METSAPP

Metal supported SOFC technology for stationary and mobile applications

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http://Metsapp.eu
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Programme Review Days 2016
Brussels, 21-22 November

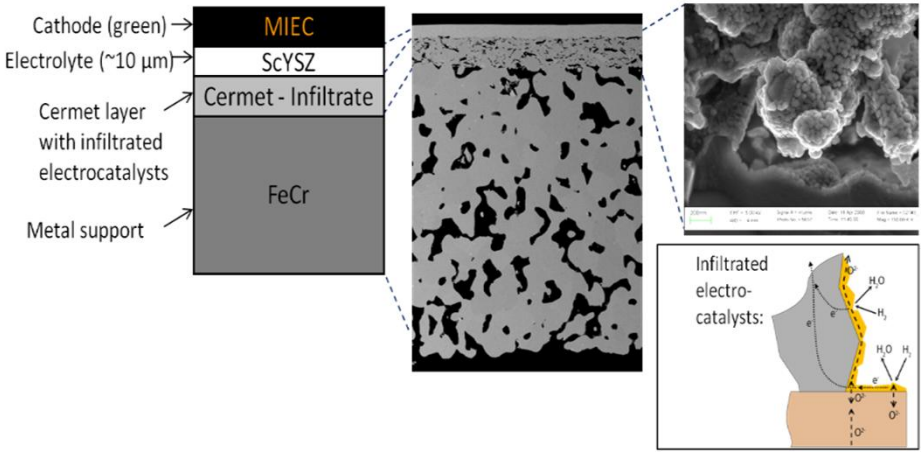
PROJECT OVERVIEW

Project Information	
Call topic	SP1-JTI-FCH.2010.3.1 - Materials development for cells, stacks and balance of plant (BoP)
Grant agreement number	278257
Application area (FP7)	Stationary power and CHP
Start date	01/11/2011
End date	31/12/2015
Total budget (€)	8.021.950
FCH JU contribution (€)	3.366.631,24
Other contribution (€, source)	945.503 (ForskEl, for Danish partners)
Stage of implementation	100% project months elapsed
Partners	DTU, Sandvik Materials Technology, Topsoe Fuel Cell A/S, AVL List GmvH, Chalmers Tekniske Hoegskole AB, Karlsruhe Institute of Technology, University of St. Andrews, ICE Stromungsforchung GmbH, JRC Joint Research Centre EC, Elringklinger AG

PROJECT SUMMARY

AIM: develop novel cells and stacks based on a robust, cost effective and reliable up-scale-able metal supported technology for distributed generation and CHP, as well as mobile applications with the following primary objectives:

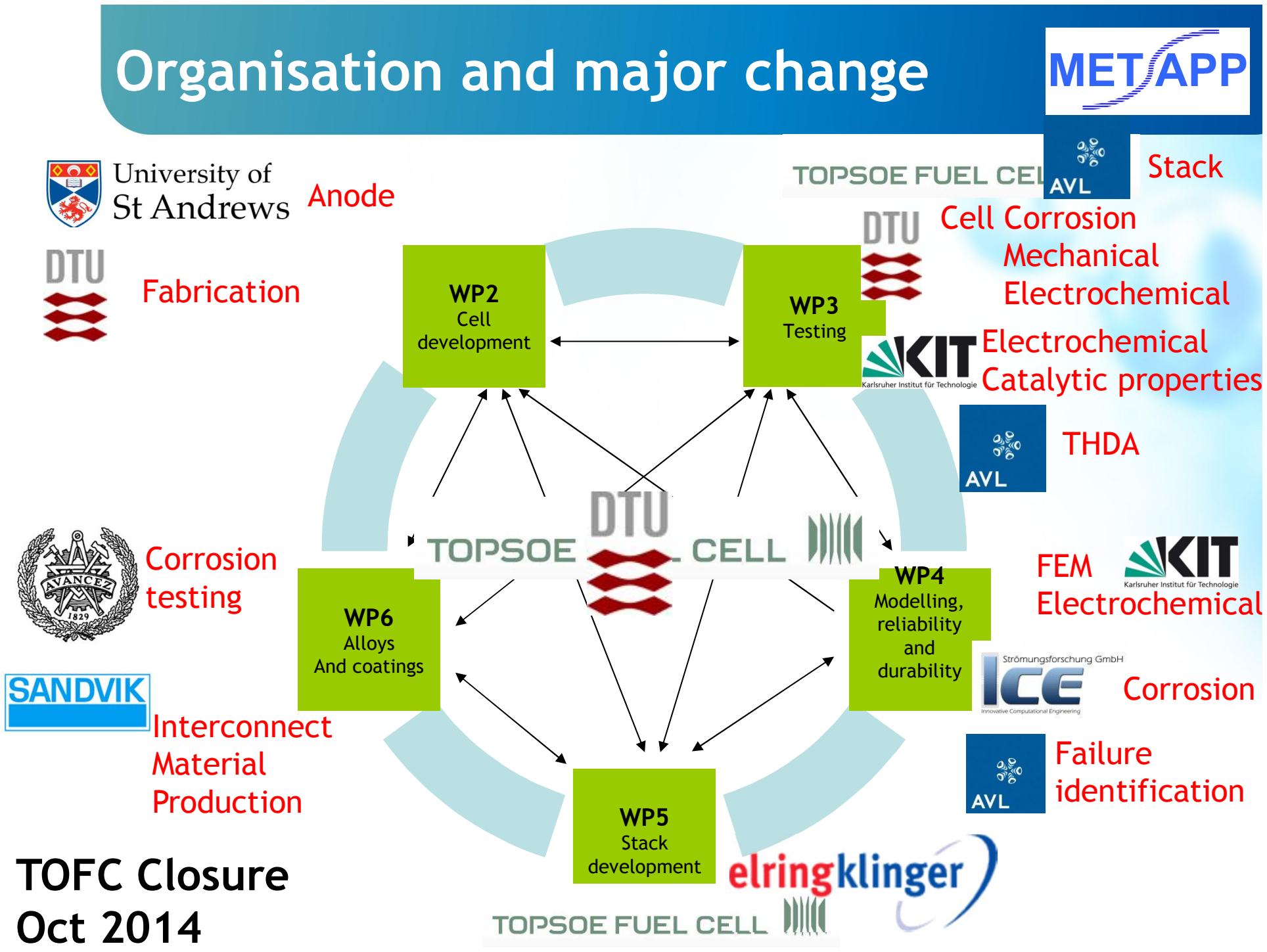
1. Robust metal-supported cell design, with ASRcell < 0.5 ohmcm^2, 650°C
2. Cell optimized and fabrication up-scaled for various sizes
3. Improved durability for stationary applications, degradation < 0.25%/kh
4. Modular, up-scaled stack design, stack ASRstack < 0.6 ohmcm^2, 650°C
5. Robustness of 1-3 kW stack verified
6. Cost effectiveness, industrially relevance, up-scale-ability illustrated.



Unique simple cell design
Flexible and up-scalable

- Tape casting of MS + A + E
- Co-sintering in reducing atm.
- Infiltrated anode functional layer
- Screen printing of C, sintering in-situ.

Organisation and major change

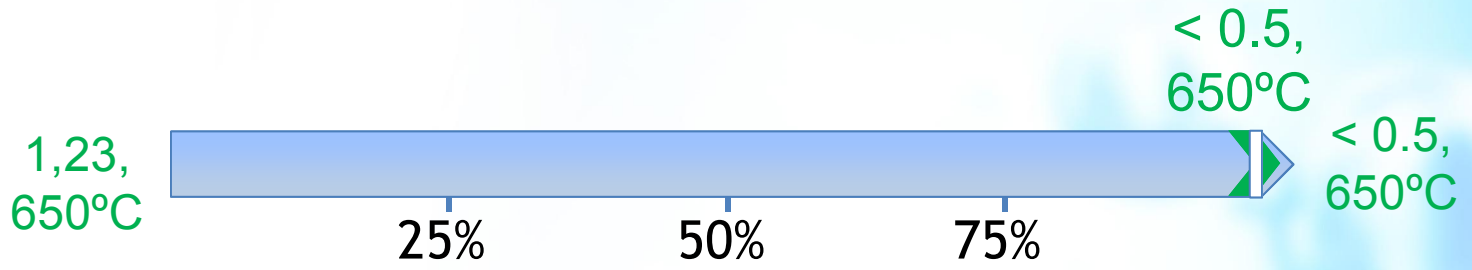


TOFC Closure
Oct 2014

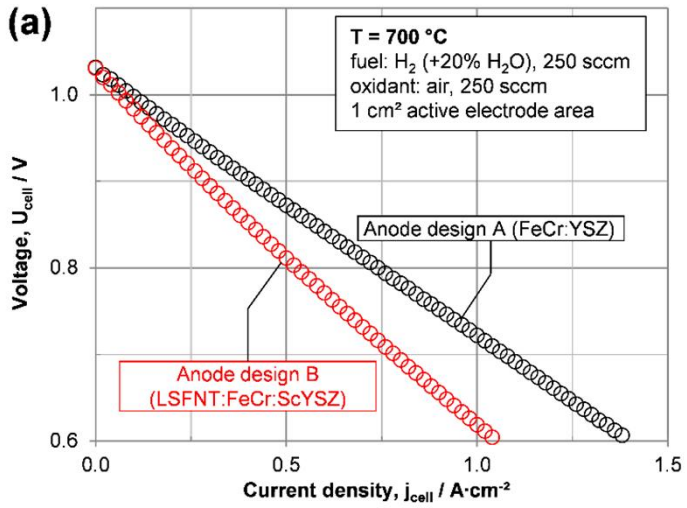
PROJECT PROGRESS/ACTION Performance

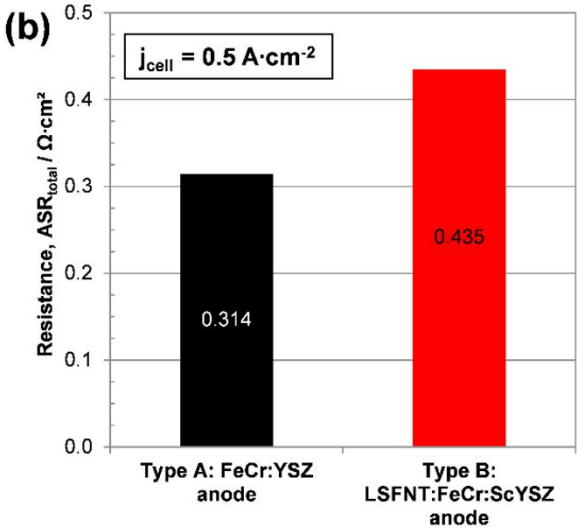
Achievement to-date

% stage of implement.



Aspect addressed	Parameter (KPI)	Unit	SoA 2016
Performance	ASRcell	ohm·cm²	< 0.5, 650ºC





PROJECT PROGRESS/ACTIONS Durability

Achievement to-date

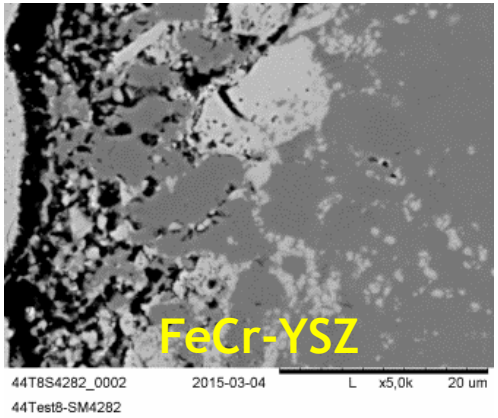
% stage of implement.

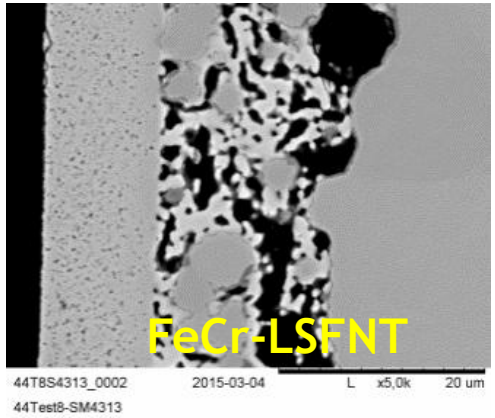
6%/kh → < 1.5%/kh → < 0.25%/kh

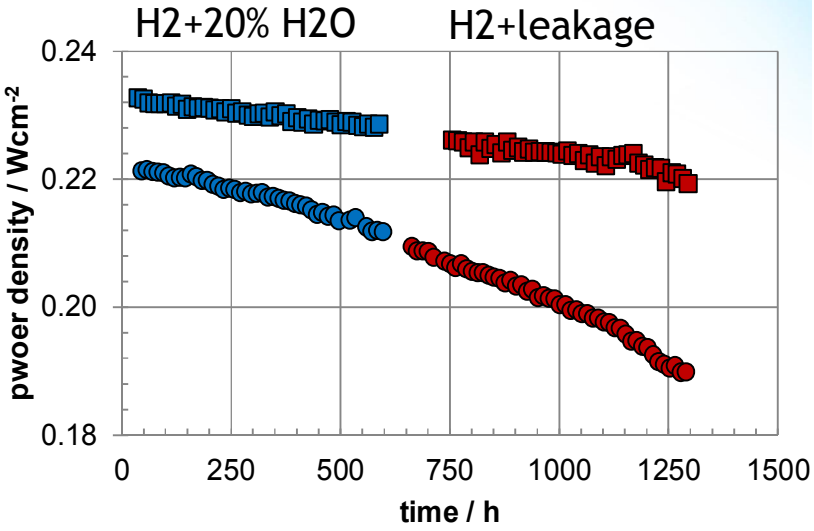
25% 50% 75%

Aspect addressed	Parameter (KPI)	Unit	SoA 2016
Durability	Degradation	ohm·cm^2	< 1.5% / kh

LSFNT anode corrosion resistant demonstrated



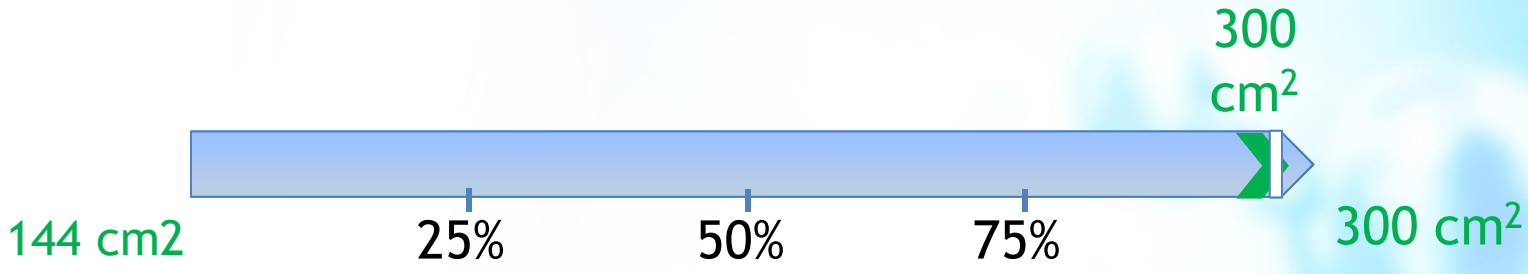




PROJECT PROGRESS/ACTIONS Fabrication

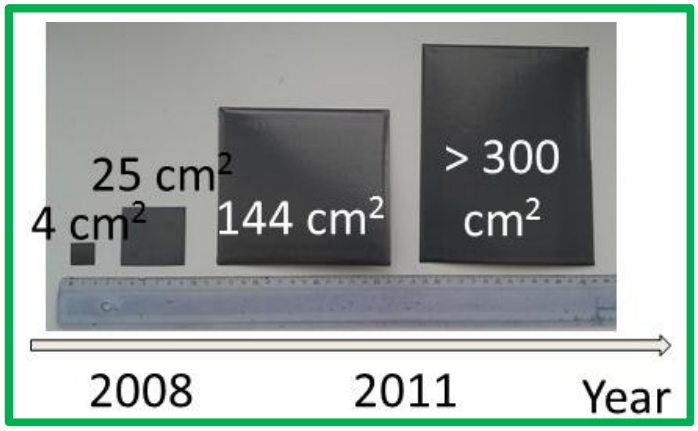
Achievement to-date

% stage of implement.



Aspect addressed	Parameter (KPI)	Unit	SoA 2016
Fabrication	Cell size	cm^2	Up to 300

Co-casting process and single step sintering



PROJECT PROGRESS/ACTIONS Stack

Achievement to-date

% stage of implement.

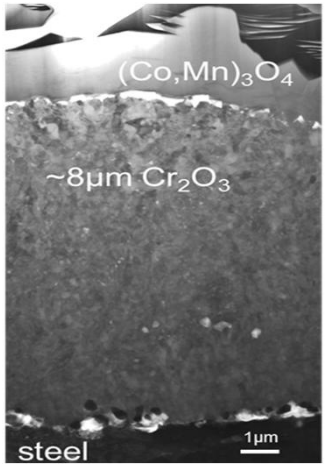
Not tested

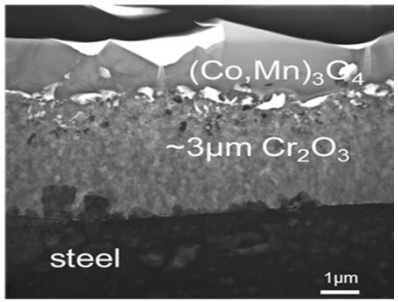
2, 650ºC

25% 50% 75%

< 0.6, 650ºC

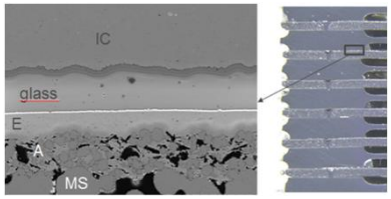
Aspect addressed	Parameter (KPI)	Unit	SoA 2016
Stacking	ASRstack	ohm·cm^2	-

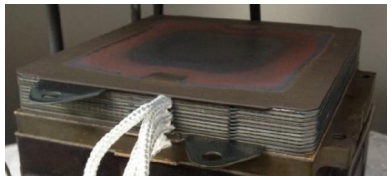




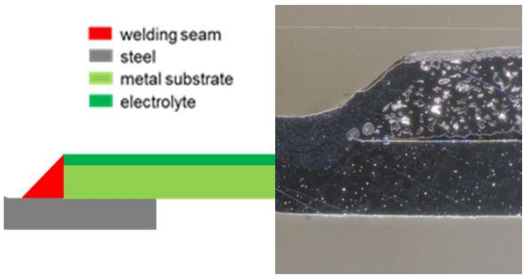
Stack component

TOFC

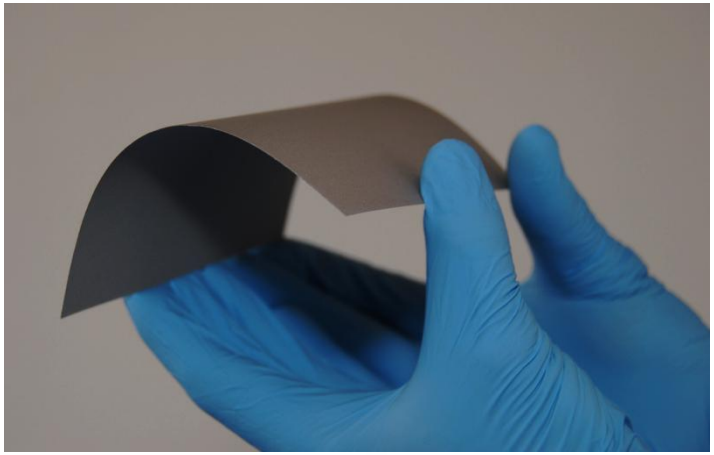




EK



SYNERGIES WITH OTHER PROJECTS AND PROGRAMMES



Interactions with projects funded under EU programmes	
RAMSES	Common workshop, exchange of knowledge
METPROCELL	Common workshop, exchange of knowledge
ProSOFC	Exchange of knowledge concerning modelling
METSOFC	METSAPP is a continuation of METSOFC
SCOTAS	Exchange of knowledge on electrode development

DISSEMINATION ACTIVITIES

Public deliverables

- 4.7 Publication on microstructural modelling of SOFC electrode phenomena
- 8.1 METSAPP project website
- 8.2 Presentation of project intermediate results
- 8.3 Presentation of final project results

Conferences/Workshops

- 4 workshops organised
- 47 conference participations (31 oral)

Social media

http://www.metsapp.eu/

Publications: 26 peer reviewed journal articles

- In situ growth of nanoparticles through control of non-stoichiometry, Dragos Neagu , George Tsekouras , David N. Miller , Hervé Ménard , John T. S. Irvine, Nature Chemistry 2013, Vol. 5/Issue 11, 916-923
- Nano-socketed nickel particles with enhanced coking resistance grown in situ by redox exsolution, Dragos Neagu , Tae-Sik Oh , David N. Miller , Hervé Ménard , Syed M. Bukhari , Stephen R. Gamble , Raymond J. Gorte , John M. Vohs , John T.S. Irvine, Nature Communications 2015, Vol. 6, 8120.
- Chromium vaporization from mechanically deformed pre-coated interconnects in Solid Oxide Fuel Cells, Hannes Falk-Windisch , Mohammad Sattari , Jan-Erik Svensson , Jan Froitzheim, Journal of Power Sources **2015**, *297*, 217.

Patents: 2

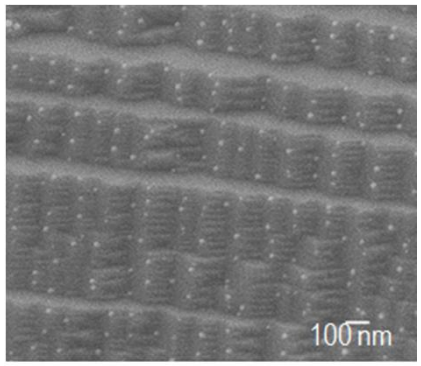
- EP2830127, Air electrode sintering of temporarily sealed metal-supported solid oxide cells, Brandon J. McKenna, Cliver Klitholm, 2013
- EP2808932, Metal-supported solid oxide cell, Brandon J. McKenna, Rainer Küngas, Tobias Holt, Peter Blennow, 2013

Dissemination to results

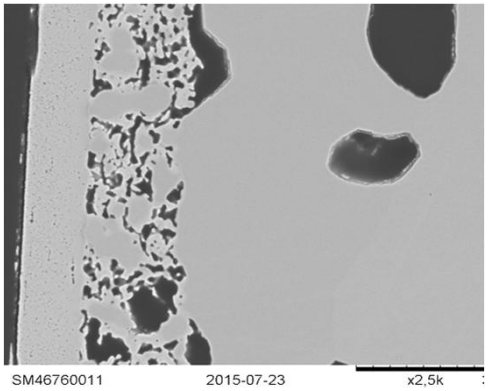
ARTICLES
PUBLISHED ONLINE: 6 OCTOBER 2013 | DOI: 10.1038/NCHEM.1773
nature chemistry

In situ growth of nanoparticles through control of non-stoichiometry

Dragos Neagu[1]*, George Tsekouras[1†], David N. Miller[1], Hervé Ménard[2] and John T. S. Irvine[1]*



Nanoparticle exsolution in LSFNT



LSFNT Integrated in anode

- Nanoparticle exsolution, good sinterability and compatibility → Improved adhesion with adjacent cell components
- Superior transport properties
- Open and improved anode microstructure

EXPLOITATION PLAN/EXPECTED IMPACT

Exploitation

- Exploitation planned for special markets, such as mobile home, houseboat, for which customers are willing to spend more on advanced products. ElringKlinger assumes a volume of 5000 units for the year 2030.
- Following these special markets, the larger markets for APUs in the transport sector and micro-CHPs become accessible, which will reduce cost further.
- Advanced models for flow-homogenization optimization used for SOEC (HTAS) and SOFC (Resolvent I/S) applications
- Demonstration of THDA device to assist the development process of SOFC stacks for the first time (AS SOFC stacks). This method is exploited further for all types of SOFC stacks and at the cell level.

Impact

- Feasibility of a stable metal supported cell, with significantly improved corrosion resistance and electrocatalytic stability. The current stability level reached makes the cell usable for mobile applications. Further development would be needed for stationary applications.
- New highly performant coatings that can be mass produced on thin interconnects developed. Expected impact on SOFC stack concept using thin metallic interconnects.

Thank You!

Coordinator: Severine Ramousse rase@dtu.dk
Speaker: Anke Hagen anke@dtu.dk

Guidelines and Template
for project oral presentation

Programme Review Days 2016
Brussels, 21-22 November 2016

GENERAL GUIDELINES
Content

The presentation must focus on targets and current state of project achievements in relation to the contractual objectives and overall strategic context of FCH JU and its annual and multi-annual plans.

The presentation refers to the information provided in the self-assessment report, including:

- as introduction: an overview and a summary with context, objectives, and position towards international state-of-art (SoA)
- a main part with emphasis on advancement towards the objectives focusing on maximum 3 main achievements (up to 2 slides per objective) and actions planned
- some slides about general activities such as links with other projects or dissemination

GENERAL GUIDELINES
SLIDE STRUCTURE - TIME SCHEDULE

The presentation should last 15 minutes when a single project is presented / 20 minutes when 2 or more projects are presented in the same slot

- Use the PowerPoint template of this presentation
- Use a *Trebuchet MS font* for all the slides
- Recommended font size for text is minimum 18 pt
- Representative photo, images, figures etc. are encouraged (maximum 2 figures on a slide!)
- Recommend around 10-15 slides
    - 1 title page
    - 1 general info on the project
    - 6 slides maximum on progress vs objectives
    - 1 on synergies with other projects
    - 1 on dissemination
    - Some “optional slides”
- Please send the presentation to FCH JU by 16 November 2016 (email to prd@fch.europa.eu)

GENERAL GUIDELINES
How to use the template

- Please replace text in red with relevant information from the project and change its colour to blue
- The text in green is used for instruction/explanations: please remove it
- Please click on the comment boxes for further instructions on how to provide the information MC(F)57
- The proposed “Optional slides” can be presented or should be removed from the presentation

Slide 17

MC(F)57 This is what a comment box looks like (it will not be visible on slide show mode)
MARENCO Claudia (FCH), 16/02/2016

USEFUL REFERENCES

- *Fuel Cells and Hydrogen Joint Undertaking (FCH 2 JU)*
  - *Website* http://www.fch.europa.eu
  - *Reference documents (MAIP/AIPs and MAWP/AWPs)*
    - *Multi-annual plans (MAIP/MAWP): http://www.fch.europa.eu/page/multi-annual-work-plan*
    - *Annual plans: AIPs (http://goo.gl/VSpuAi) or AWPs (http://goo.gl/Hz8iby)*
  - *Previous Programme Review Days* http://goo.gl/2XCk9q
- *European Commission non-nuclear Energy Research (incl. FCH): http://ec.europa.eu/research/energy/eu/index_en.cfm*
- *FCH JU Industry Grouping: Hydrogen Europe: http://www.hydrogeneurope.eu*
- *FCH JU Research Grouping: N-ERGHY: http://www.nerghy.eu*

PROJECT SUMMARY

Short project introduction describing

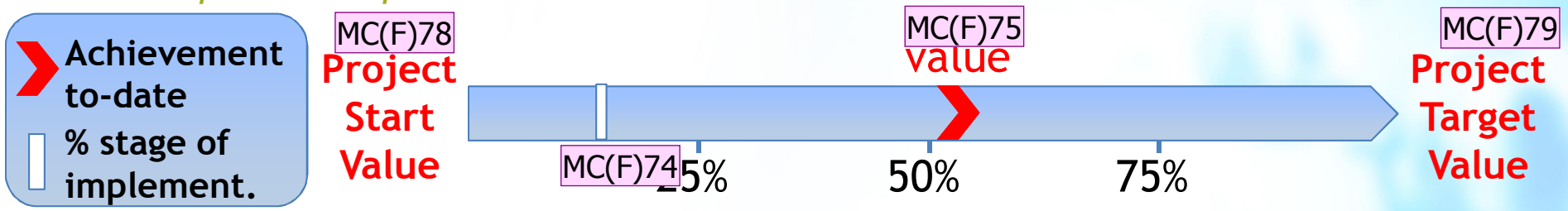
- Objectives
- Global positioning vs international state-of the art
- Application and market area

(Feel free to include pictures or figures)

PROJECT PROGRESS/ACTIONS – Aspect 1

Project LOGO

Example and explanation in the next slide



Aspect addressed	MC(F)76 Parameter (KPI)	Unit	SoA 2016	MC(F)77 FCH JU Targets		
				Call topic	2017	2020
Aspect 1	Parameter addressed					

Future steps:

Specify next steps and actions to be carried out within the project for this aspect

Slide 20

MC(F)74 Position white cursor according to % project stage of implementation at date of 01/11/2016
The position of the white cursor should remain the same throughout the presentation
MARENCO Claudia (FCH), 15/02/2016

MC(F)77 Indicate the targets defined in the specific call topic to which you had originally applied and/or in the multi-annual programmes (MAIP/MAWP)
MARENCO Claudia (FCH), 16/02/2016

MC(F)76 Please refer to the objectives/targets/KPIs set in the multi-annual work plans (MAIP or MAWP) or in the topic description for the call for proposals to which you successfully applied (see the relevant annual plan - AIP or AWP - for reference).

Please add extra rows in case you have more than one objective/target/KPI adressing the same aspect
MARENCO Claudia (FCH), 08/09/2016

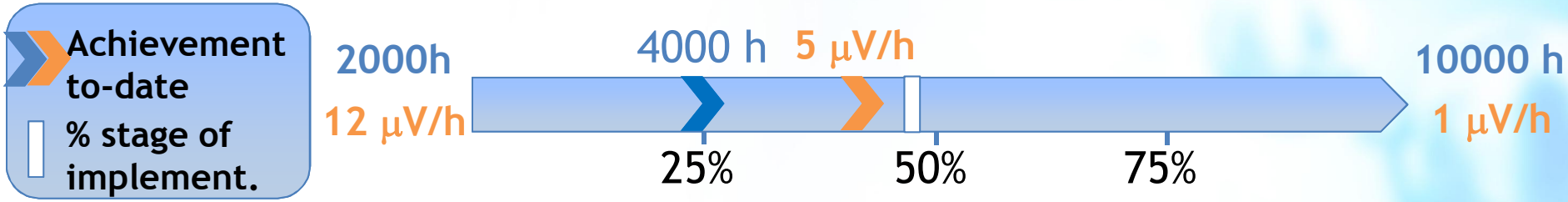
MC(F)78 Indicate here the value of the parameter monitored at the beginning of the project and the corresponding unit.
If another parameter monitored in the project addresses the same aspect, add a second value in a different colour.
MARENCO Claudia (FCH), 08/09/2016

MC(F)79 Indicate the project target value for this parameter and the corresponding unit.
If another parameter monitored in the project addresses the same aspect, add a second value in a different colour.
MARENCO Claudia (FCH), 08/09/2016

MC(F)75 Position red cursor according to achievement to date (Oct/Nov 2016) (in scale between starting point and target value) + indicate achieved value and unit.
If another parameter monitored in the project addresses the same aspect, add a second arrow in a different colour.
Repeat for any additional paramaters addressing the same aspect.
MARENCO Claudia (FCH), 08/09/2016

Example and explanation of PROJECT PROGRESS/ACTIONS - Durability

Status at month 17 of a 36 months project at date 01/11/2016 (stage of implement. = 47%)



Aspect addressed	Parameter (KPI)	Unit	SoA 2016	FCH JU Targets		
				Call topic	2017	2020
Durability	Lifetime	h	8000	10000	10000	12000
	Degradation rate	µV/h	10	1	1	0.5

An "aspect" is intended as a research aspect addressed within the project.

Within an aspect, several parameters can be monitored to assess progress.

Examples:

Aspect = Durability

Parameter 1 = lifetime (h)

Parameter 2 = degradation rate (µV/h)

% stage of implementation is the % of project *duration* (months) elapsed on 01/11/2016

OPTIONAL SLIDES

Project LOGO

You can use any of the following slides and insert them inside the presentation, otherwise delete them

RISKS AND MITIGATION

Project LOGO

Risk 1

Mitigation 1

Risk 2

Mitigation 2

Risk 3

Mitigation 3

EXPLOITATION PLAN/EXPECTED IMPACT

Project LOGO

Exploitation

Explain

Impact

Explain

HORIZONTAL ACTIVITIES

Project LOGO

Free slide illustrating activities on training, RCS (Regulations, Codes and Standards), public awareness, etc.