SCOTAS-SOFC
(256730)

Peter Holtappels
Technical University of Denmark
Department of Energy Conversion and Storage

Project Overview

General Overview

- Sulphur, Carbon, and re-Oxidation Tolerant Anodes and Anode Supports for Solid Oxide Fuel Cells
- Duration: Oct 1st 2010 - Sept 30th 2013, 36 month
- Budget
  - total budget: € 4368579.00
  - FCH contribution: € 1701770.00
  - DK TopUp Funding € 735215.05
- Partnership/consortium description
  - Danmarks Tekniske Universitet, DK
  - Forschungszentrum Jülich GmbH, D
  - Hexis AG, CH
  - Topsoe Fuel Cell A/S, DK
  - University of St Andrews, UK

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1. Project achievements (1/??)

Goals, Targets & Milestones

- To demonstrate a new full ceramic SOFC cell with superior robustness compared to Ni-cermet based anodes and anode supports
  - Improved tolerance to sulfur, carbon deposition, & re-oxidation
  - Materials based approach to simplify operation strategies, reduce costs
- Technical targets:
  - Up-scaling fabrication to full cells, area of 100-140 cm^2 for short stacks
    - Ceramic backbone with infiltratet electro catalysts
  - Cell tests under application relevant conditions
    - Sulfur content up to 100 ppm
    - S/H/O ratios corresponding to partly reformed hydrocarbons
    - 50-100 redox cycles with 100% re-oxidation
- Important milestones
    - Prototype cells (M11)
    - Performance improvement 0.25 → 0.5 W/cm^2 (M15-M33)
    - 1 kW system test & assessment (M33)

1. Project achievements (2/??)

Approach

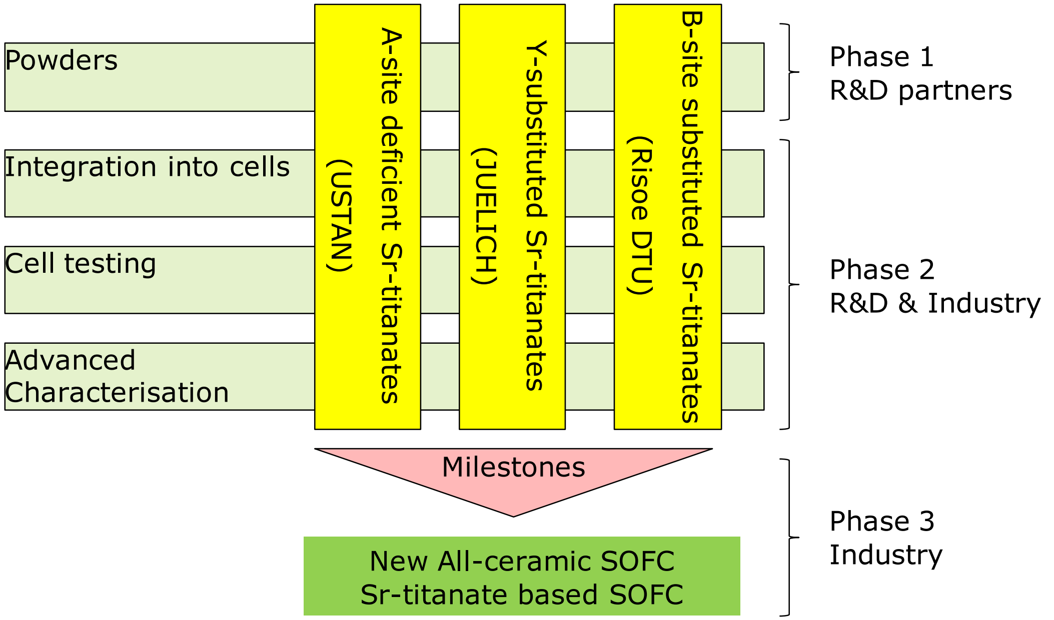
- The project is based on materials development in FP6 IP's Real-SOFC & SOFC600
- Small consortium with clearly focussed partners/ responsabilities

R&D Partners

provide materials and prototype cells

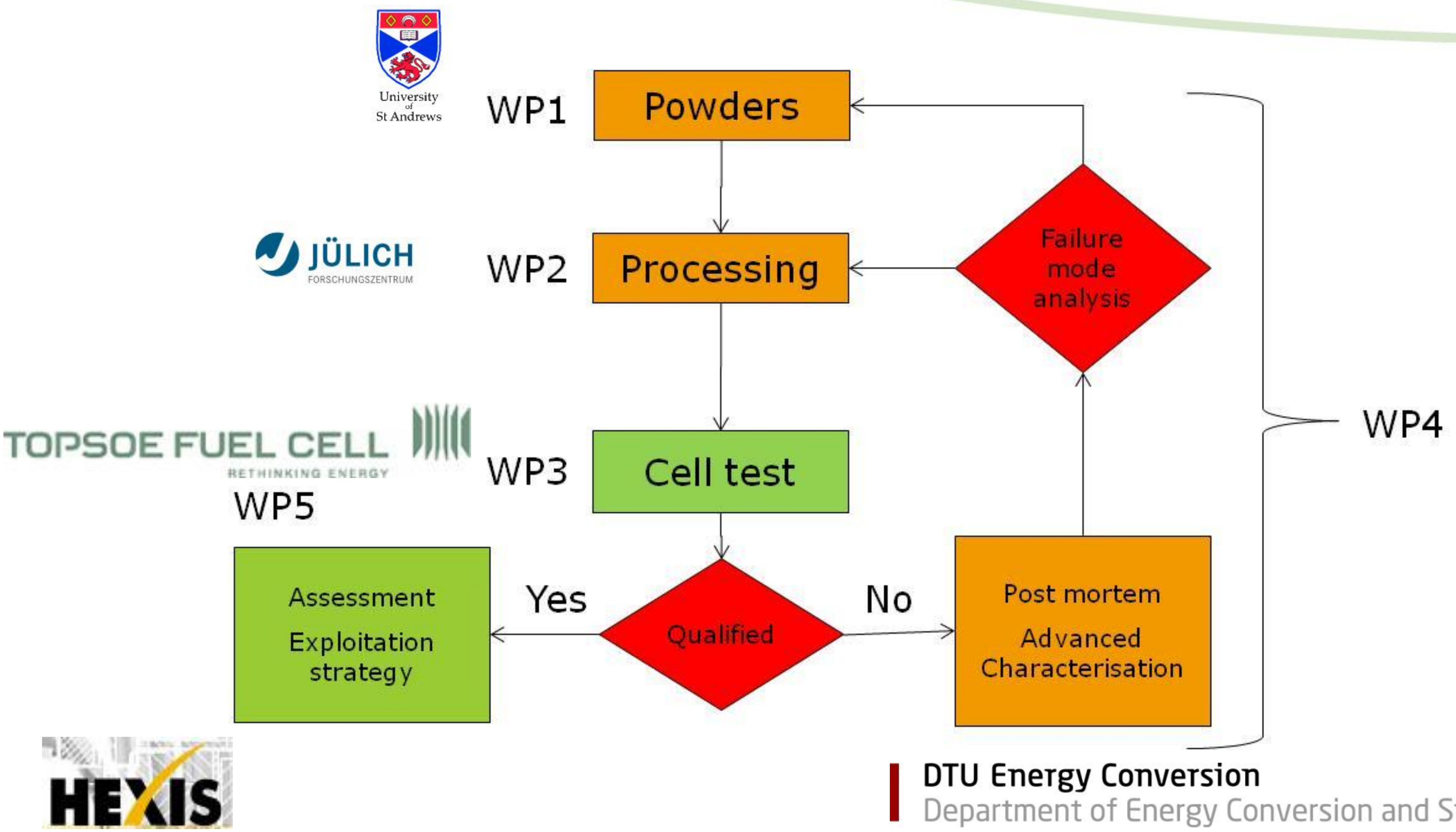
Industry Partners

test and evaluate the SOFC perform.



1. Project achievements (3/??)

Approach



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1. Project achievements (4/??)

Testing procedures

- **Non standardized** test procedures agreed by the partners
  - Deliverable 5.01: Report on application relevant testing conditions (M09)

	Target values	**Accepted values**
Temp. [°C]	ASR_{cell} [Ω*cm^2]	ASR_{cell} [Ω*cm^2]
900	0.27	0.45
850	0.38	0.65
800	0.51	0.85
750	0.63	1.05

- Testing schemes
  - Redox-cycles
  - Thermo-cycles, Thermo-redox-cycles
  - High Fuel utilisations
  - Sulphur tolerance
  - CO-conversion, Performance with CH4 (STR, CPOx)
  - coking tolerance
  - Long-term testing (>1000 h)

→For both electrolyte supported and anode supported cells

1. Project achievements (5/??)

Technical accomplishment and overall progress

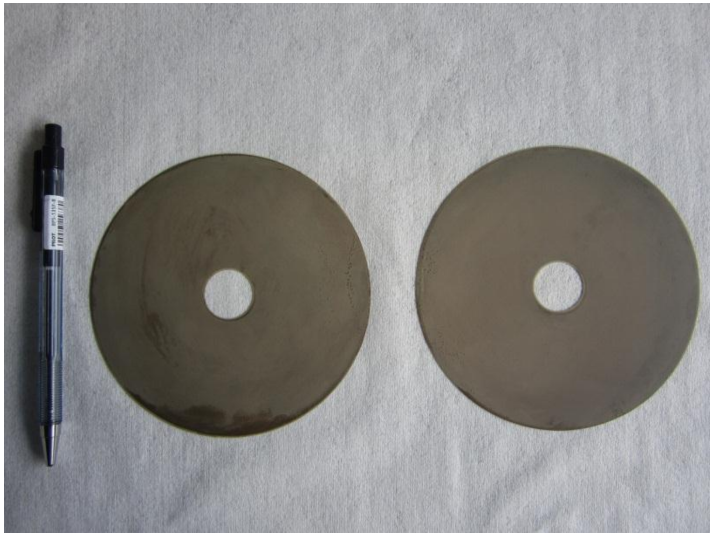
First 5 cell stack

La-Sr-Ca-Titanate based cells, Ni/ CGO – infiltration

Size: Ø 12 cm

Fabr. @ USTAN

Test @ Hexis



Initial Performance @900 C, July 2012

- Fuel inlet: approx. 51 W of natural gas (CPOx reformed)
- Power output: up to 20 W, equal to 200 mW/cm^2
- electrical efficiency: up to 38 %
- FU up to 79 %, not measured further
- ASR: 0.95 – 1.1 W cm^2

→Performance close to Hexis standard cells

1. Project achievements (6/??)

Technical accomplishment and overall progress

Y-Sr-Titanate based cells / Ni – infiltration

Size 5.3*5.3 cm^2

Fabr. @ JUELICH

Test @ Risoe DTU

Initial Performance

T : 850 C

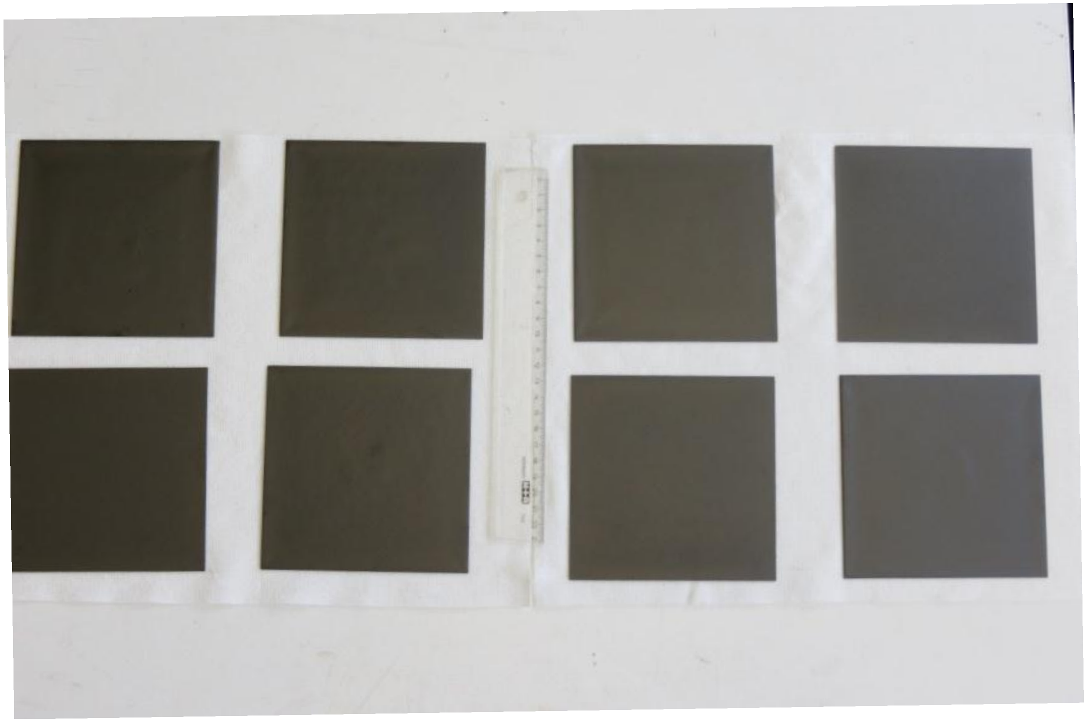
Fuel: 4% H_2O in H_2

Oxid.: air

Power output: 0.33 W/cm^2

@0.7 V (0.45 A/cm^2

ASR: 0.5-0.6 Wcm^2



ASCs 12*12 cm^2

1. Project achievements (6/??)

Technical accomplishment and overall progress

- General experience from cell and first stack test
  - Initial performance
    - Good starting performance ☺
    - Large voltage scattering between cells 😐
  - Redox cycling ☺
  - Durability ☹
  - Sulphur tolerance ☹

R&D focus: longterm exposure

- ceramic backbone
  conductivity & stability
- infiltrate
  electrocatalyst stability

Application Area

2. Alignment to MAIP/AIP (1/3)

- Application area: stationary fuel cells
- Contribution to targets
  - 45% electrical efficiency
  - 80% CHP efficiency
  - Use of multiple fuels
  - 40000 life time
  - Competitive costs
- Component/ materials R&D rel. to robustness, degradation and life-time under typical operation conditions
- The project addresses critical issues related to the operation of micro CHP FCs
  - **Start Up/Shut down**: redox stability, C tolerance
  - **Grid outage/system failures**: redox, sulphur, C-tolerance
  - **Costs**: replacement of Ni

Results vs MAIP/AIP

2. Alignment to MAIP/AIP (2/3)

- The project contributes to the aims of the MAIP / AIP for new materials
- Component development
  - new cell type
- Operation relevant performance
  - Short stack level testing
  - Specifications acc to industrial partners
  - Full system test (Hexis Galileo platform)
  - Industrial Advisory Board
- However, component development is on a scale that does not justify inclusion of a large scale powder manufacturer as foreseen in AIP.

Comments on AIP/ MAIP

2. Alignment to MAIP/AIP (3/3)

Over/under estimated priorities or topics:

- Inclusion of large scale materials supplier not appropriate in a first phase or ”proof of concept” project
- Effort for implementation of new materials is likely to be underestimated
- Support of development activities after ”proof of concept” is needed and should be secured

Summary

2. Alignment to MAIP/AIP (4/4)

Expected output AIP Topic: SP1-JTI-FCH.2009.3.2 Call: 2009	Objectives Project	Status at 50% of the project	Expected revised objectives
Solutions to specific identified failure mechanisms	*Materials based solution to three main failure mechanism for micro CHP Redox tolerance, sulphur poisoning and carbon content in the fuel*	Redox tolerance of all ceramic cells verified Sulphur and carbon tolerance to be tested	All three failure mechanisms will be assessed at the end
Prove of improved performance for existing design of cells, stacks and BoP	*Not addressed*	*Not addressed*	*Not addressed*
New material production techniques and new inspection techniques	*No particular production techniques microstructure analysis in 3D and on nano scale is relatively new*	Microscopic techniques evaluated to investigate infiltrate structure and preferential deposition Thermo-mechanical models under development	No revision foreseen
Recommendations for use of materials in specific stack or BoP components)	*Overall assessment of the concept of an all- ceramic solid oxide fuel cell*	Not relevant at mid term	No revison foreseen

3. Cross-cutting issues

- No particular training/education activities
  - involves young, early stage researchers in the project
  - → training on the job
- Dissemination
  - Public reports on materials and electrode performance / cell tests foreseen
  - Publishabe results will be communicated to the scientific community
- Advisory Board was used to:
  - Advise on powder supply
  - Advise on alternative applications

4. Enhancing cooperation and future perspectives

- Technology Transfer / Collaborations
  - Through common partners: esp. METSAPP
  - Advisory Board member from APU technology
- Project Future Perspectives
  - Proposed future research approach and relevance
    - Considered too early now, but planned for the final year
    - Need/opportunities for funding from proof of concept to prototype development
  - Need/opportunities for international collaboration
    - To be defined further
  - Possible contribution to the future FCH JU Programme
    - Prototype/stack demonstration