Fuel cells and hydrogen

Joint undertaking

RESelyser

Hydrogen from RES: pressurised alkaline electrolyser with high efficiency and wide operating range

New Energy World JU

fuel cells & hydrogen for sustainability

Programme Review Day 2012

Brussels, 28 & 29 November 2012

RES elyser

http://www.fch-ju.eu/

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RESelyser

Hydrogen from RES: pressurised alkaline electrolyser with high efficiency and wide operating range

Contract No. 278732

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http://www.reselyser.eu

General Overview

- “Hydrogen from RES: pressurised alkaline electrolyser with high efficiency and wide operating range”
- Duration Nov. 2011 – Oct. 2014
- Total budget: 2.89 Mio. €, FCH-JU contribution: 1.48 Mio. €
- Consortium:

  DLR Dt. Zentrum f. Luft- und Raumfahrt - Germany (coordinator)

  VITO Vlaamse Instelling voor Technilogisch Onderzoek N.V. – Belgium

  Hydrogenics Europe NV – Belgium

  DTU Danmark Techniske Umiversitet, Risoe Lab - Denmark

Project summary

The project develops **high pressure**, **low cost** alkaline water electrolysers that can be integrated with **renewable power sources** using

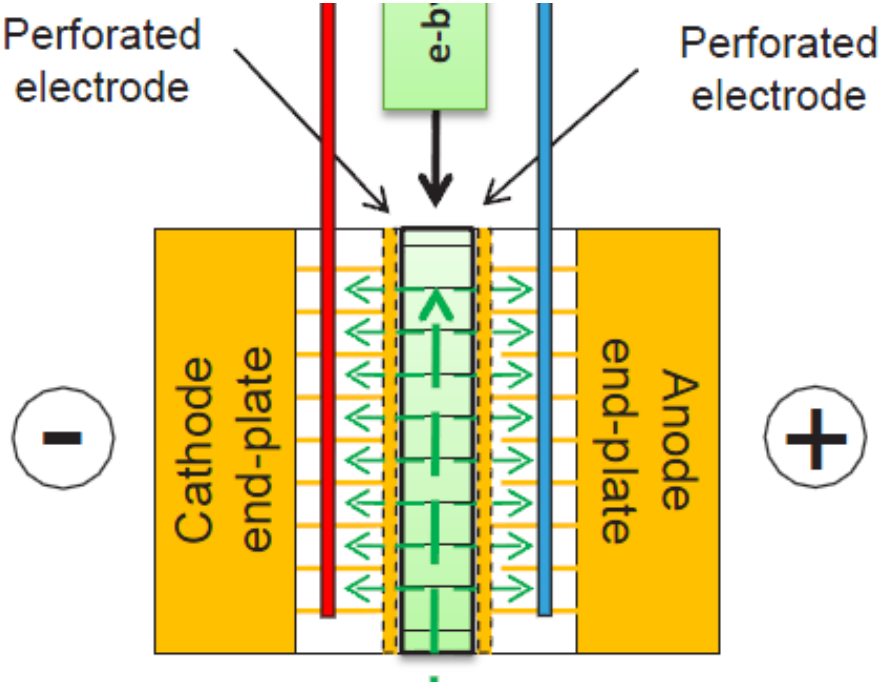
- an advanced membrane concept,
- highly efficient electrodes
- and a new cell concept

Alkaline water electrolysis – advantages and problems

- Well established technique up to large scale systems
- Cheap materials
- Gas purity problems at low load and high pressure
- Electrode stability when electrolyser off
- System adaptation to use with RES

New approaches to solve the problems

- double layer diaphragm with internal KOH supply ("E-bypass membrane") and adapted cell concept

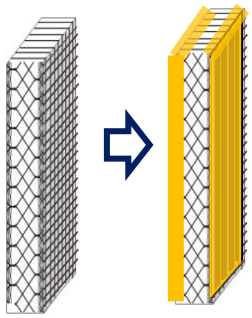


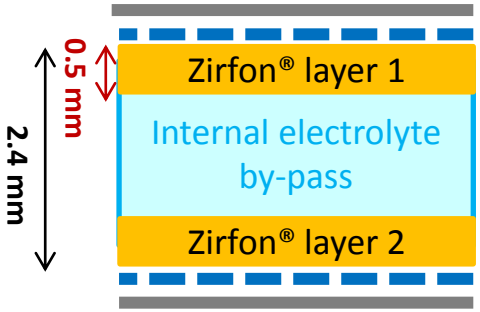
Developing a membrane diaphragm for a three-compartment alkaline cell with internal electrolyte supply

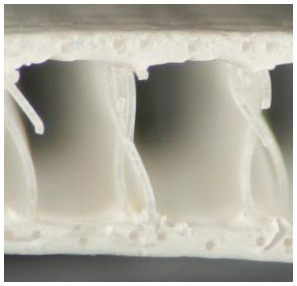
Goals: develop the "E-bypass separator" diaphragm with internal electrolyte bypass and properties for maximum benefit of the cell
develop technical scale fabrication methods

Results so far: First version: double side coated PP spacer-fabric, total thickness approx. 2.4mm:

- Zirfon®(ZrO2/polymer composite) dual layer, each layer ca. 0.5 mm.
- interposed free electrolyte channel, 1.4 mm.
- Diaphragm of 300 cm^2 delivered for first cell integration



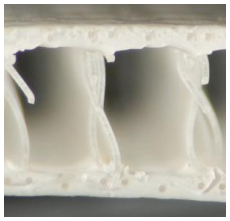




Results so far:

Diaphragm properties:

	Thickness (mm)	Resistivity @ 30°C (Ωcm)	P single layer (l/hm²bar)	Bubble point (bar)
E-by pass separator v1.1	2.1	2.8	200	6.02 (1.26)
E-by pass separator v1.2	2.1	2.4	1300	16.37 (3.41)
PP-spacer-fabric	1.5	1.9	na	na
Zirfon® PERL UTP	0.5	3.8		



Electrode development for low overpotential, long life-time and low costs

Goal: Using the VPS coating, electrodes are developed with low-cost materials that have a high efficiency/low overpotential and little degradation in intermittent operation

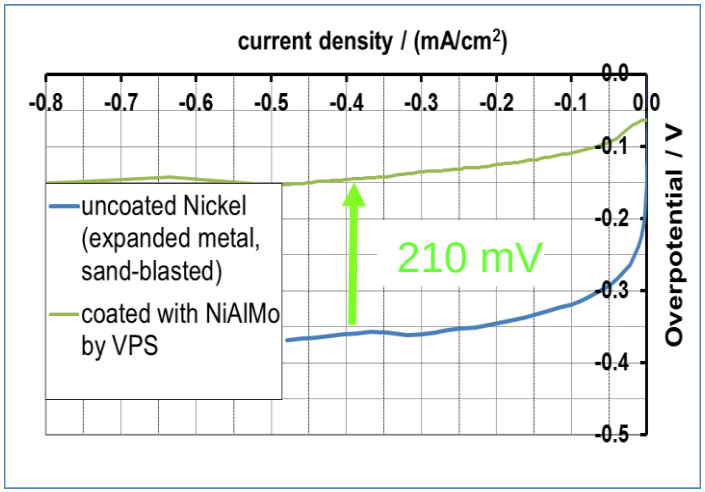
Results so far:

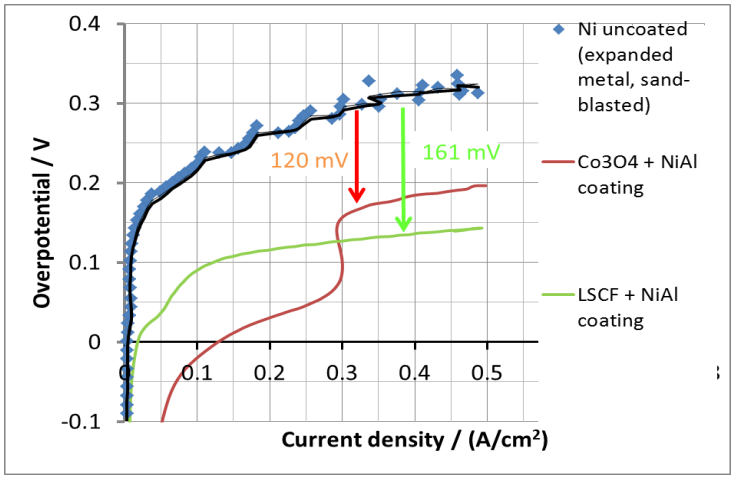
Overpotential reduction to uncoated Ni electrode:

Cathode 210 mV using NiAlMo

Anode 161 mV for coating LSCF + NiAl

120 mV for coating Co_3O_4 + NiAl



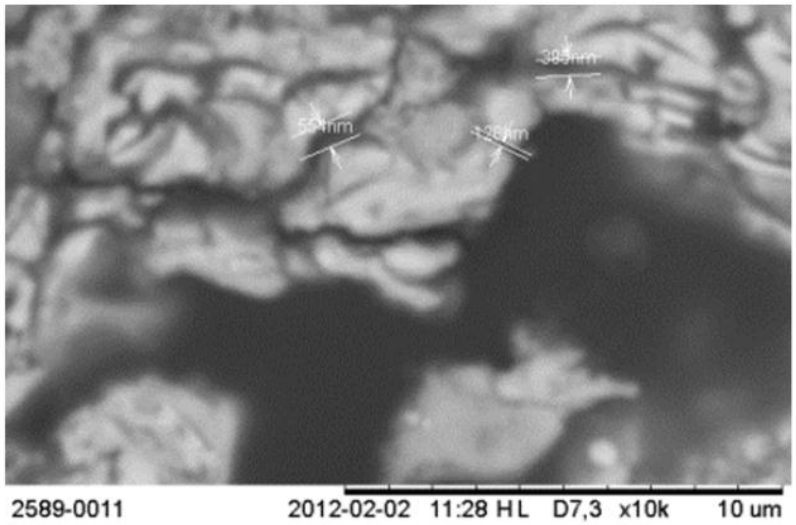


Half cell measurement 70°C in 35 % KOH, potentials IR-corrected

Characterisation of porosity of unused and used electrodes by 3D SEM reconstruction

Goal: understanding the mechanisms in electrode degradation due to evolution of the pore size distribution

Results so far: preliminary SEM characterisation of the porous electrode coating structure



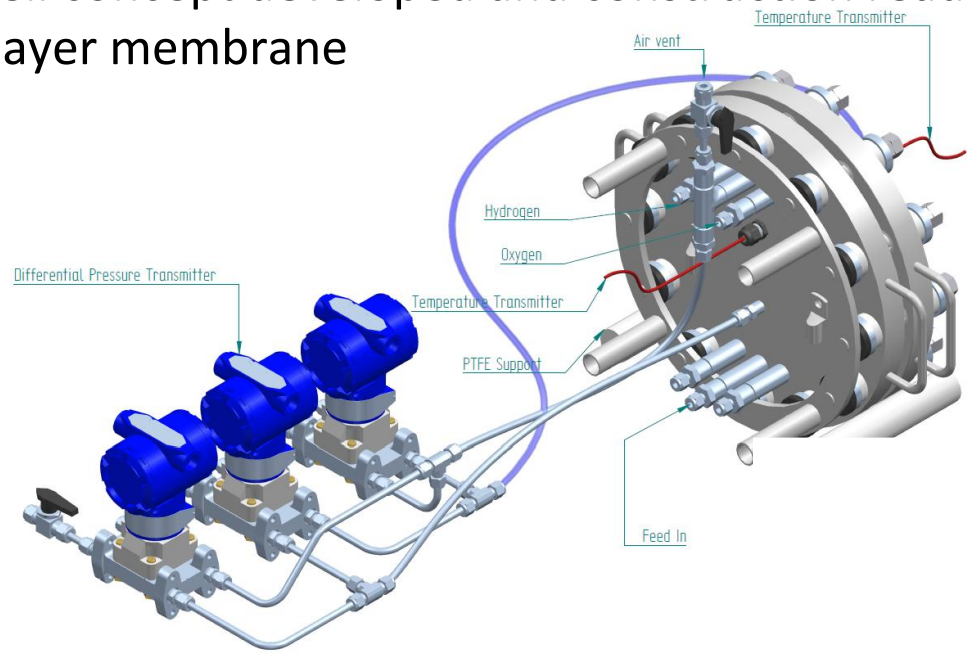
VPS-coated and activated

NiAlMo electrode

Single cell, 10 kW and 30 kW stack development, construction and test

Goal: realisation of electrolysers with the new concept up to technical size, up to 25 bar, concept development for 150 bar

Results so far: Cell concept developed and construction ready for single cell with double layer membrane



2. Alignment to MAIP/AIP

- 2010 AIP
- Application Area SP1-JTI-FCH.2: Hydrogen Production & Distribution
- Topic SP1-JTI-FCH.2010.2.1: Efficient alkaline electrolysers
- “Development activities on low cost, low temperature, high efficiency electrolysers based on alkaline technology, including prototyping and testing; demonstration of the application and production readiness.“ (description of SP1-JTI-FCH.2010.2.1 in AIP 2010)
- The project targets are in alignment with the numbers given in AIP 2010. The project is still at an early stage. Accomplishments of the targets is planned for later in the project. No revision of the targets necessary yet.

2. Alignment to MAIP/AIP

Expected output AIP Topic SP1-JTI-FCH.2010.2.1 Call: 2010		Objectives Project	Status at 31% of the project	Expected revised objectives
power level single stack	exceeding 5kW	30 kW	N/A (tests not started)	?
@ Current density 0.75 A/cm²	η>80% on HHV basis	eta>80% on HHV basis demonstrated with 300 cm² electrodes	N/A (tests not finalized)	?
electrolyser system operating at high pressure	15MPa = 150 bar with internal compression or 3MPa = 30 bar without additional compressing means	100-150 bar concept, 25 bar realisation	N/A (tests not finalized)	?
Retention of …% of initial efficiency over at least 1000 on/off switching cycles	>90%	> 90% demonstrated with 10kW electrolyser	N/A (tests not started)	?
Modular system cost	€1,000 per Nm^3/h plant capacity for the stack and 3.000 €/Nm^3 for a complete system	System costs 3.000 €/(Nm^3/h) plant capacity for the complete system	N/A (technique not finalised)	?

- Project results are presented at conferences, Hannover fair
- Paper publications and patents are planned

Technology Transfer / Collaborations:

- there is much activity establishing hydrogen production for storing renewable energy, for grid stabilisation and for “green” local hydrogen supply in Germany. DLR is involved in negotiations on future projects. The electrode coating technology is a major part of DLR activities there.
- Hydrogenics being one of the major supplyers of electrolysers in the world makes part of many electrolyser – RES application projects. New developments will be used for future electrolysers

Project Future Perspectives:

Proposed future research approach:

Next step: to realise the technique in a full scale technical electrolyser and demonstrate the connection to renewable energy sources

Further improvements of the electrolyser by establishing and using techniques for measurement in the electrolyser (e.g. current density distribution) and by theoretical simulations (eg. bubble formation and transport)

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Thank you for your attention!

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