Development and Characterisation of Solid Oxide Electrolyser Cells (SOEC)

Günter Schiller[1], Michael Hörlein[1], Frank Tietz[2]

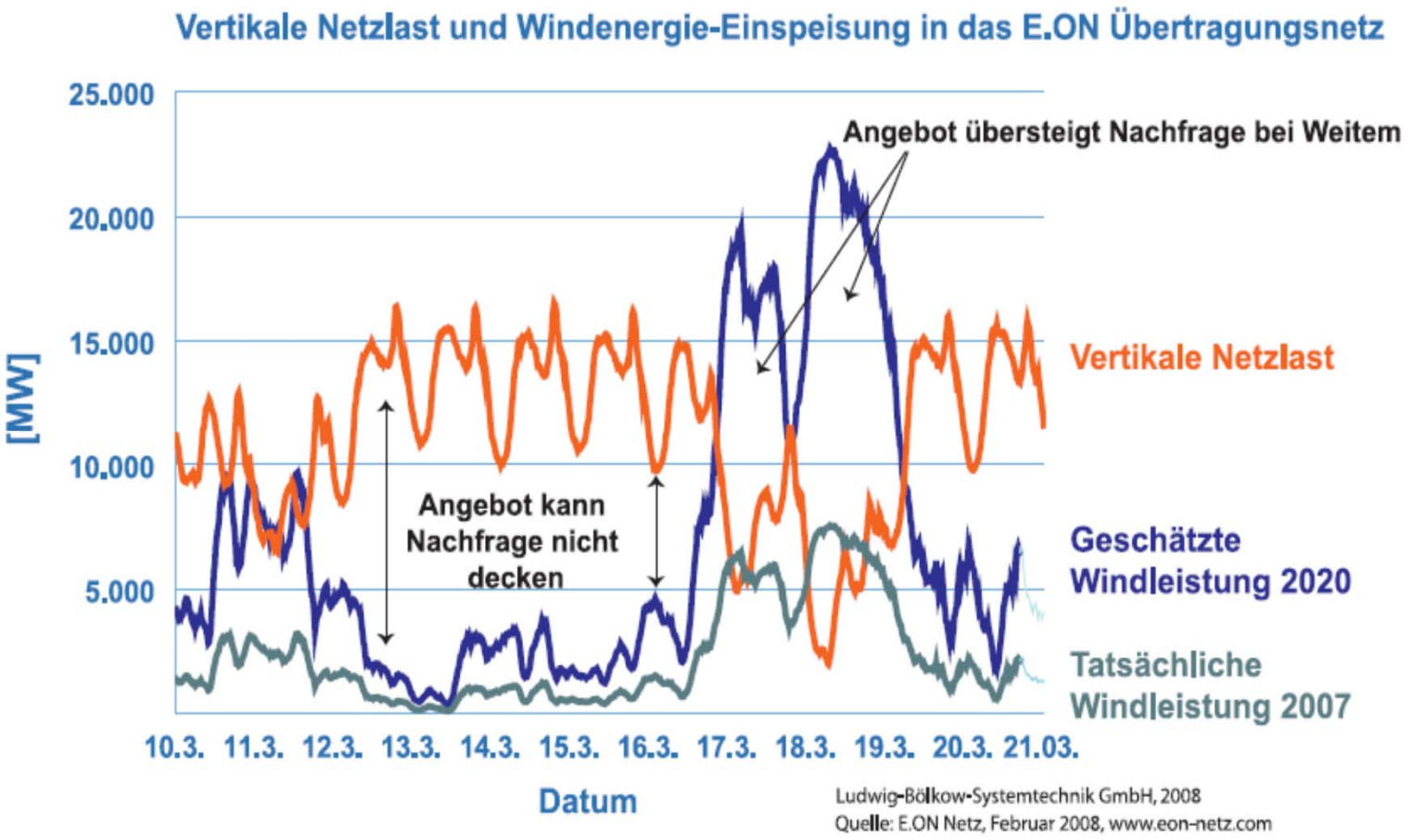
[1]Deutsches Zentrum für Luft- und Raumfahrt (DLR),
Institute of Technical Thermodynamics

[2]Forschungszentrum Jülich
Institute for Energy and Climate Research
Materials Synthesis and Processing (IEK-1)

Outline

- **Introduction**
- **Cell Manufacturing**
- **Electrochemical Characterisation**
- **Experimental Results**
- **Conclusion and Outlook**

Fluctuating Regenerative Current Production

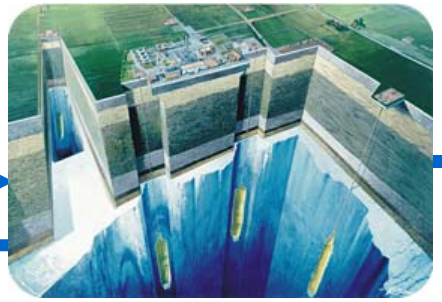


Hydrogen as Storage Option

Electricity

Hydrogen

or



Source: LBST

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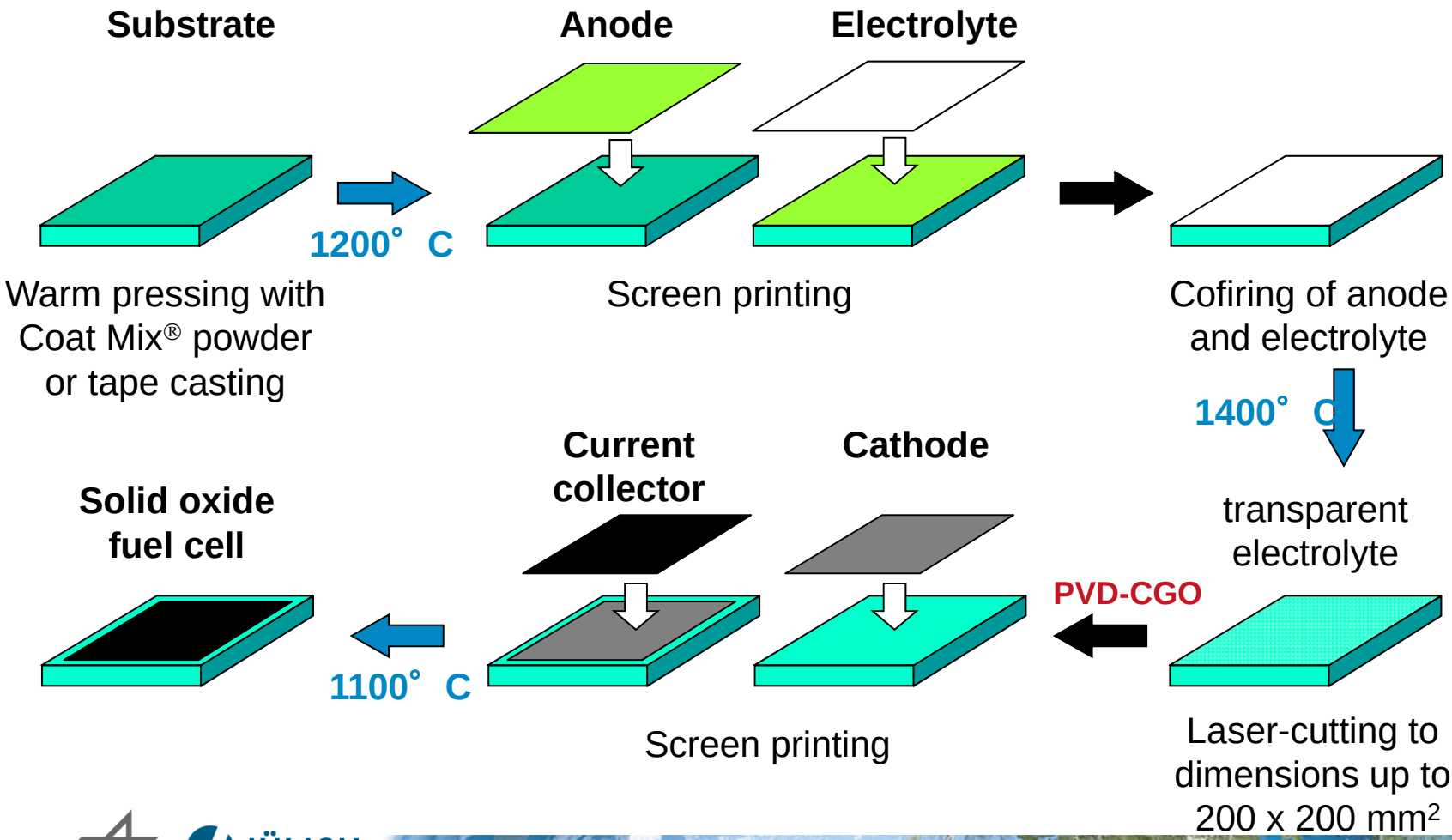
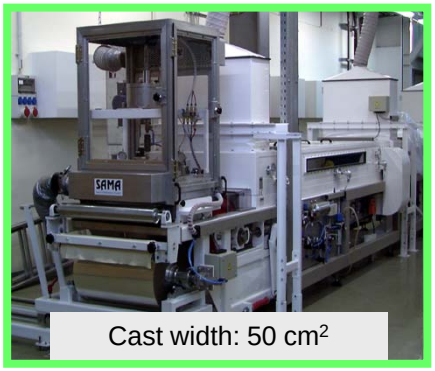
Manufacturing Steps of SOFC Anode-Supported Cells



Manufacturing Scheme of SOFC Anode-Supported Cells

Substrate manufacturing
Coat-Mix + warm pressing /
Tape casting

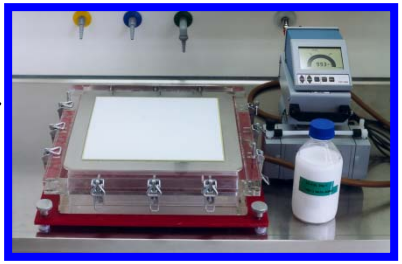
Pressed size: 33 x 33 cm^2



Cast width: 50 cm^2

Debindering +
Pre-sinterung

Anode + electrolyte
vacuum slip casting /
screen printing



Co-firing
1400° C

Cathode
screen printing /
wet powder spraying

Firing
1000-1200° C

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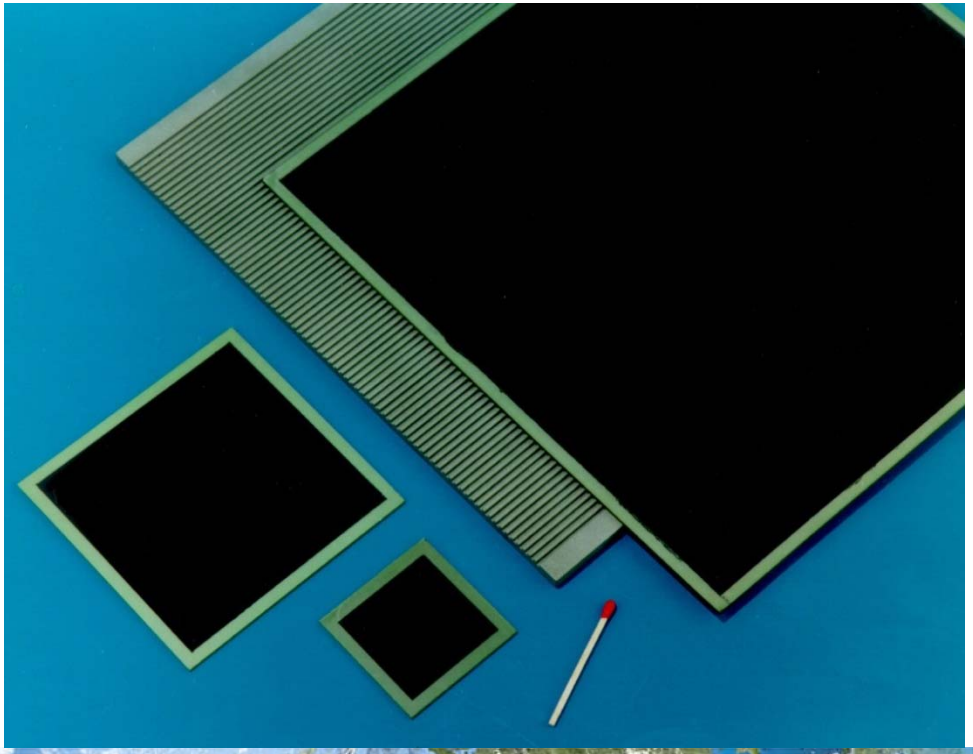
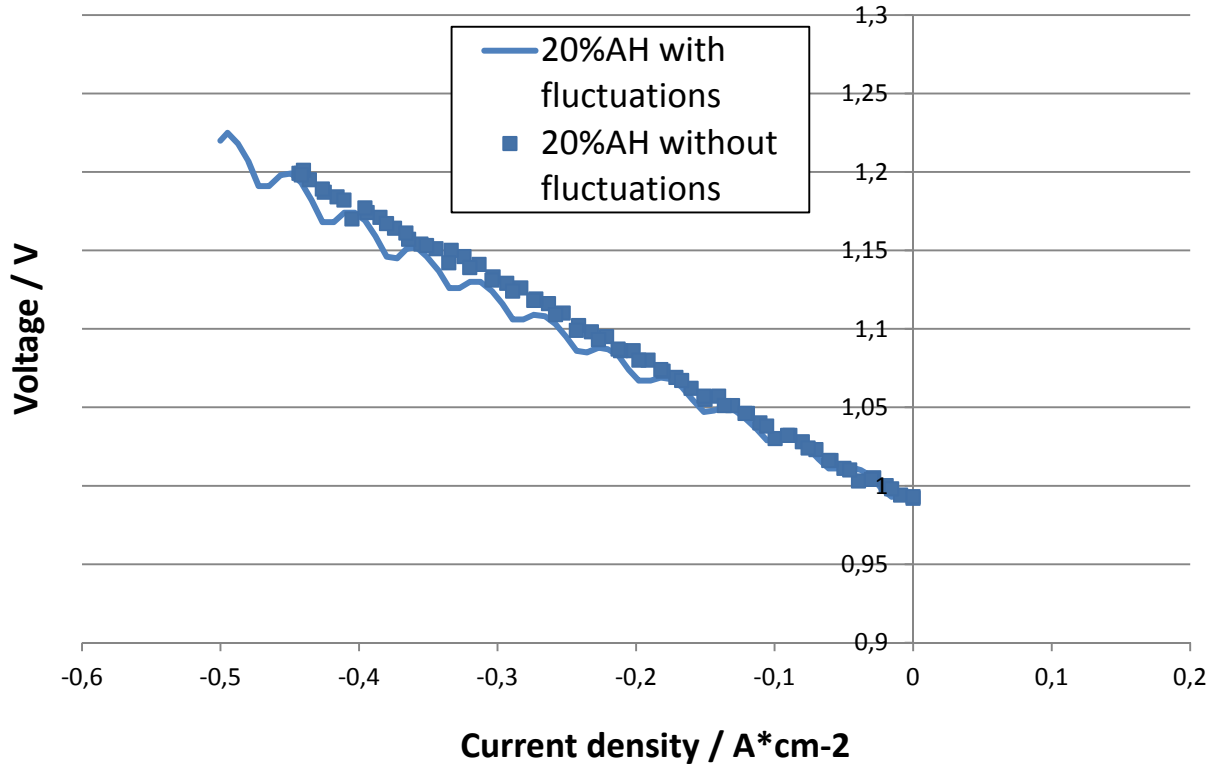
Solid Oxide Electrolyser Cells: Planar Design

	Materials
Anode:	$(La,Sr)(Fe,Co)O_3$
Diffusion barrier:	CGO – 1-5 µm
Electrolyte:	8YSZ – 5-10 µm
Cathode:	Ni/YSZ
Cathode Substrate:	Ni/YSZ



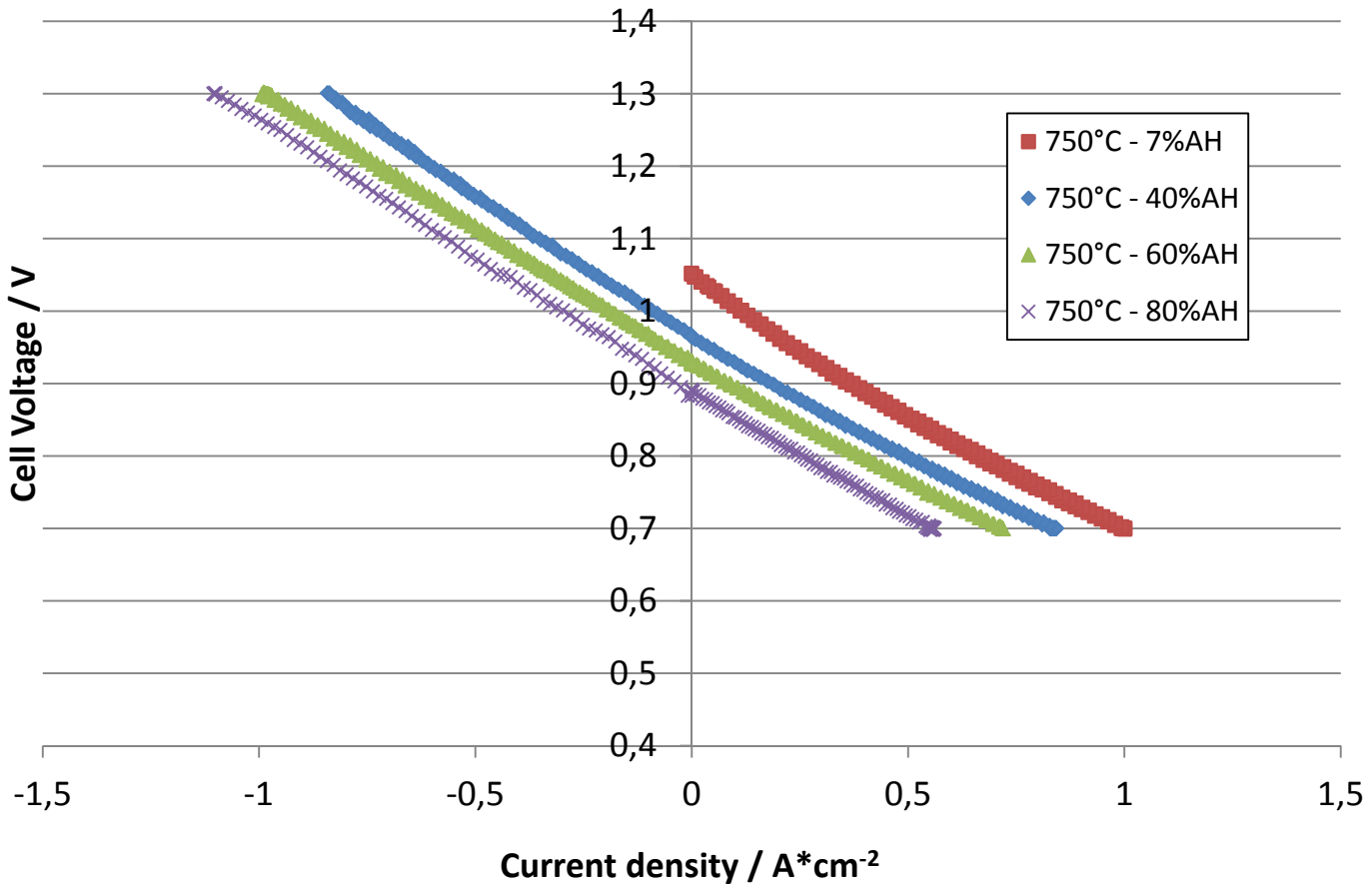
Evaporator for Steam Generation

Challenge:
Pulse-free steam generation



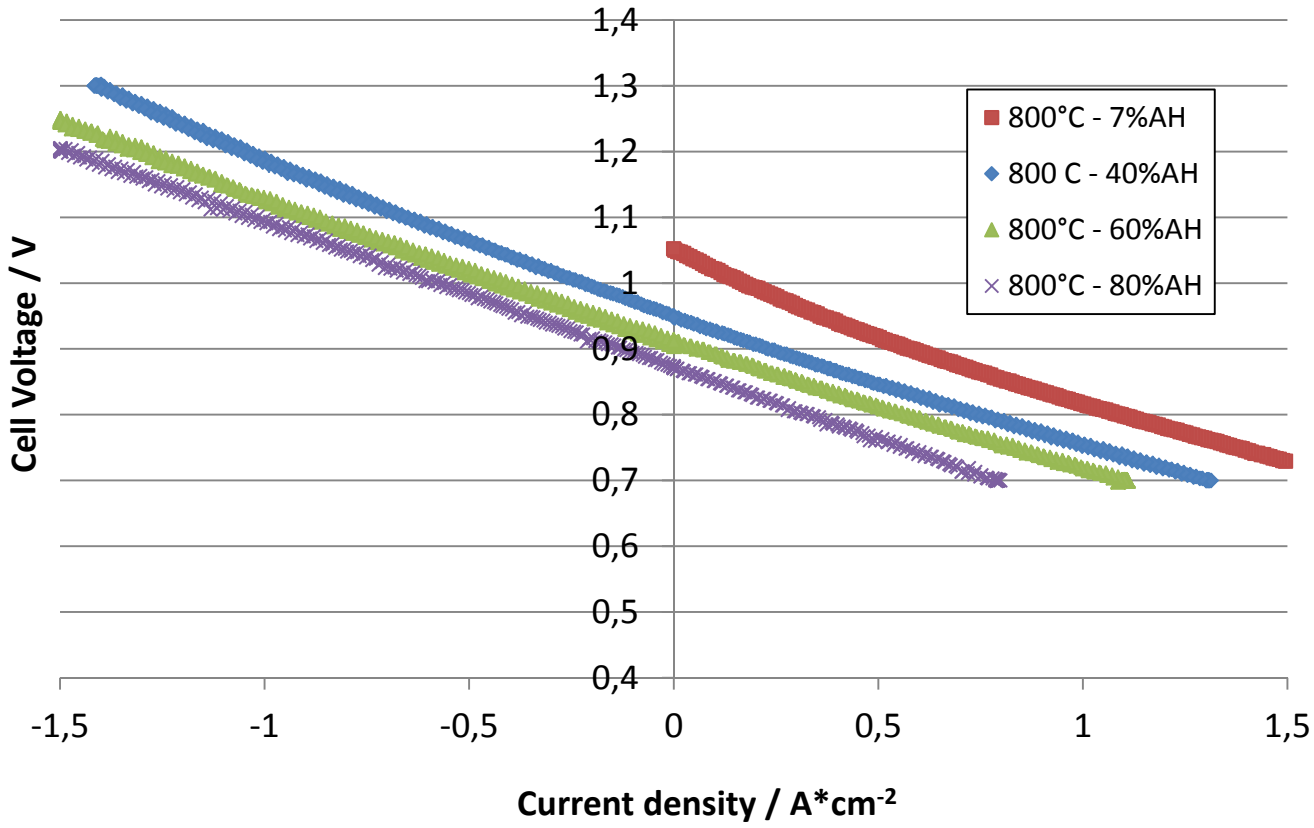
I-V Curves at 750 ° C as a Function of Steam Content

(Flow rates: 2 l/min H_2/H_2O, 3 l/min air)

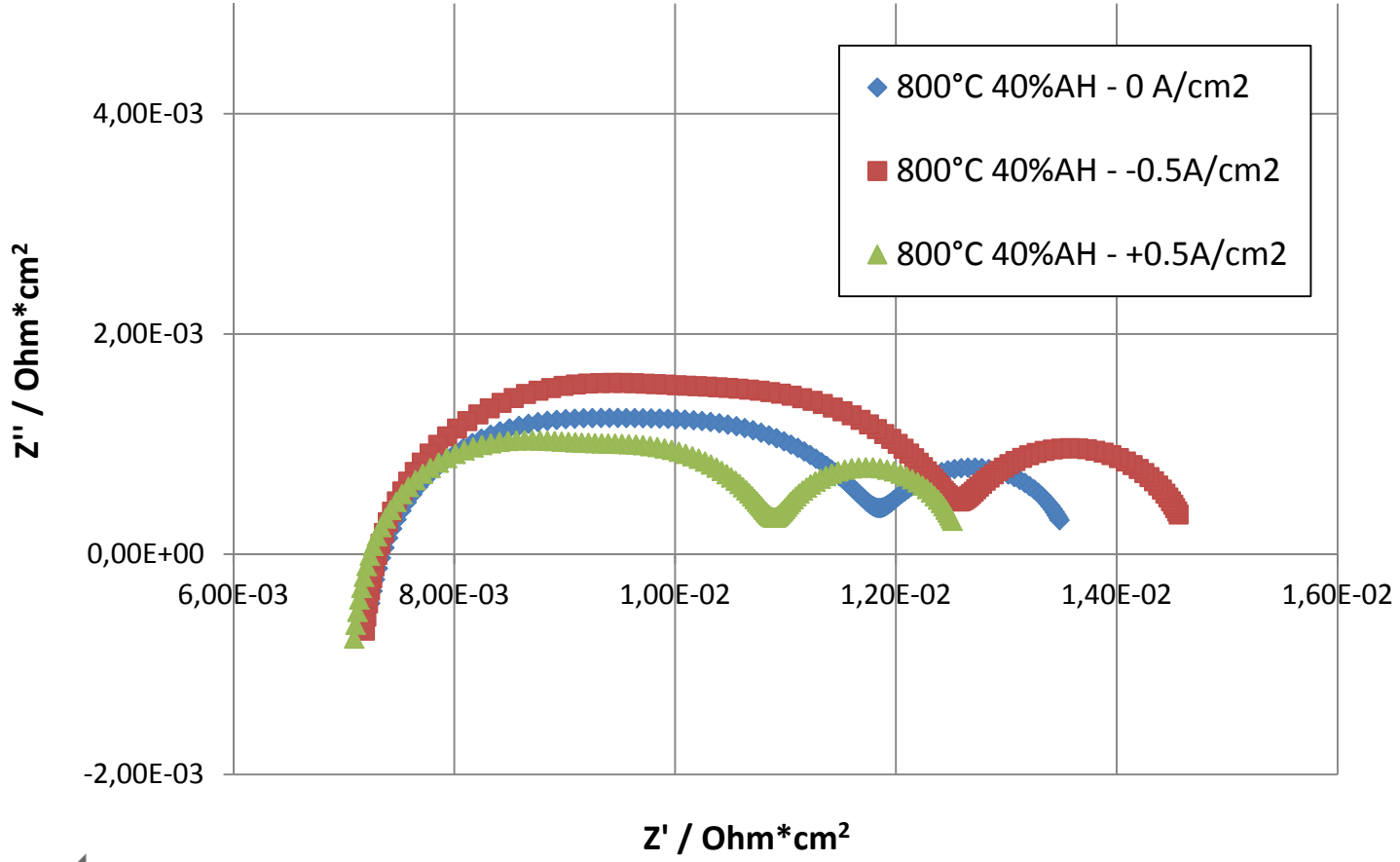


I-V Curves at 800 ° C as a Function of Steam Content

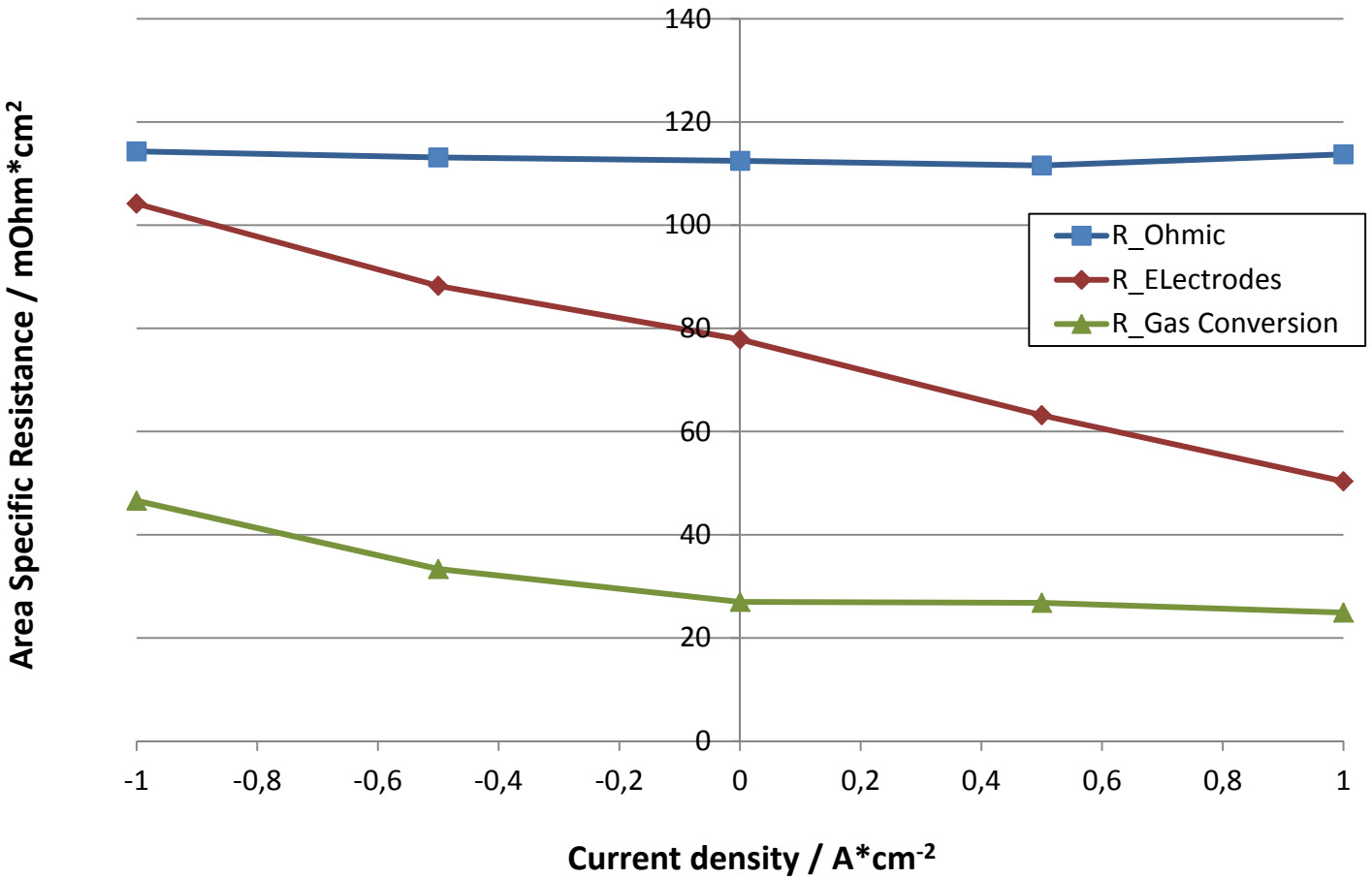
(Flow rates: 2 l/min H_2/H_2O, 3 l/min air)



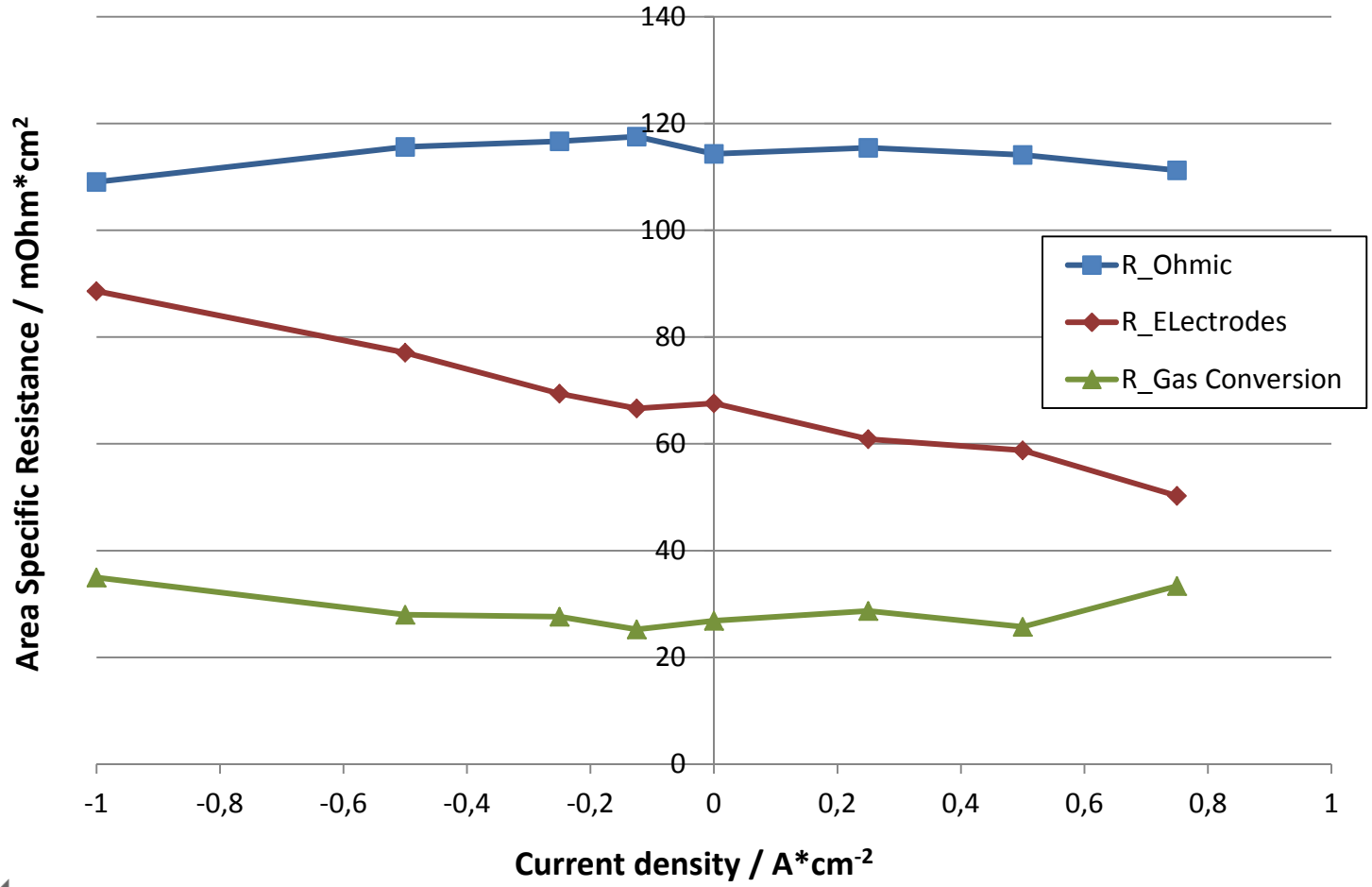
Impedance Spectra at 800 ° C and 40% Steam Content as a Function of Current Density



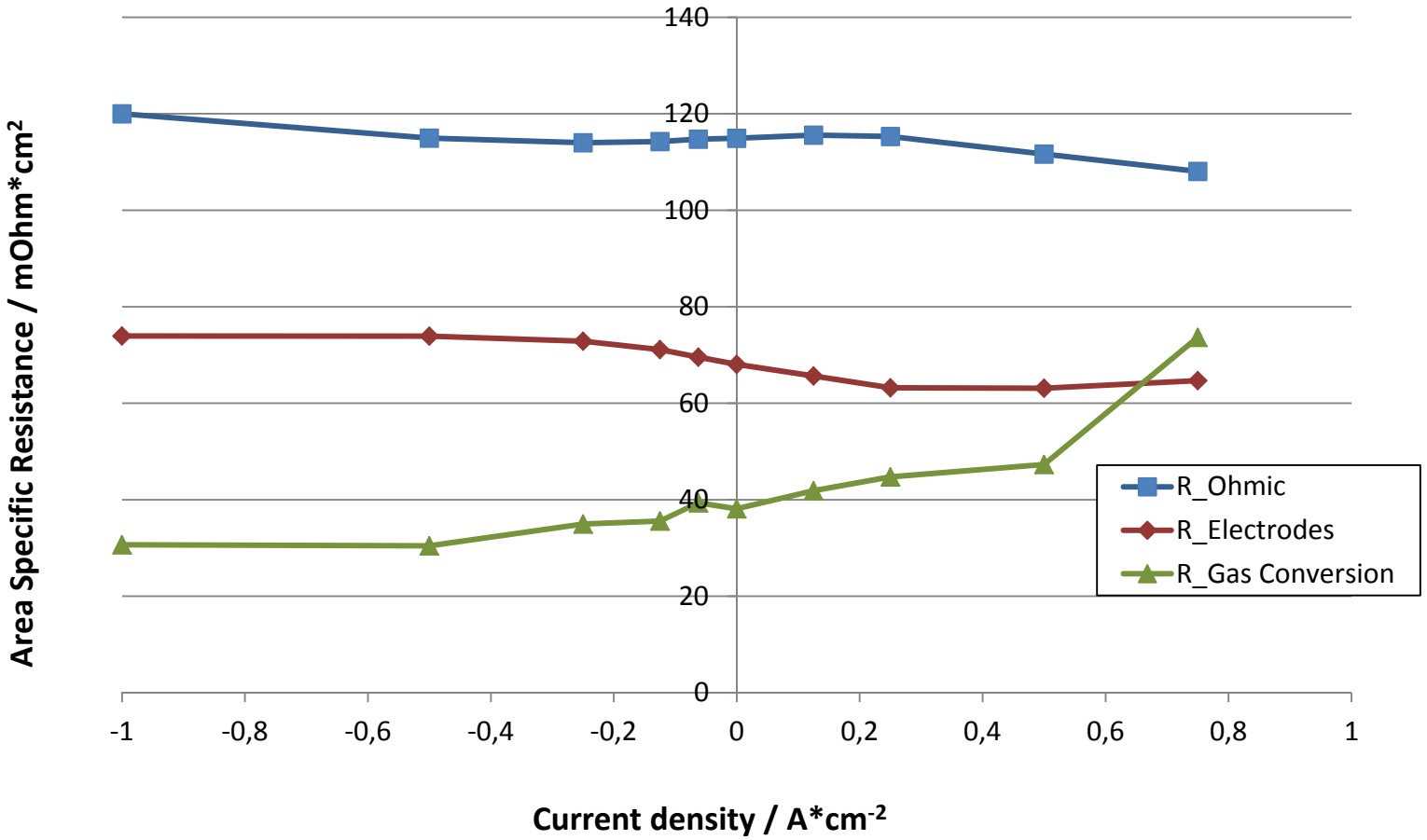
Impedance Data at 40% Steam Content in Dependence of Current Density



Impedance Data at 60% Steam Content in Dependence of Current Density



Impedance Data at 80% Steam Content in Dependence of Current Density



Conclusion and Outlook

- SOFC standard cells from Forschungszentrum Jülich have been characterised in electrolysis mode at 750 and 800 ° C in dependence of different steam contents.
- The cells show good performance; long-term tests and degradation studies have not yet been performed.
- Future activities will focus on improvement of performance by variation of stoichiometry of air electrode and on material variation of fuel electrode.
- Long-term measurements of > 1000 h at high current density (> 1 A/cm^2) and high humidification (> 60% AH) will be performed to identify degradation mechanisms and to develop mitigation strategies in order to obtain highly efficient and durable SOEC cells.

Acknowledgment

I‘d like to thank my PhD student Michael Hörlein for his scientific work and strong effort and Frank Tietz and his co-workers from Forschungs-zentrum Jülich for manufacturing and providing cathode-supported cells for electrolysis operation.

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