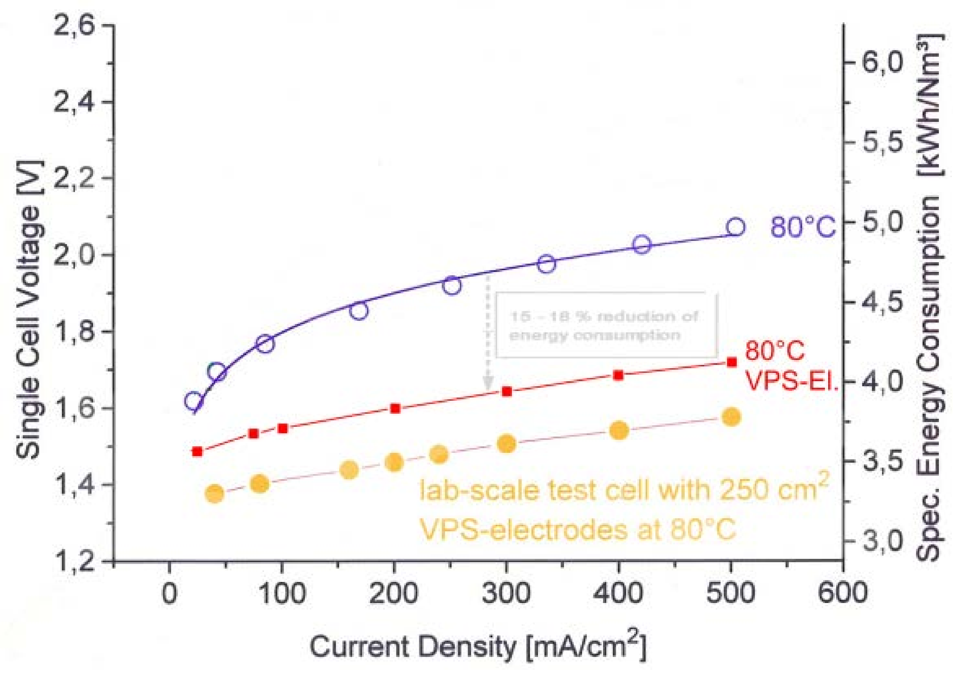

Fig 2: Coated compared to uncoated electrodes. For a coating with NiAlMo on the cathode and NiAl/Co_3O_4 on the anode a prominent reduction of the overpotentials was achieved. The electrodes have a surface of more than 30 000 cm²/cm² electrode area.

Electrolysis test stations are operated at DLR capable of testing half cells and single cells to short stacks up to 100 cm² cell area. By linking the results to ex situ analysis methods degradation processes are identified.

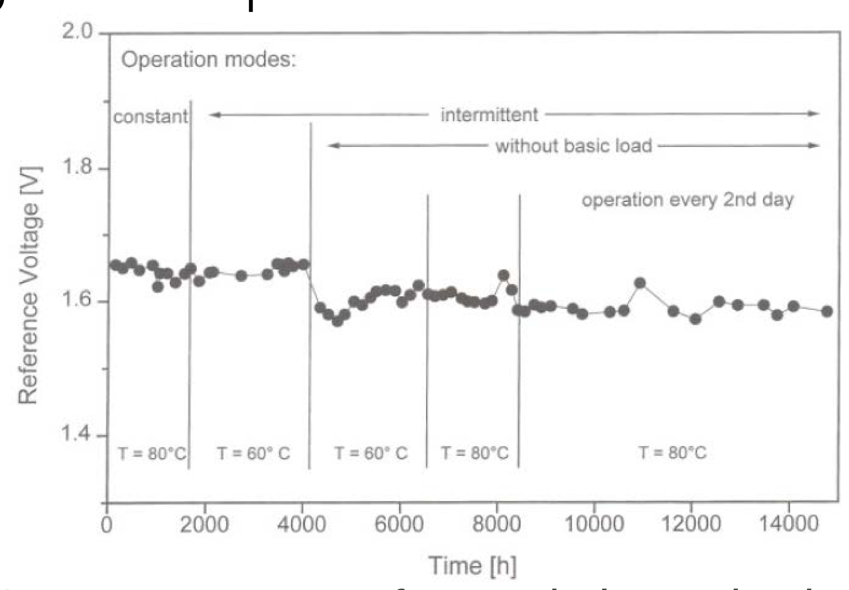

Fig 3: Long-term test of coated electrodes in 10kW electrolyser

FCH-JU-Project RESelyser

The project RESelyser, coordinated by DLR, develops high pressure, highly efficient, low cost alkaline water electrolysers that can be integrated with renewable energy power sources (RES) using an advanced membrane concept, highly efficient electrodes and a new cell design. A new separator membrane with internal electrolyte circulation and an adapted design of the cell to improve mass transfer, especially gas evacuation is investigated and demonstrated. Intermittent and varying load operation with RES will be addressed by improved electrode stability and a cell concept for increasing the gas purity of hydrogen and oxygen especially at low power and at high pressure operation. Also the system architecture will be optimized for intermittent operation of the electrolyser.

The RESelyser Project is supported by the European Union's Seventh Framework Programme (FP7/2007-2013) for the Fuel Cells and Hydrogen Joint Technology Initiative under grant agreement n° [278732]

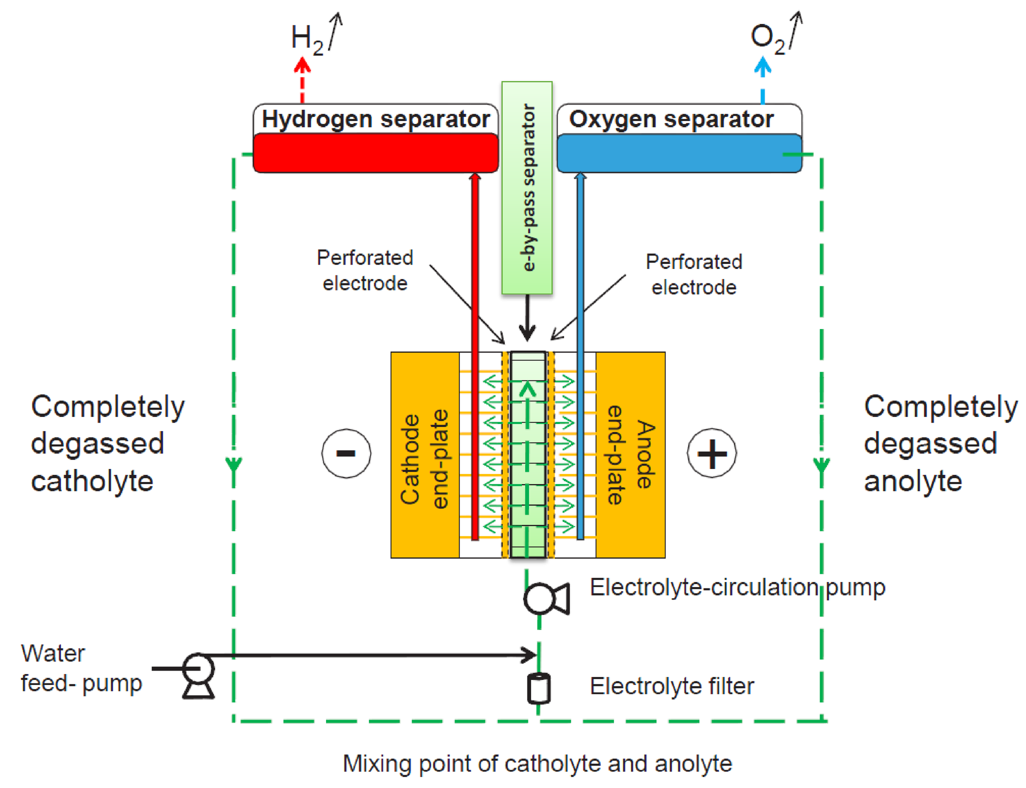

Fig 4: Set-up electrolyser with e-bypass separator and single electrolyte pump. A double layer diaphragm (E-bypass-separator) with internal KOH supply improves the gas purity and high current density performance of the cell.

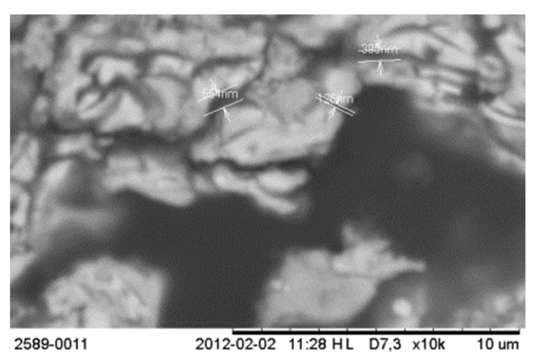

Fig 5: pore size analysis of new Plasma-sprayed Raney-Nickel electrode coating.

Project partners:

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