METSAPP

Metal supported SOFC technology for stationary and mobile applications

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http://Metsapp.eu
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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

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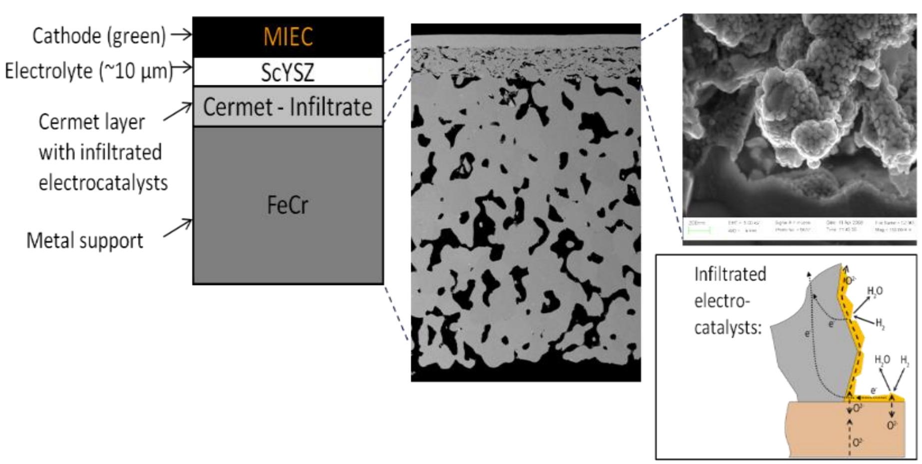
AIM: develop novel cells and stacks based on a robust, cost effective and reliable up-scale-able metal supported technology for distributed generation and CHP, as well as mobile applications with the following primary objectives:

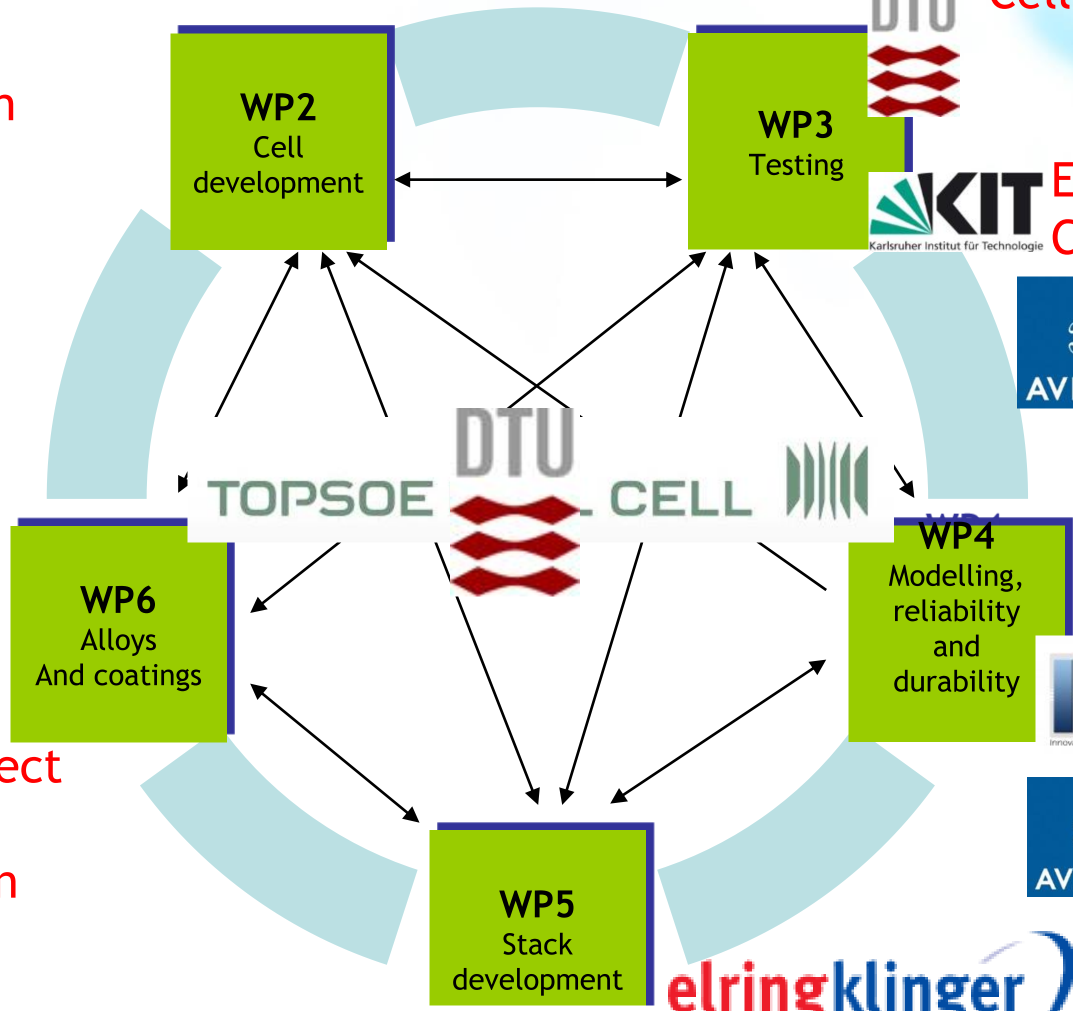
1. Robust metal-supported cell design, with ASRcell < 0.5 ohmcm^2, 650°C
2. Cell optimized and fabrication up-scaled for various sizes
3. Improved durability for stationary applications, degradation < 0.25%/kh
4. Modular, up-scaled stack design, stack ASRstack < 0.6 ohmcm^2, 650°C
5. Robustness of 1-3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



Anode

Fabrication

Stack

Cell Corrosion
Mechanical
Electrochemical

Electrochemical
Catalytic properties

THDA

FEM
Electrochemical

Corrosion

Failure identification

Corrosion testing

Interconnect
Material
Production

TOFC Closure
Oct 2014

PROJECT PROGRESS/ACTION Performance

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Achievement to-date

% stage of implement.

1,23, 650ºC

25%

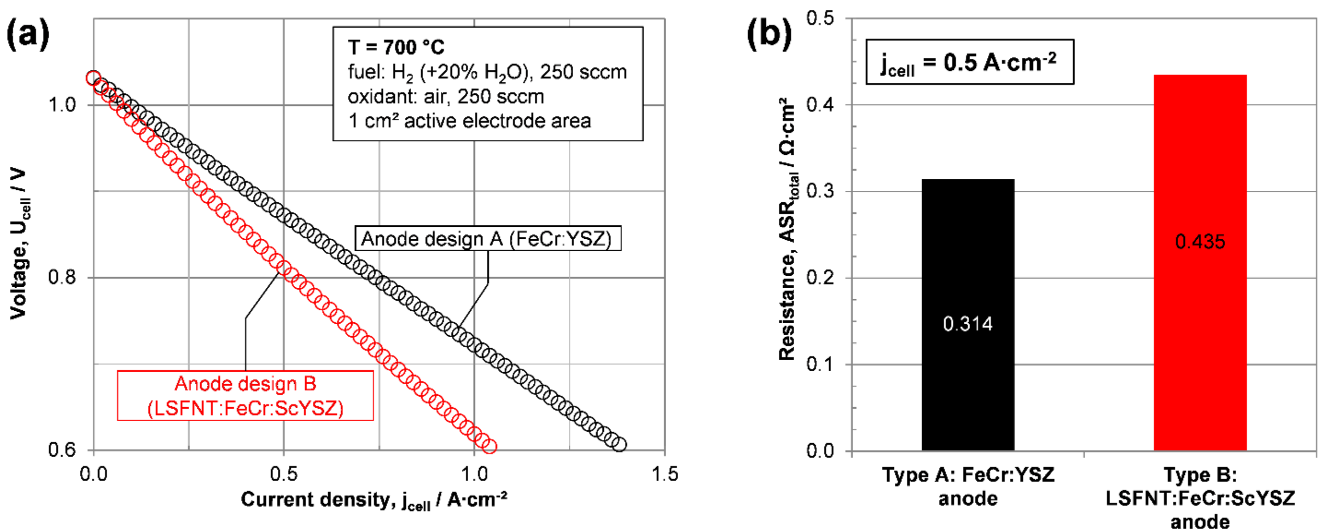
50%

75%

< 0.5, 650ºC

< 0.5, 650ºC

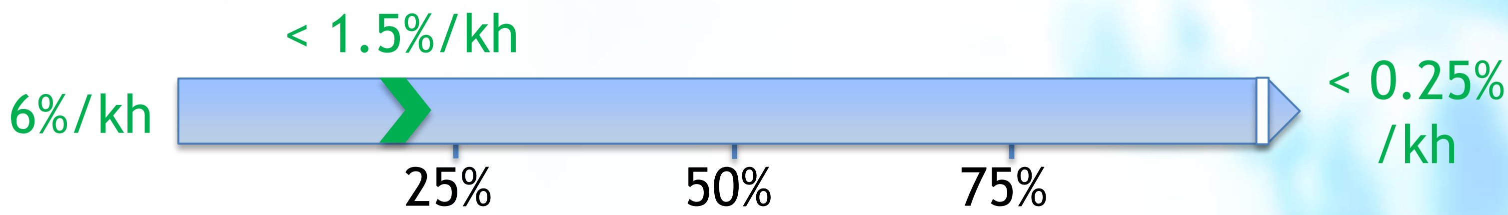
Aspect addressed	Parameter (KPI)	Unit	SoA 2016
Performance	ASRcell	$ohm \cdot cm^2$	< 0.5, 650ºC



PROJECT PROGRESS/ACTIONS Durability

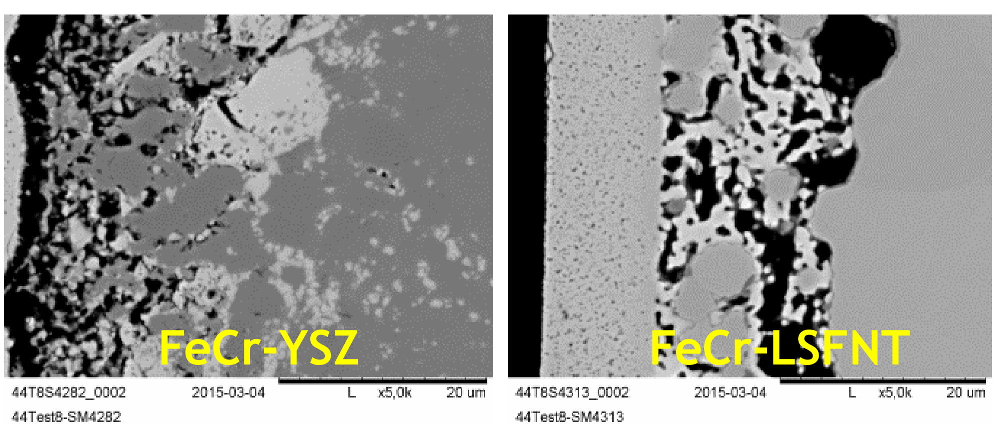
Achievement to-date

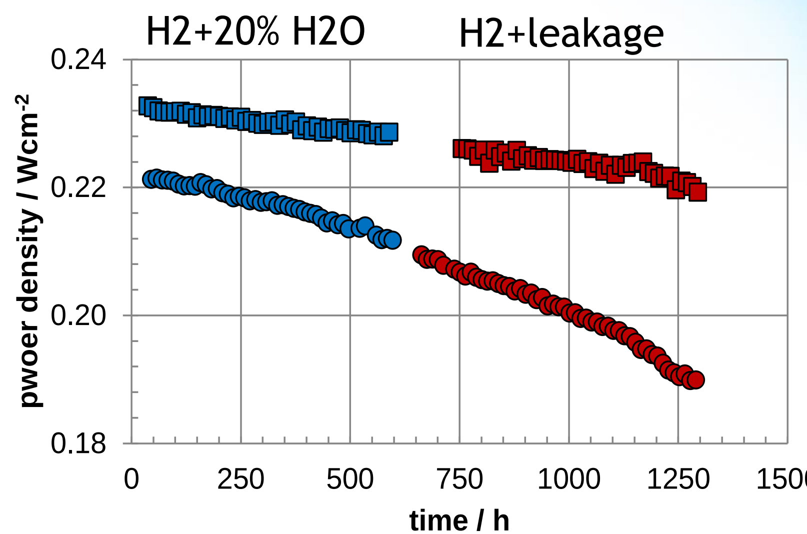
% stage of implement.



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

LSFNT anode corrosion resistant demonstrated





PROJECT PROGRESS/ACTIONS Fabrication

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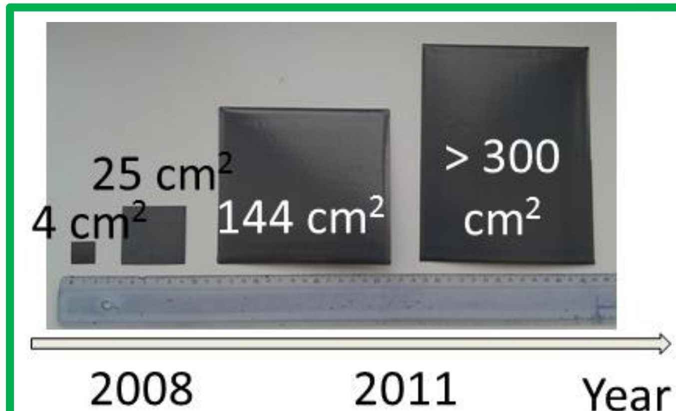
- Achievement to-date
- % stage of implement.

144 cm2 — 25% — 50% — 75% — 300 cm^2

300 cm^2

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.

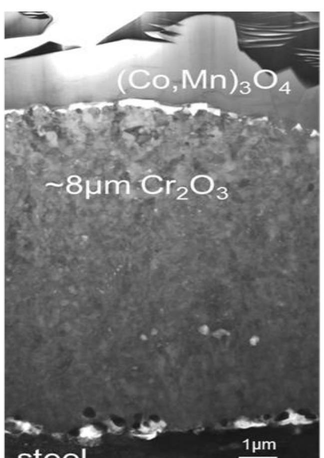
Not tested

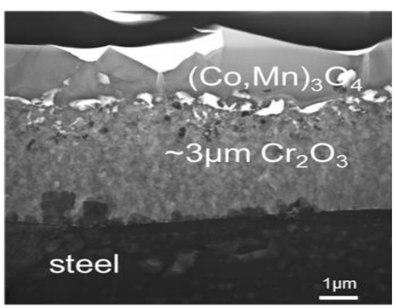
2, 650ºC

25% 50% 75%

< 0.6, 650ºC

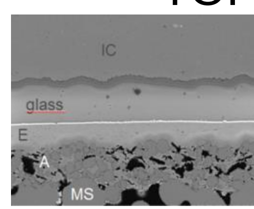
Aspect addressed	Parameter (KPI)	Unit	SoA 2016
Stacking	ASRstack	ohm·cm^2	-

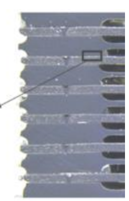


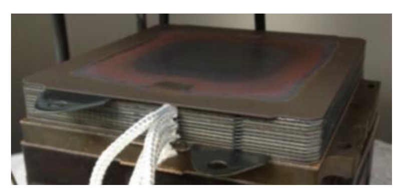


Stack component

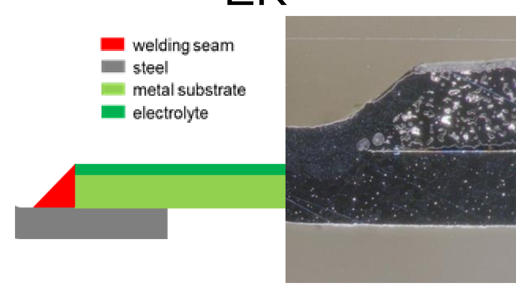
TOFC







EK



SYNERGIES WITH OTHER PROJECTS AND PROGRAMMES

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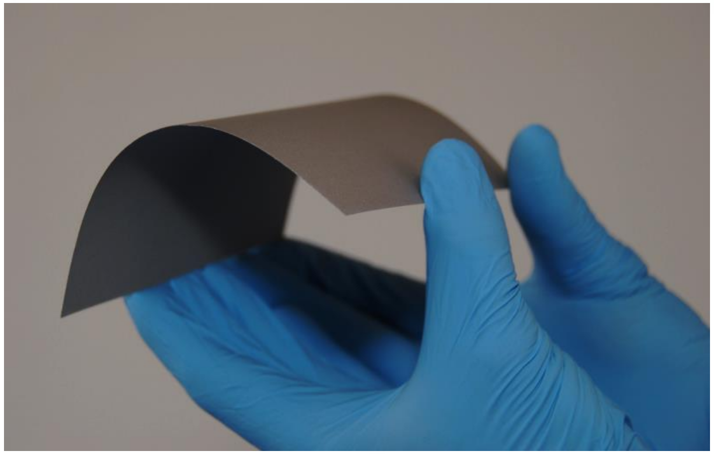


Interactions with projects funded under EU programmes	
RAMSES	Common workshop, exchange of knowledge
METPROCELL	Common workshop, exchange of knowledge
ProSOFC	Exchange of knowledge concerning modelling
METSOFC	METSAPP is a continuation of METSOFC
SCOTAS	Exchange of knowledge on electrode development

DISSEMINATION ACTIVITIES

METSAPP

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

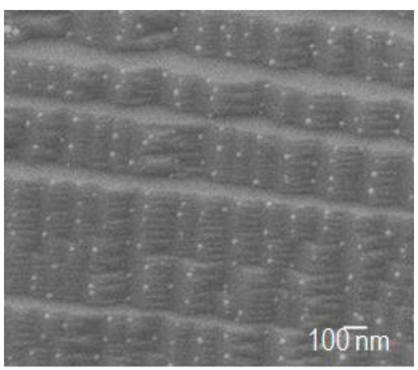
- EP2830127, Air electrode sintering of temporarily sealed metal-supported solid oxide cells, Brandon J. McKenna, Cliver Klitholm, 2013
- EP2808932, Metal-supported solid oxide cell, Brandon J. McKenna, Rainer Küngas, Tobias Holt, Peter Blennow, 2013

Dissemination to results

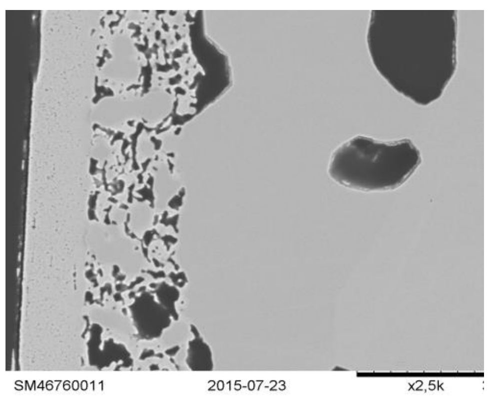
ARTICLES
PUBLISHED ONLINE: 6 OCTOBER 2013 | DOI: 10.1038/NCHEM.1773
nature chemistry

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!

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