NANOCAT

Development of advanced catalysts for PEMFC automotive

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Programme Review Days 2017
Brussels, 23-24 November

PROJECT OVERVIEW

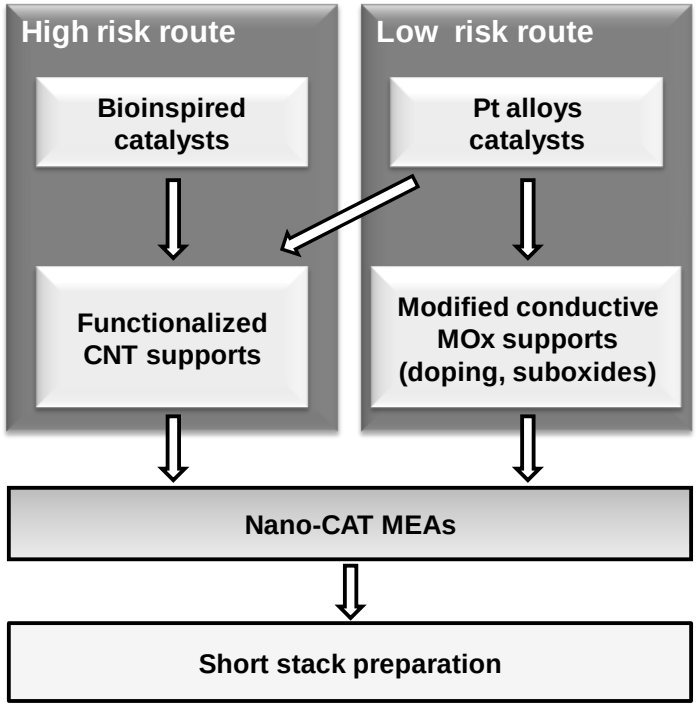
Nano CAT
Advanced Catalysts PEMFC Auto

- Call year: 2012
- Call topic:
  SP1-JTI-FCH.2012.1.5 New catalyst structures and concepts for automotives PEMFC
- Project dates: 05/2013 – 01/2017
- % stage of implementation 01/11/2017: 100 %
- Total project budget: 4,394,330 €
- FCH JU max. contribution: 2,418,439 €
- Other financial contribution: 0 €
- Partners: CEA – ARMINES – TECNALIA – NANOCYL – JRC – C-TECH – DLR – VOLVO

PROJECT SUMMARY

The objectives are to:

- Develop innovative catalyst structures and concepts
- → working both on catalyst and support
- Obtain a power density of 1 **Wcm^{-2}** with Pt loading 0.3-0.5 mg_{Pt}/cm^2
- Reduce catalyst / catalyst layer degradation and increase MEA life time.



PROJECT SUMMARY / Motivation

Nano CAT
Advanced Catalysts PEMFC Auto

Benchmark of commercial catalysts and degradation study:

→ Change of catalyst activity

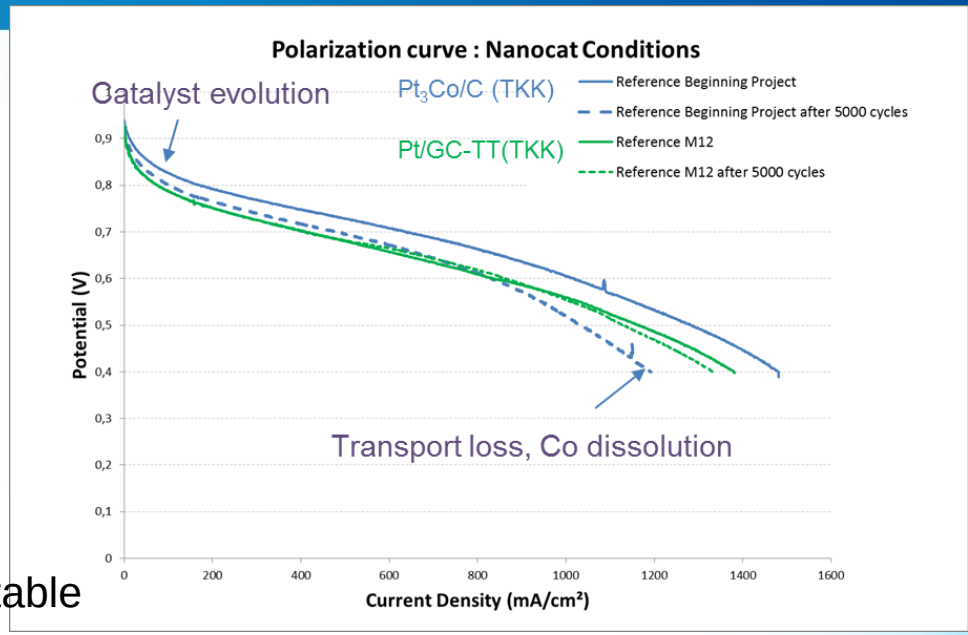
and increase of transport loss

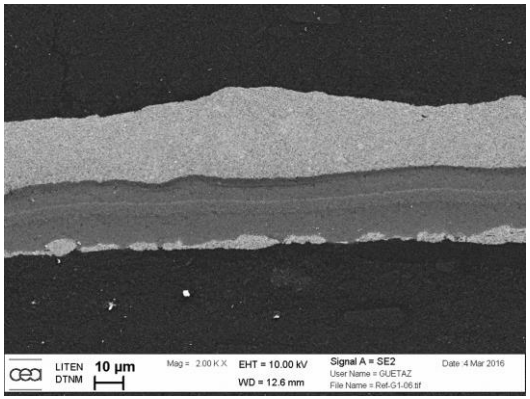
→ « graphitized » catalyst at the anode

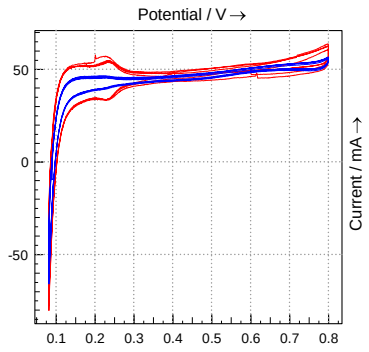
more resistant but less active

→ Using harsh cycle : loss of anode ECSA

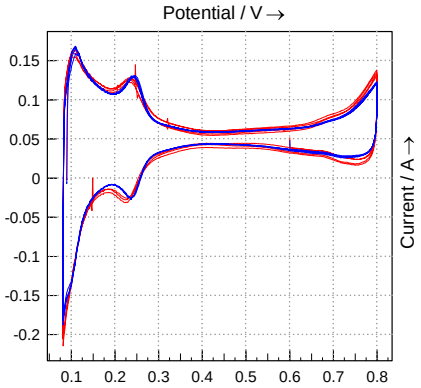
→ « graphitized » catalyst at the anode less stable







botanode2
eotanode1ok



botcathode
eotcathode1

DLR

Characterisation after durability cycle (grapithized catalyst)

cea
liten

New stable catalyst to reduce catalyst loading without decreasing life time

PROJECT PROGRESS/ACTIONS - new catalysts

Nano CAT
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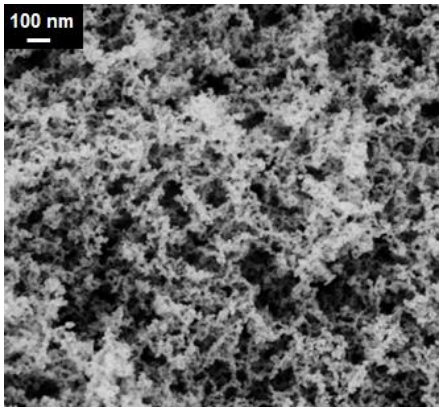
Achievement to-date

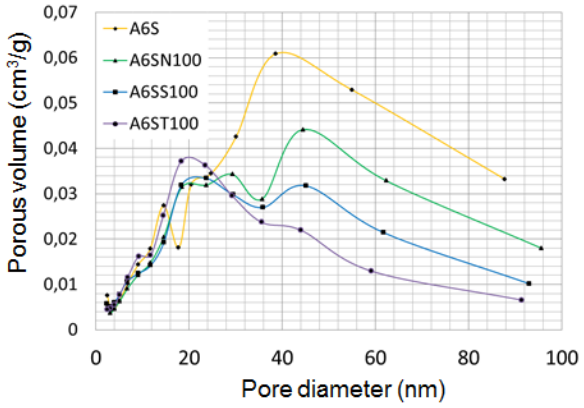
% stage of implement.

Pt deposition on SnO_2-Sb OK ✓

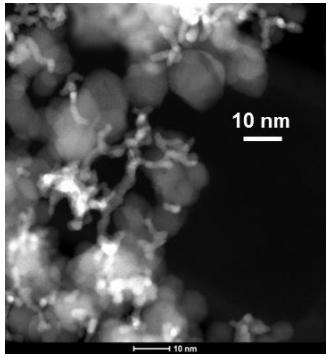
10^{-4} S/cm — NA — 25% — 50% — 75% — 1 S/cm (Xerogel) — 0,12 S/cm (Aerogel) — 85 m²/g (20-40 nm)

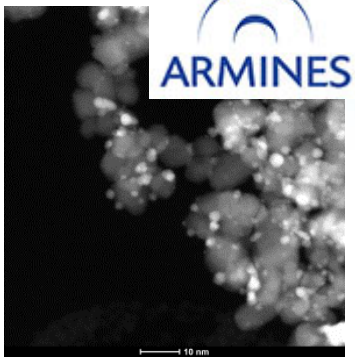
Aspect addressed	Parameter (KPI)	Unit	SoA 2017	FCH JU Targets		
				Call topic	2017	2020
Ctalyst on new robust support / durability	conductivity	S/cm	1	-	0.2	<0.2
	Morphology (PSD)	m²/g	85	N/A	N/A	N/A





SEM image of 10 at.% Sb-doped SnO_2 Aerogel and Pore Size Distribution (BJH) of SnO_2 and 10 at.% doped SnO_2 (Nb, Sb, Ta) Aerogels





Pt/ATO (left: polyol synthesis, right: UV synthesis)

PROJECT PROGRESS/ACTIONS - new catalysts

Nano CAT
Advanced Catalysts PEMFC Auto

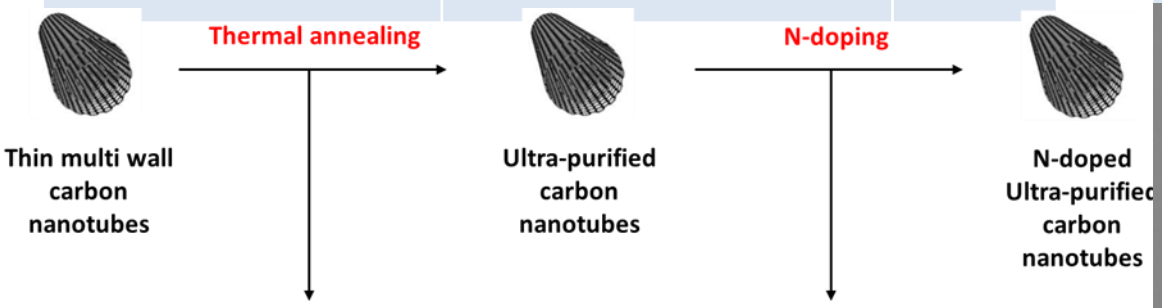
Achievement to-date

% stage of implement.

33 cm^{-2}/g_{Pt} — Durability > Pt/C (50%) commercial ref ✓ — 75 cm^{-2}/g_{Pt}

14 A/g — 25% — 50% — 75% — 18 A/g

Aspect addressed	Parameter (KPI)	Unit	SoA 2017	FCH JU Targets		
				Call topic	2017	2020
New robust catalyst support / durability	Activity JO_2 @ 0.9 V, H_2SO_4	A/g_{Pt}	-	>commercial SoA	-	-
	ECSA	cm^2/g_{Pt}	-	>commercial SoA -	-	-

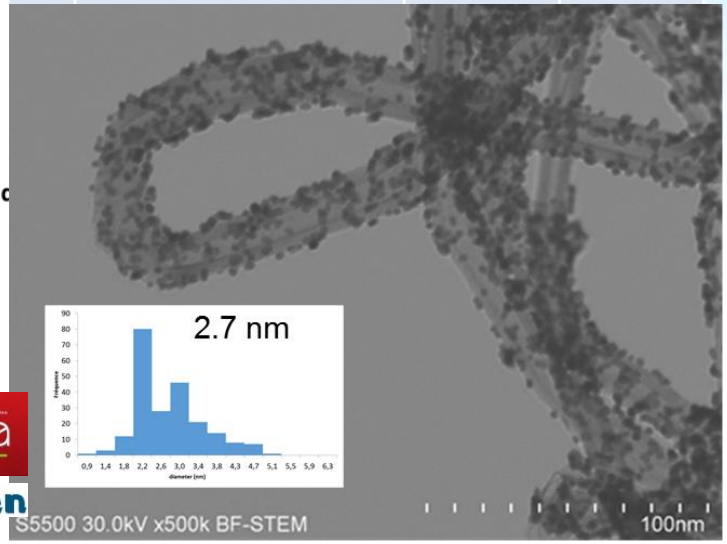


- *Improvement of graphitic structure*
- *Enhanced corrosion resistance*
- *Better electrical conductivity*
- *No activity of residual catalyst*

nanocyl

- *Enhanced electrocatalytic activity (lower Pt loading)*
- *Better dispersion and anchoring of Platinum particles on N sites*
- *Improved lifetime of electrocatalyst*

cea liten



PROJECT PROGRESS/ACTIONS - new catalysts integration / MEA preparation

Achievement to-date

% stage of implement.

0,72 W/cm^{-2} @1,6 A/cm^2

NanoCAT catalyst @ the anode ✓

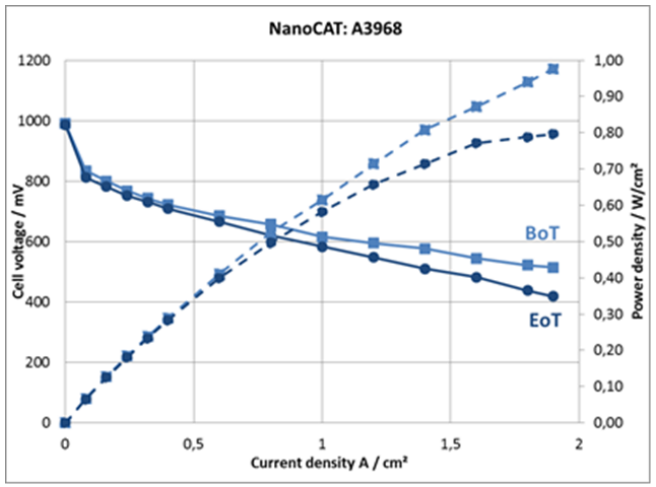
1 W/cm^{-2} @ 1,9 A/cm^2

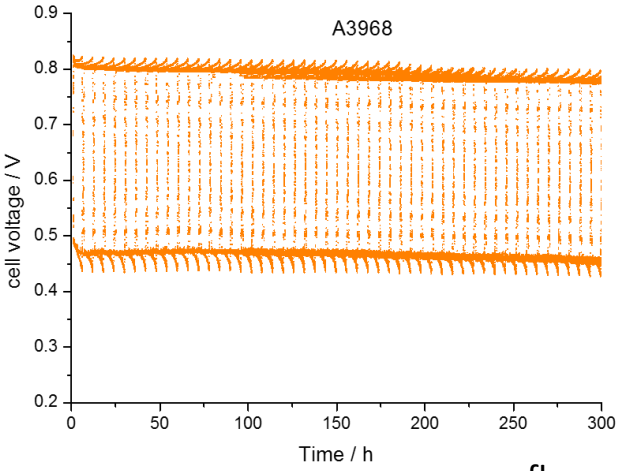
160 µV/h @1,4 A/cm^2 @300 hrs)

25% 50% 75%

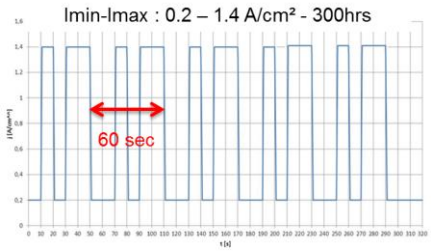
50 µV/h @ 1,4 A/cm^2 @ 300 hrs

Aspect addressed	Parameter (KPI)	Unit	SoA 2017	FCH JU Targets		
				Call topic	2017	2020
New MEA performance and durability	performance	W/cm^2	1,3	1	N/A	N/A
	Durability	µV/h	N/A	13 (5000 hrs)	10	10



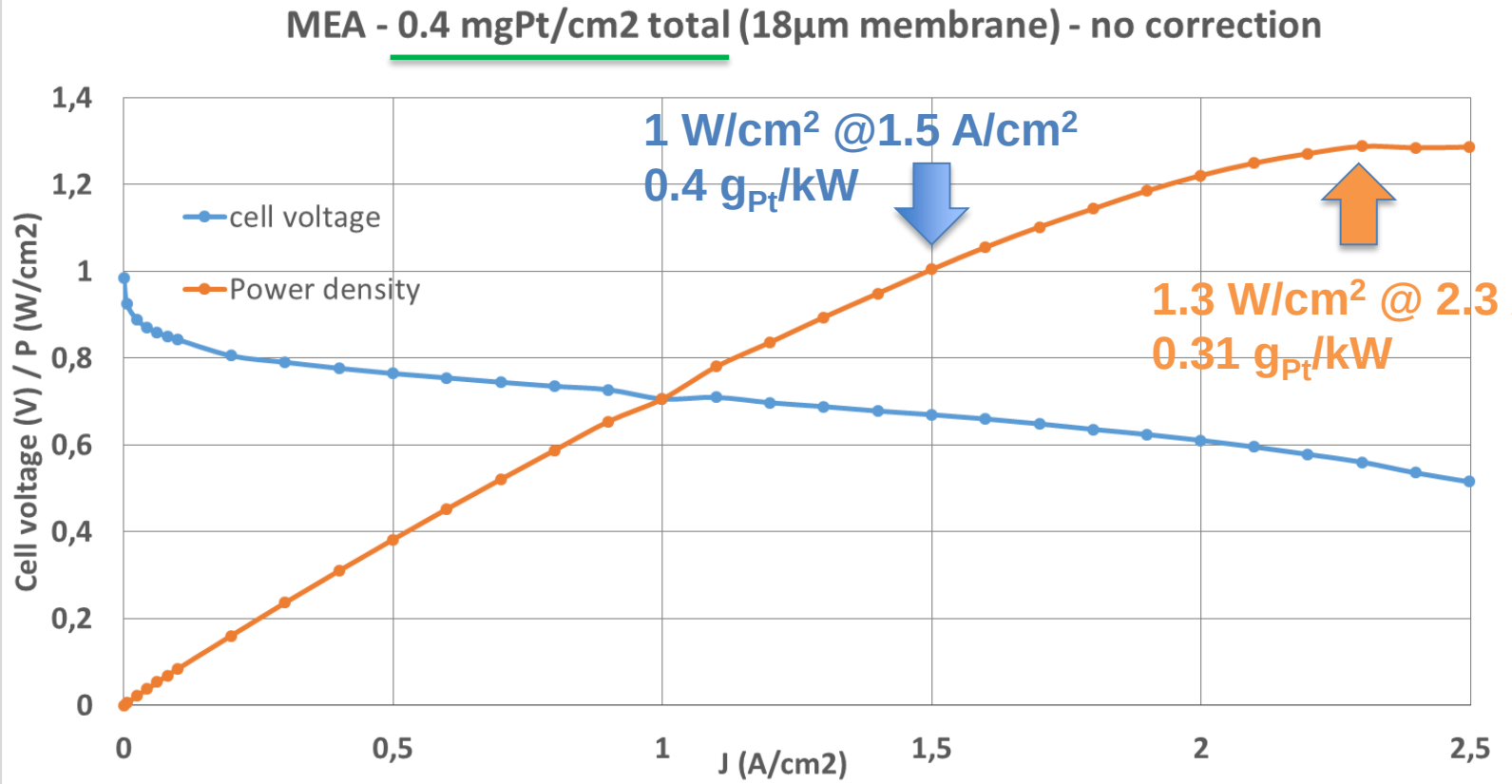


DLR



RH: 100 %,
flow: corresponding to St1.2/2 at 1.4 A/cm^2

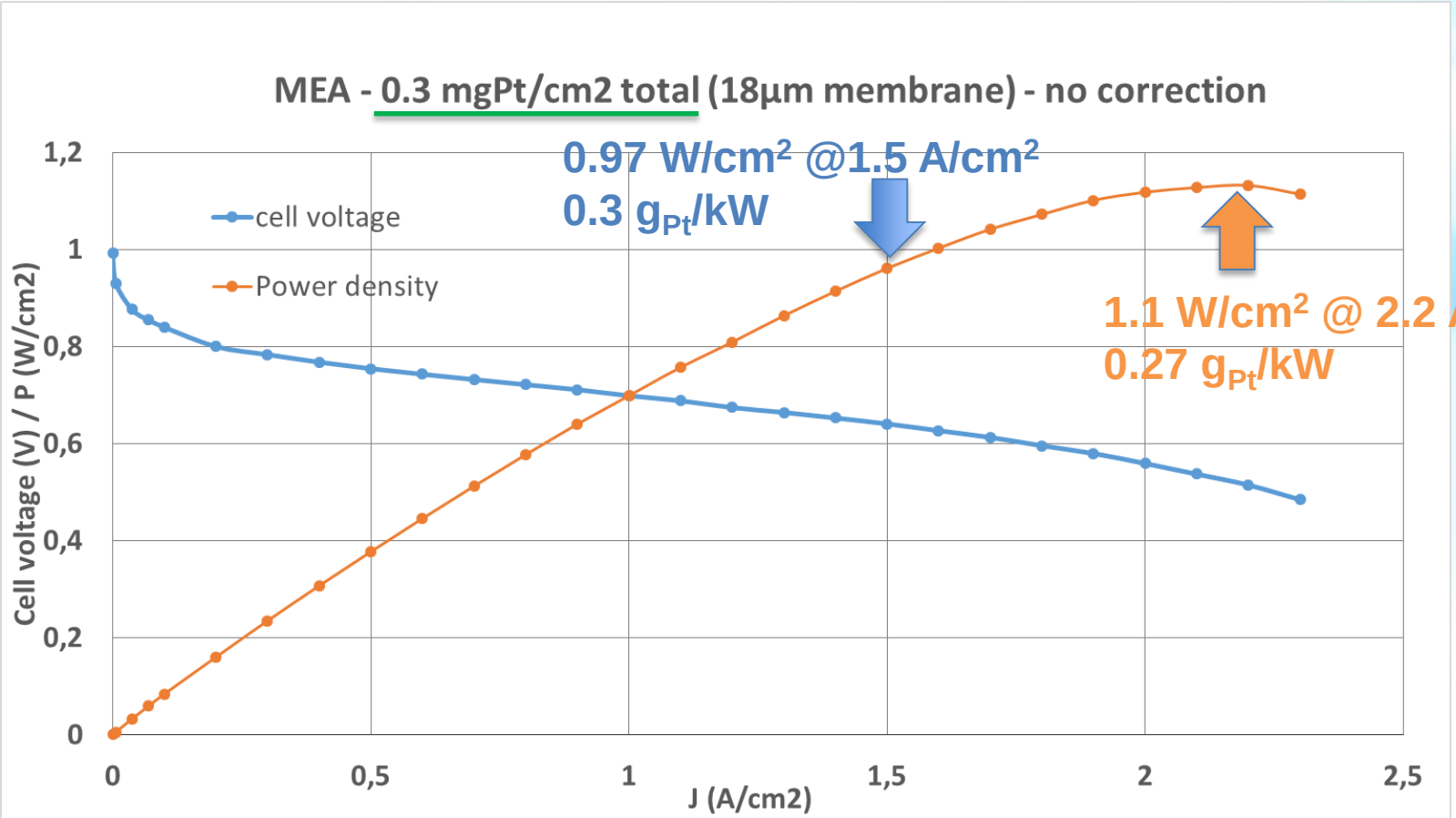
Last Progress



Operating conditions: **68° C, $P_{ano/cath}$ 2.2 / 2.0 bara; $RH_{ano/cath}$ 40 /50; $St_{H2/air}$, 1.4/1.6**

CEA large area single cell design (>100 cm^2)

Last Progress



Operating conditions: **68° C, $P_{ano/cath}$ 2.2 / 2.0 bara; $RH_{ano/cath}$ 40 /50; $St_{H2/air}$, 1.4/1.6**
CEA large area single cell design (>100 cm^2)

Technical conclusions

Developement of new catalysts (based on Pt):

→ Ex situ caractérisation : **all targets reach**

→ NTC : difficulties for integration in AL (agglomerates of NTC), **good integration @ anode side → new methodology to functionnalize graphitized support.**

→ SnO_2 – Sb : dopant leaching @ low potentiel (**very promising for PEMWE**)

Developement of bio inspired catalyst :

→ Anode side: stability decreases with temperature (new concepts to be found)

→ Cathode side: difficulties for integration (**working on the AL structure and material morphology is mandatory**)

Degradation of anode side when harsh load cycle used

SYNERGIES WITH OTHER PROJECTS AND PROGRAMMES

FCH and FP projects	Interaction and/or joint activities
DECODE	Provides knowledge about degradation processes and mechanisms; Use of DECODE GDLs in IMPACT
Autostack CORE	Uses IMPACT results on ultra-low loaded MEAs under automotive conditions
PremiumAct	Provides results on degradation
Second Act	Provides results on degradation
IMPALA	Exchange about improved GDLs
IMPACT	Provides input related to low loaded MEAs
PEMICAN	Provides input related to low loaded MEAs
Immediate	Provides stack

National projects	Interaction and/or joint activities
SURICAT	Catalyst supported metal oxide

DISSEMINATION ACTIVITIES

Public deliverables

- Report on dissemination (D7.1 – 7.2)
- Standards recommendation (7.7-7.8 – 7.9)
- Open workshop (D7.4)

Conferences/Workshops

- 1 organised by the project :

- 25 in other

Social media

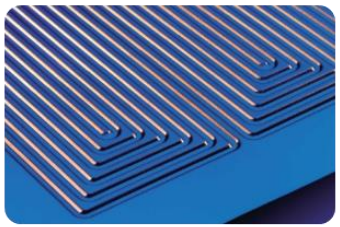
- http://www.nanocat-project.eu/

Publications: 15

- G. Ozouf, C. Beauger, Niobium- and antimony-doped tin dioxide aerogels as new catalyst supports for PEM fuel cells, **Journal of Materials Science** 51(11) (2016) 5305-5320
- T. N Huan et al, Bio-inspired Noble Metal-Free Nanomaterials Approaching Platinum Performances for H2 Evolution and Uptake

Patents: 2

Some Advertisement



COBRA

Find more information and contact us on:
http://www.cobra-fuelcell.eu/

Open Workshop dedicated to PEMFC bipolar plate innovations : from manufacturing to real field testing

December 13th 2017 at CEA Grenoble, France

Registration is free but inscription is necessary
Inscription deadlines :
For non-EU people : November 10th
For EU people : December 1st
Please contact : fabrice.micoud@cea.fr for registration and more information

The COBRA project, funded by FCH-JU and gathering European industrials and scientists, has been initiated to study **new manufacturing methods and coating concepts for metal bipolar plates** and demonstrate their interest for Fuel cell systems in real life conditions.

European Commission · FCH · Mateis · cea · borit · IMPACT COATINGS · IK4 CIDETEC

Thank You!

Coordinator: pierre-andre.jacques@cea.fr