ENDURANCE

Enhanced DuRability Materials for Advanced Stacks of New solid oxide fuel Cells

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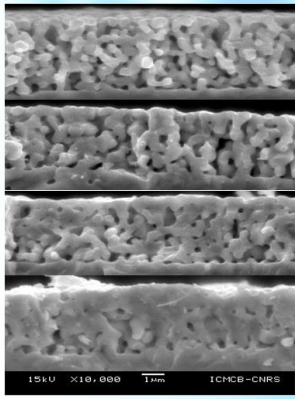
Programme Review Days 2017
Brussels, 23-24 November

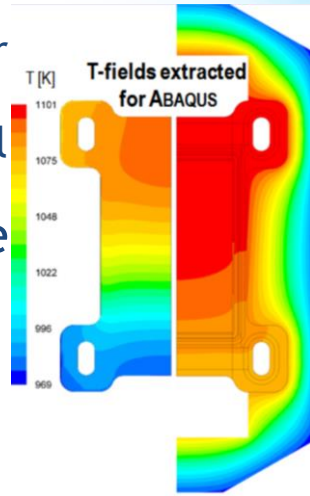
PROJECT OVERVIEW

- Call year: 2013
- Call topic: SP1-JTI-FCH.2013.3.1 Improving understanding of cell & stack degradation mechanisms using advanced testing techniques, and developments to achieve cost reduction and lifetime enhancements for Stationary Fuel Cell power and CHP systems
- Project dates: 01/04/2014 - 31/05/2017
- % stage of implementation 01/11/2017: 100%
- Total project budget: 4,414,192.60 €
- FCH JU max. contribution: 2,556,232.00 €
- Other financial contribution: 0.00 €
- Partners: UNIGE, SOLIDPOWER, MTEC, IREC, DLR, IEES, CNRS-BX, SCHOTT AG, HTCERAMIX SA, EPFL, UNIPI

PROJECT SUMMARY

- Project aims:
  - To increase reliability and durability of SOFC stack by understanding and solving the main system issues
  - To improve the awareness on degradation processes, causes, consequences. This to introduce materials enhancement and to introduce early warning signals with related counter-actions
  - To develop a predictive model from cell to stack
- Short project introduction
  - Objectives:
    - To set up a state of the art Failure Mode and Effects Analysis
    - To define most effective cell and stack improvements for durability
    - To refine state of the art modelling combining thermomechanical and electrochemical behavior
  - State-of the art commercial SOFC stacks and models as base of project development to reach higher maturity
  - Main application area: CHP on steam-reforming methane

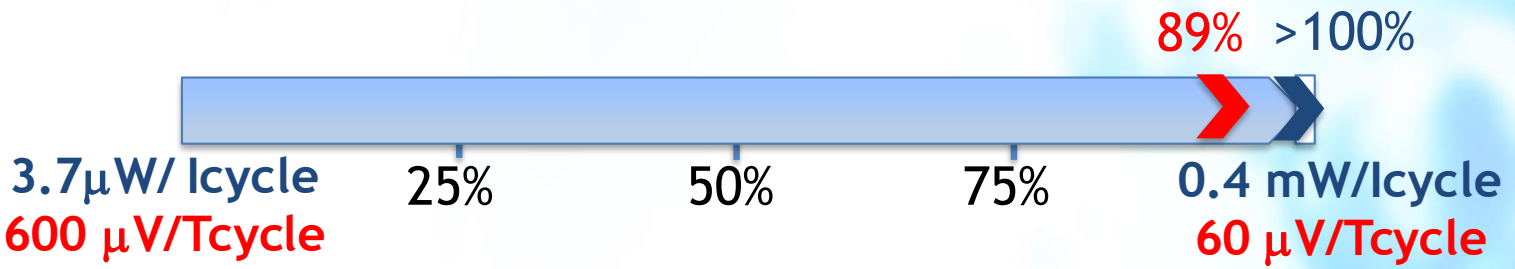




PROJECT PROGRESS/ACTIONS - Reliability
Degradation rate vs. cycles

Achievement to-date

% stage of implement.



Aspect addressed	Parameter (KPI)	Unit	SoA 2017	FCH JU Targets		
				Call topic	2017	2020
Reliability	Idle to Load cycles	µW/ Icycle	–40	0.4	-	-
	Thermal cycles	µV/Tcycle	120	60	-	-

PROJECT PROGRESS/ACTIONS - Reliability
Degradation rate vs. cycles

Achievement to-date

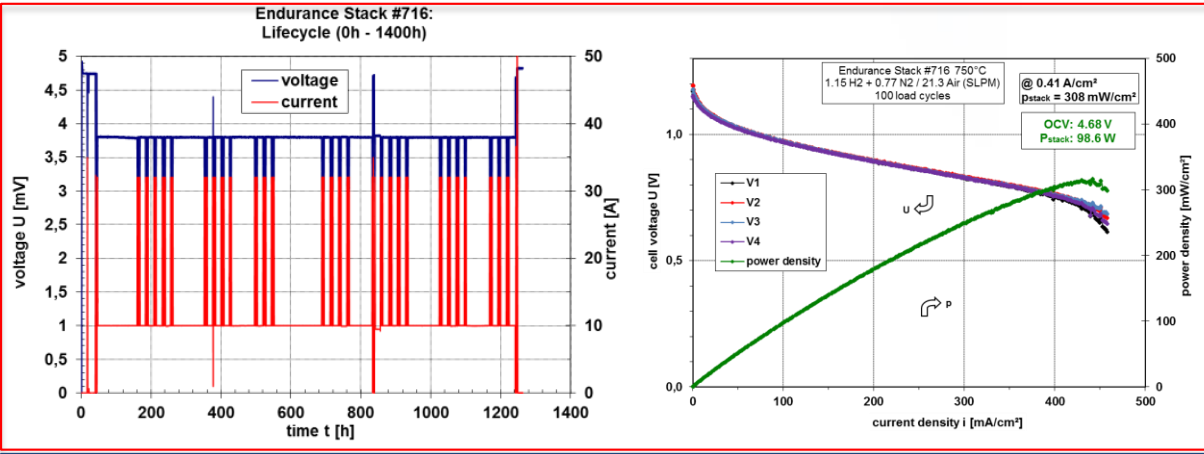
% stage of implement.

89% >100%

3.7µW/ lcycle
600 µV/Tcycle

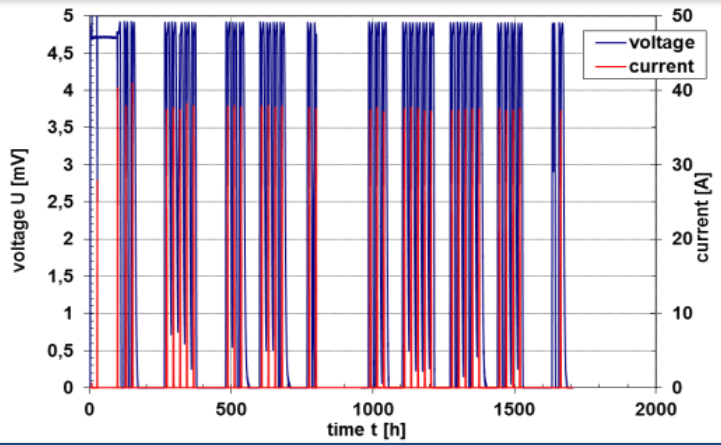
25% 50% 75%

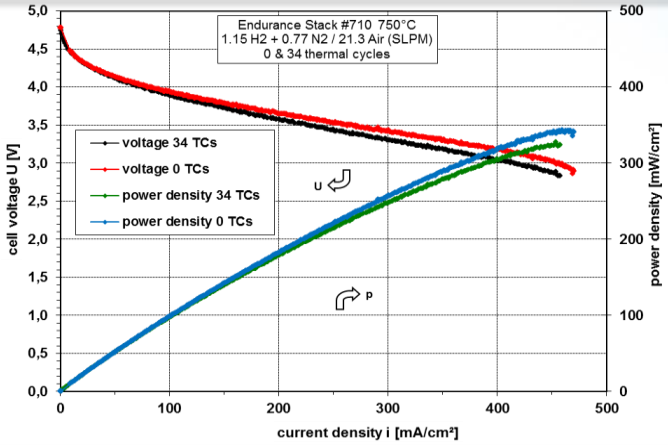
0.4 mW/lcycle
60 µV/Tcycle



Idle to load cycles on stack

Thermal cycles on stack

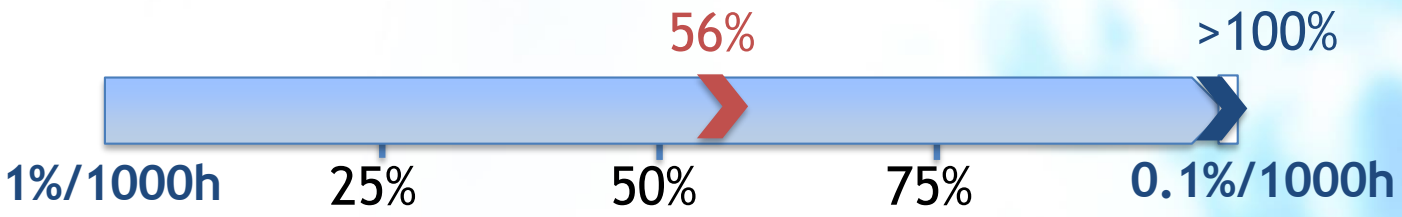




PROJECT PROGRESS/ACTIONS - Durability

Achievement to-date

% stage of implement.

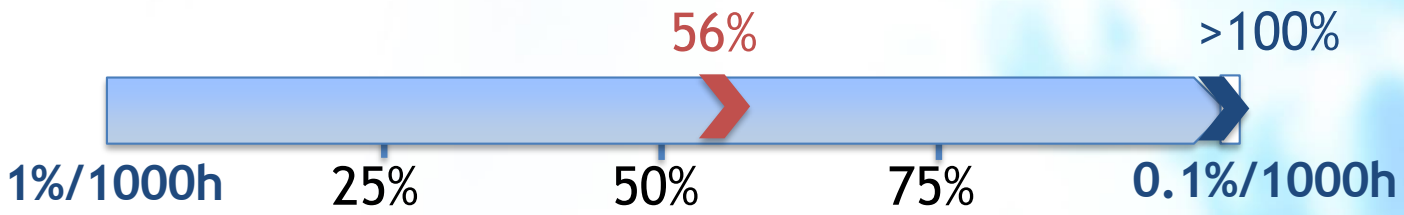


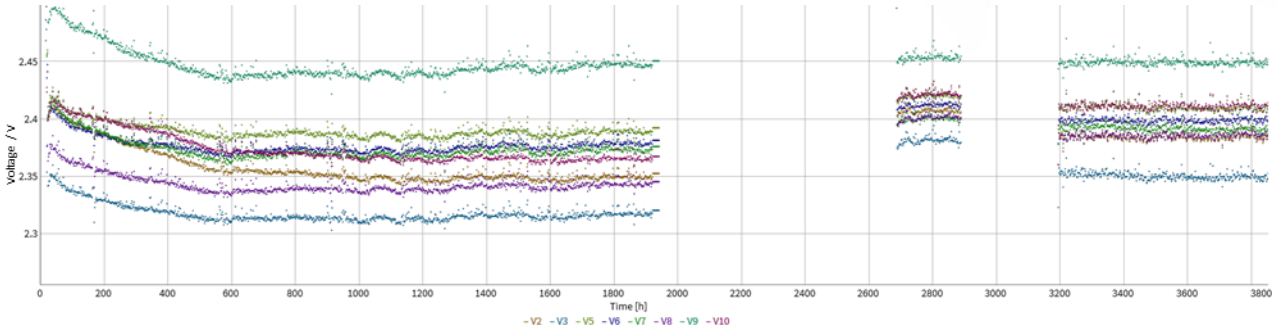
Aspect addressed	Parameter (KPI)	Unit	SoA 2017	FCH JU Targets		
				Call topic	2017	2020
Durability	Degradation rate In hydrogen	%	0.5	0.1	-	-
	Degradation rate In Steam reforming Methane	%	0.03	0.1	-	-

PROJECT PROGRESS/ACTIONS - Durability

Achievement to-date

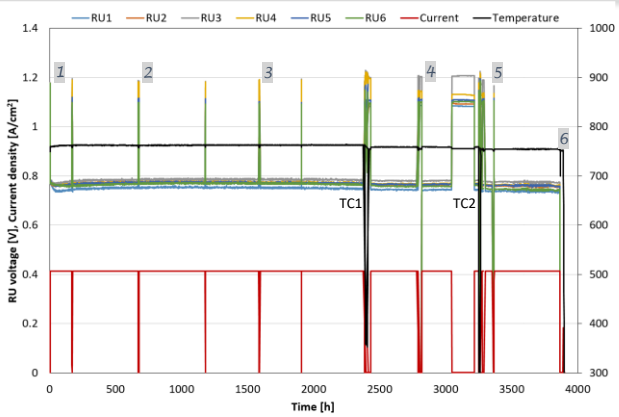
% stage of implement.

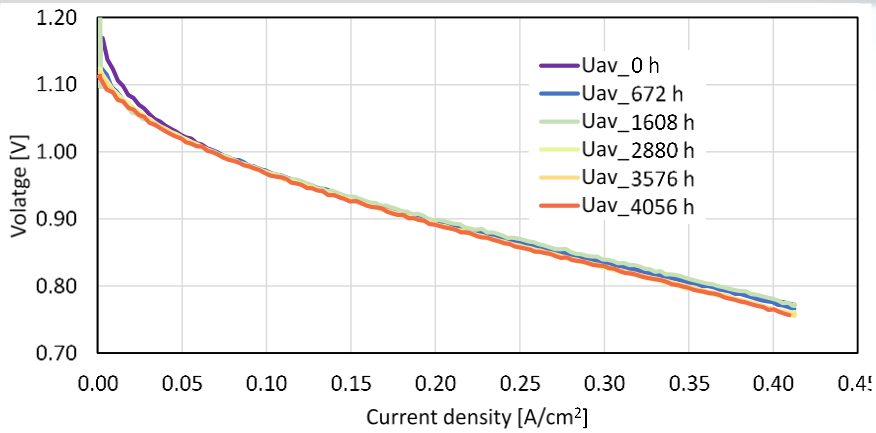




Impoved stack in Steam Reforming Methane

Short stack in Hydrogen





PROJECT PROGRESS/ACTIONS - Modelling

Achievement to-date

% stage of implement.

Separate models

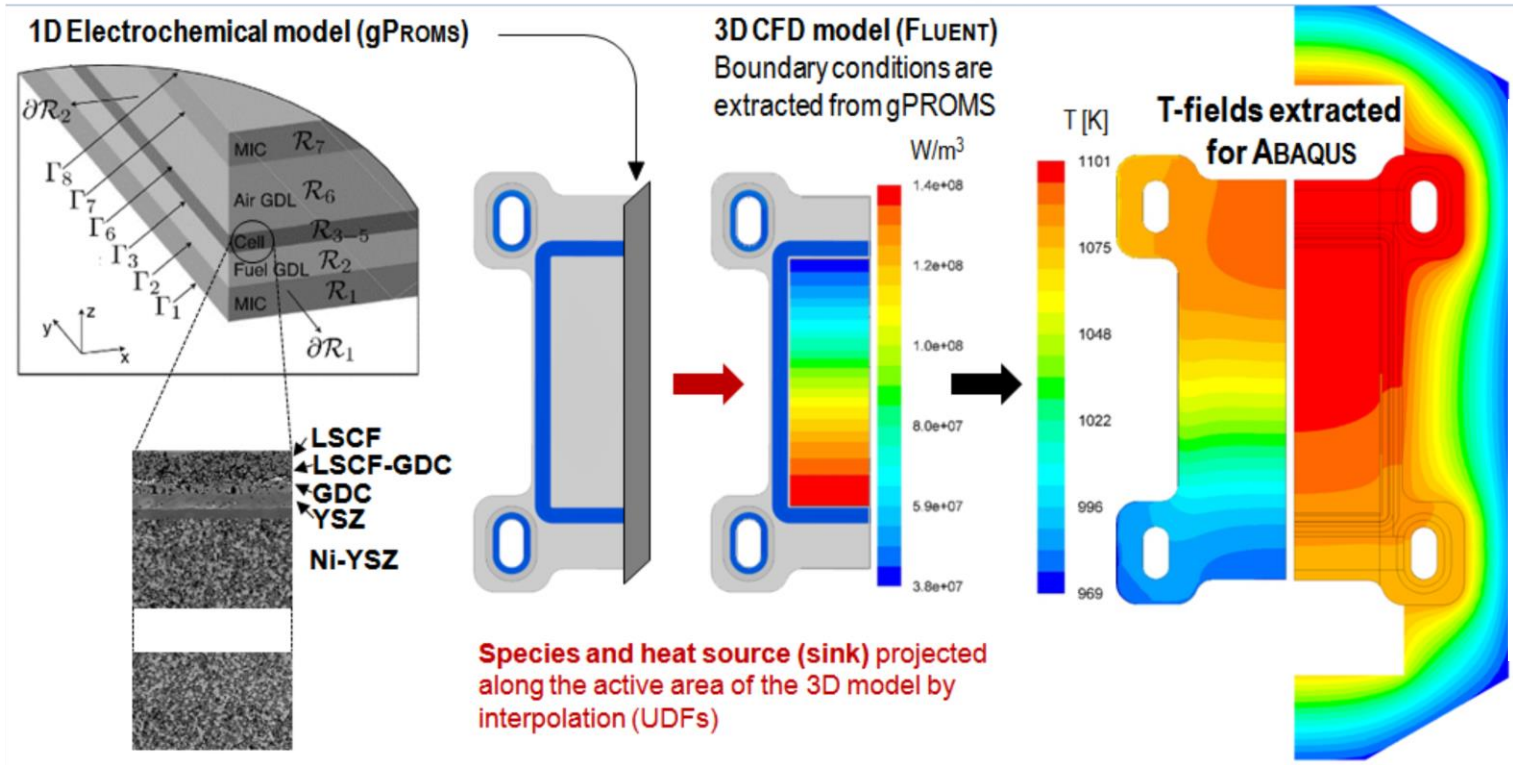
100%

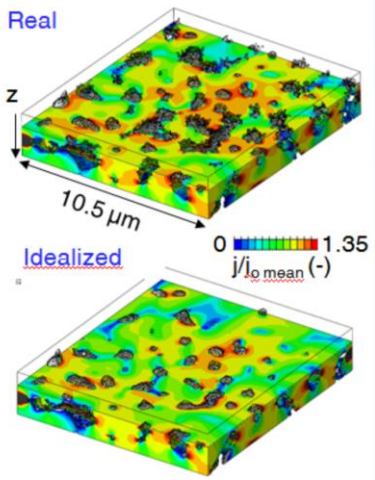
25% 50% 75%

Joined thermomechanical and Electrochemical

Thermo-electrochemical stack simulations:

- **Rationale: computation of temperature profile with detailed geometry, e.g. the sealing region, for stress analysis.**
- **Interface for Fluent-gProms in preparation: open-loop integration completed.**





SYNERGIES WITH OTHER PROJECTS AND PROGRAMMES

- Interactions with projects funded under EU programmes
  - SOCTESQA: Synergies in testing protocols
  - DESIGN: exploitation of the intellectual property
  - DIAMOND: Two common workshops, synergies on data management
  - CELL3EDITOR: Common workshop, synergies on materials
  - ECO: Common workshop, synergies on protocols

DISSEMINATION ACTIVITIES

Public deliverables

- D4.1: Handbook of testing procedures and protocols
- D8.1: Proceedings of the workshop « Degradation Mechanisms in Solid Oxide Cell and Systems »
- D8.2 and D8.3: Serious Game « The lost colony »
- D8.4: Website

Conferences/Workshops

- 2 organised by the project
- 2 in which the project has participated (but not organised)

SERIOUS GAME

« THE LOST COLONY »

Publications: 19

- **M. Morales et alii**, Multi-scale analysis of the diffusion barrier layer of gadolinia-doped ceria in a solid oxide fuel cell operated in a stack for 3000 h, Journal of Power Sources, 344 (2017) 141–151
- **M. Hubert et alii**, Role of microstructure on electrode operating mechanisms for mixed ionic electronic conductors: From synchrotron-based 3D reconstruction to electrochemical modelling, Solid State Ionics, 294 (2016) 90-107.

Thank You!

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