



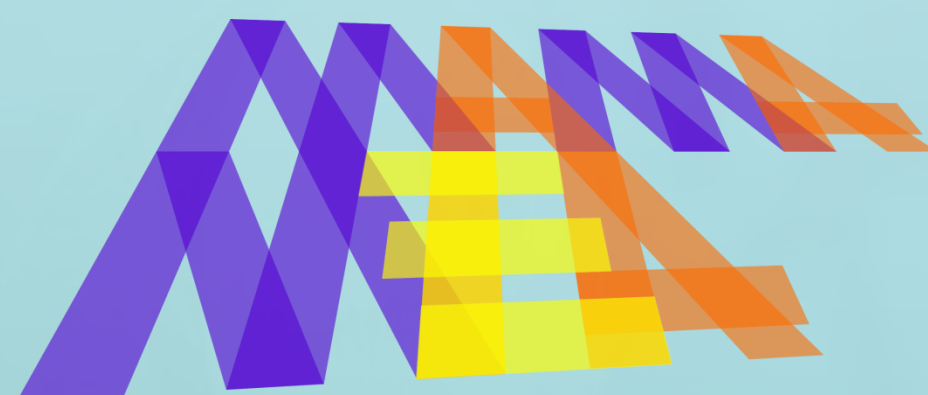
This project has received funding from the FCH JU and European Union's Horizon2020 research and innovation programme under Grant Agreement no. 779591.



FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

MAMA-MEA

Mass Manufacture of MEAs using high speed deposition processes



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Programme Review Days 2019

Brussels, 19-20 November 2019

PROJECT OVERVIEW



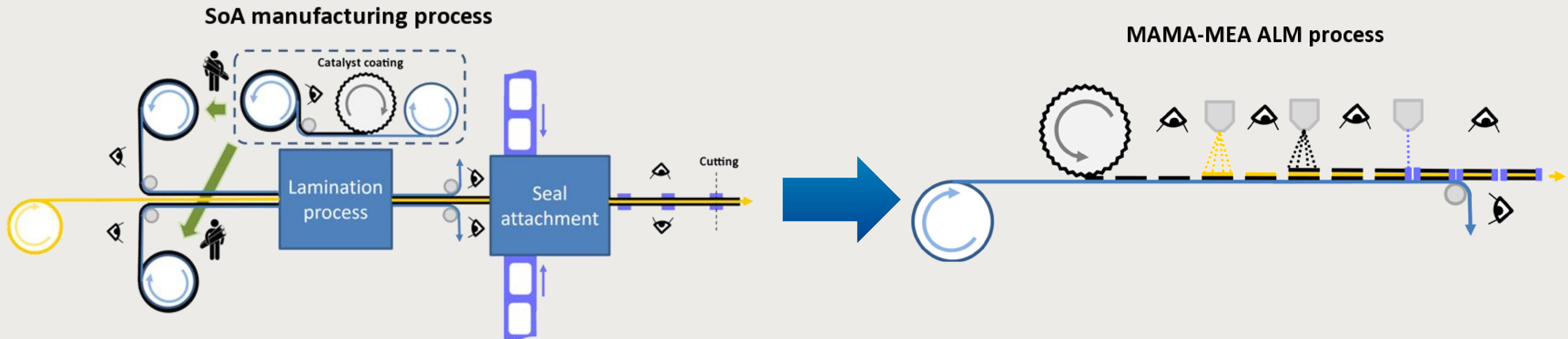
- **Call year:** 2017
- **Call topic:** FCH-02-8-2017: Step-change in Manufacturing of Fuel Cell Stack Components
- **Project dates:** 01.01.2018 – 31.12.2020
- **% stage of implementation 01/11/2019:** 60 %
- **Total project budget:** 3,189,816 €
- **FCH JU max. contribution:** 3,189,816 €
- **Other financial contribution:** 0 €
- **Partners:** Fraunhofer ENAS, INEA, JMFC, Nedstack, System Group, TU Chemnitz, UNIMORE



PROJECT SUMMARY

MAMA-MEA - Mass Manufacture of MEAs using high speed deposition processes

Main objective: Development and design of a high volume additive manufacturing process for CCMs suitable for 10 GW/year production.



PROJECT SUMMARY – KPIs and Application and Market Area

KPIs of MAMA-MEA

<i>KPI</i>	<i>MAMA-MEA and FCH targets</i>	<i>Status in the project</i>
Stack CAPEX	<350 €/kW	Not validated yet
Power density	>0.67 W/cm ²	Already reached on 50 cm ² samples
Degradation	<0.25 % / 1000 h	Not validated yet
Lifetime expectation	20,000 h	First RH-cycling of ALMCCMs performed on par with the baseline material
Material utilisation	>95%	Not validated yet
Metal loading control	≤10 % at ≤0.1 mg _{Pt} /cm ²	Not validated yet
Production web speed	~1 lm/s	Speed on the DCL for first ALMCCMs 50 lm/min
Production capacity	Potential of reaching 10 GW/a	Not validated yet
Performance target	Within 10 % of benchmark CCM	Reached for 50 cm² ALMCCMs

Application and market area: fuel cell, electrolysers and CCM manufacturers; other similar multi-layer structures

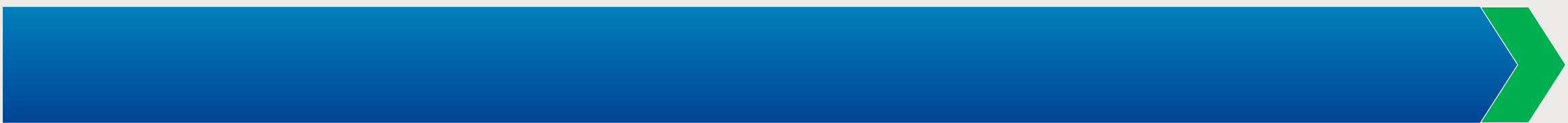
PROJECT PROGRESS/ACTIONS – Deposition Technology Assessment



Selection, grading and categorisation of suitable techniques for high volume production

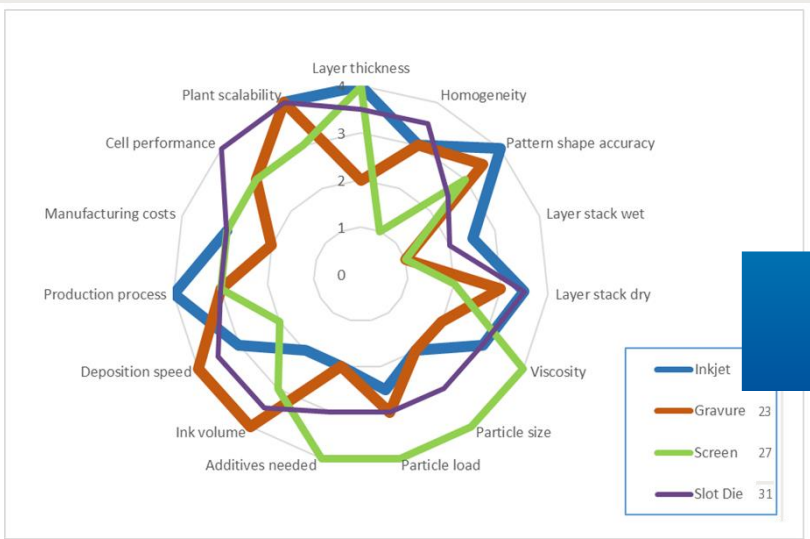
Achievement to-date

Deposition technologies



Selected deposition technologies

- Specification of deposited layers
 - Review of scientific and technical literature about liquid deposition technologies
 - Detailed deposition technology assessment
 - Deposition techniques down-selected according to industrial MEA requirements
- Deposition technologies selected for proof of concept



Component layer	Coating or printing technique			
	Inkjet printing	Gravure printing	Screen printing	Slot-die coating
Foundation catalyst				
Foundation ionomer				
Membrane				
Capping catalyst				
Seal				

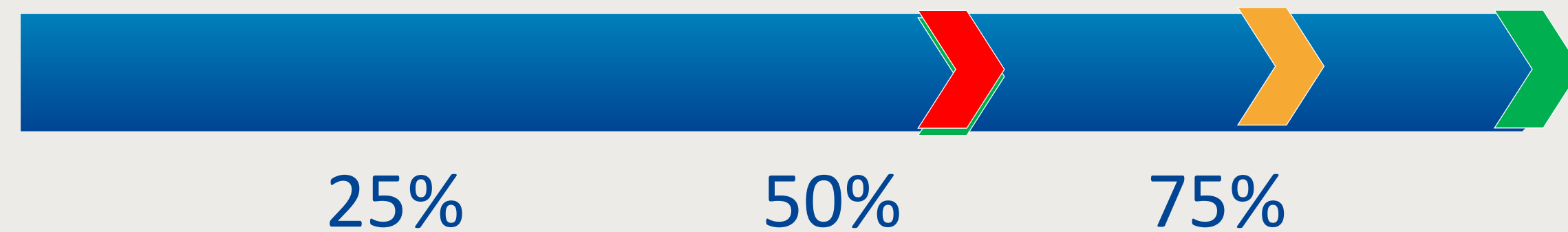


PROJECT PROGRESS/ACTIONS – Deposition of Multi-layers

Deposition process optimisation and multi-layer printing

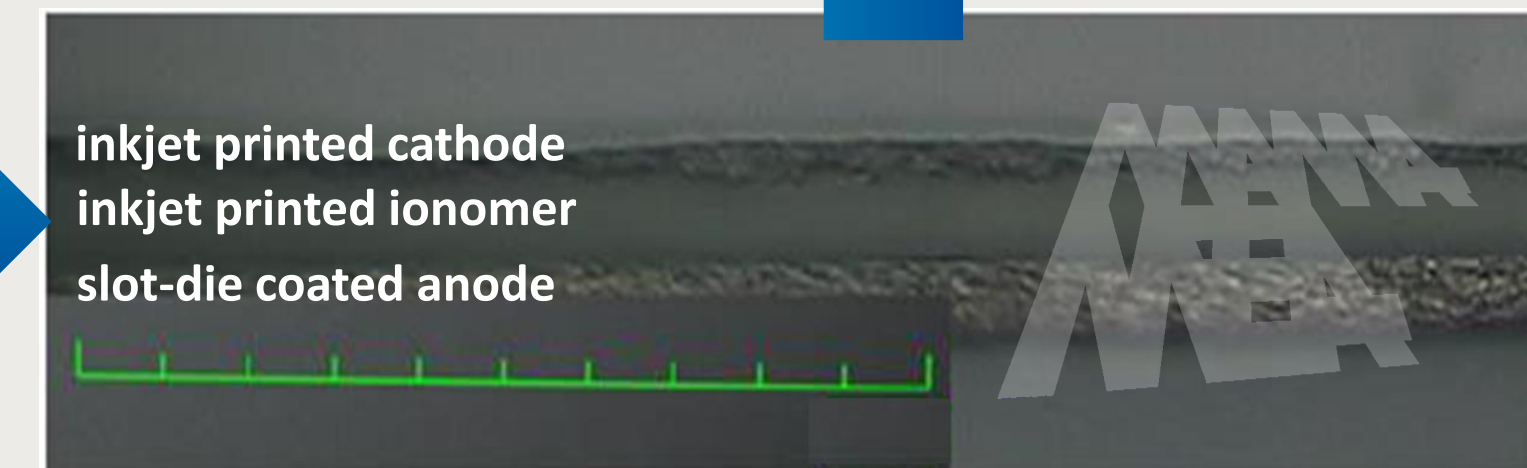
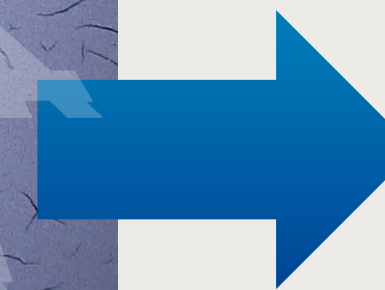
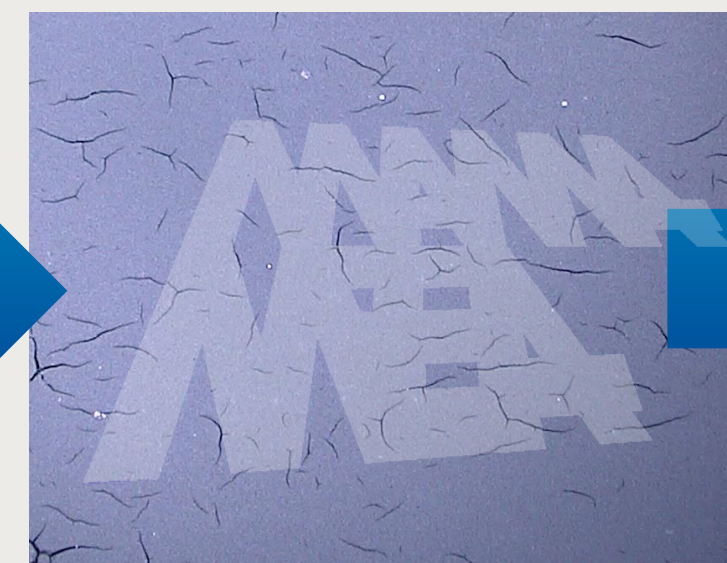
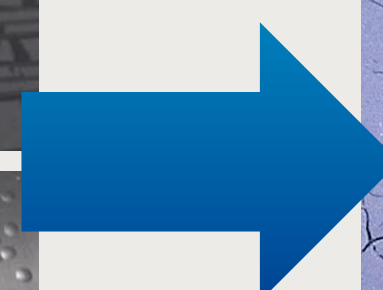
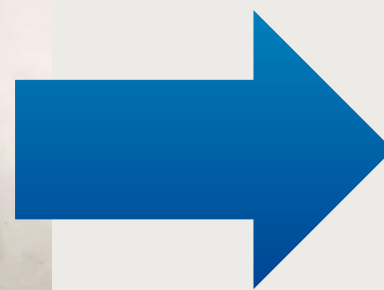
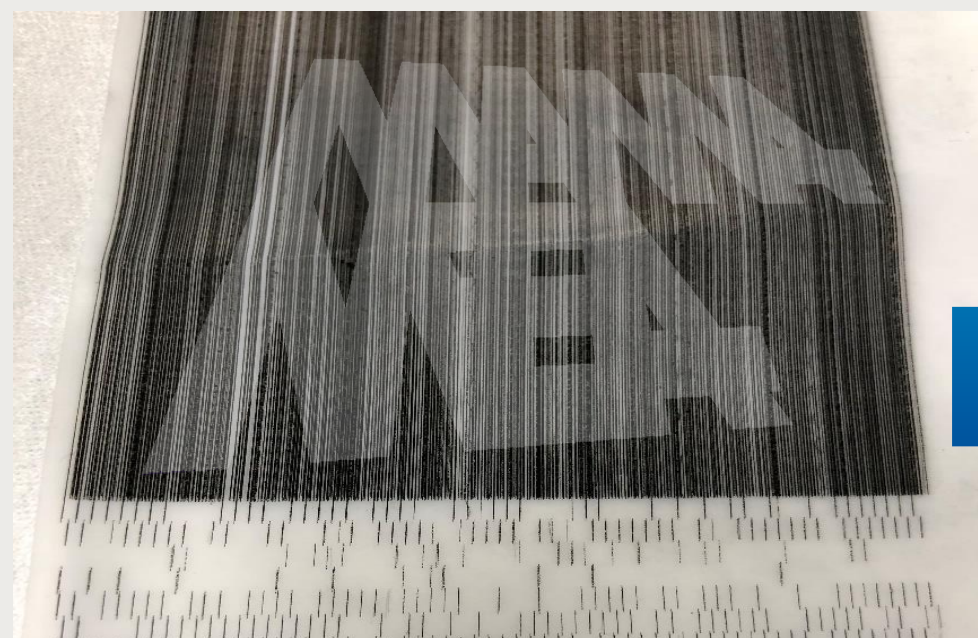
Achievement to-date

Deposition technologies



Inks
Single-layers
Multi-layers

- Development of appropriate compatible ink formulations for deposition techniques
- Initial single-layer depositions and evaluation
- Multi-layer deposition
- Demonstration of a 30lm roll of ALMCCM in industrial environment

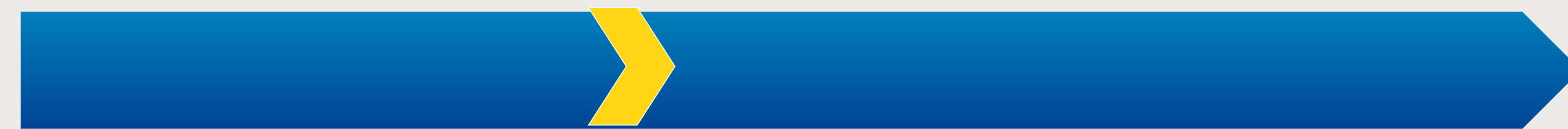


PROJECT PROGRESS/ACTIONS – Process validation

Benchmark against reference state-of-the-art (SoA) CCMs

Achievement to-date

SoA
CCMs



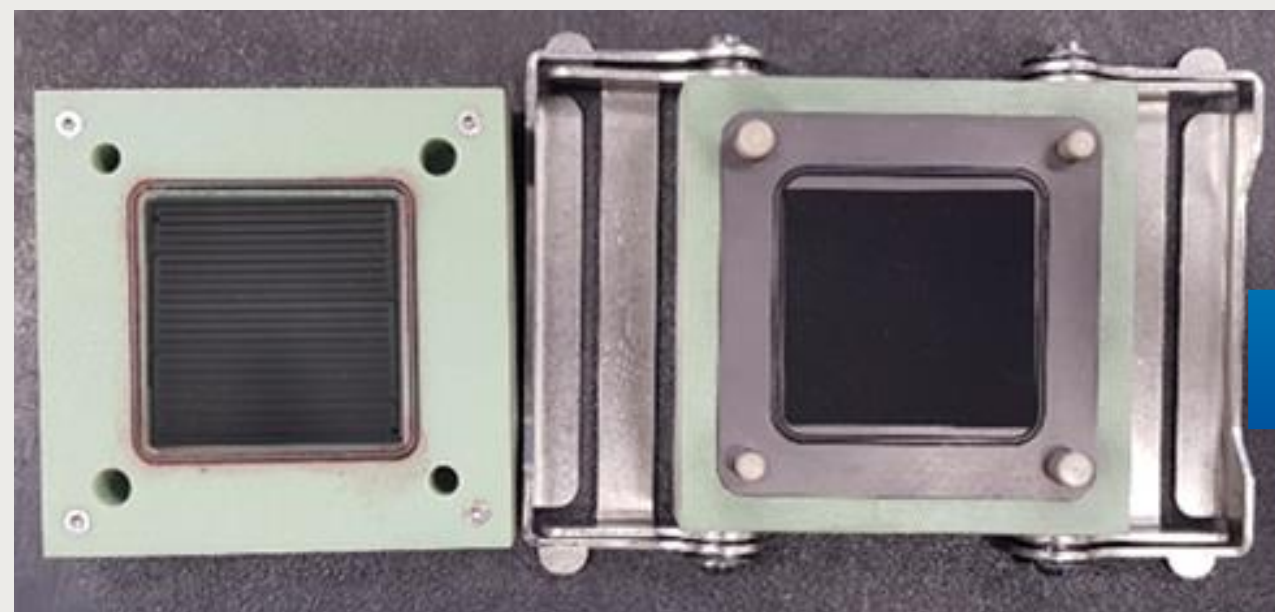
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50%

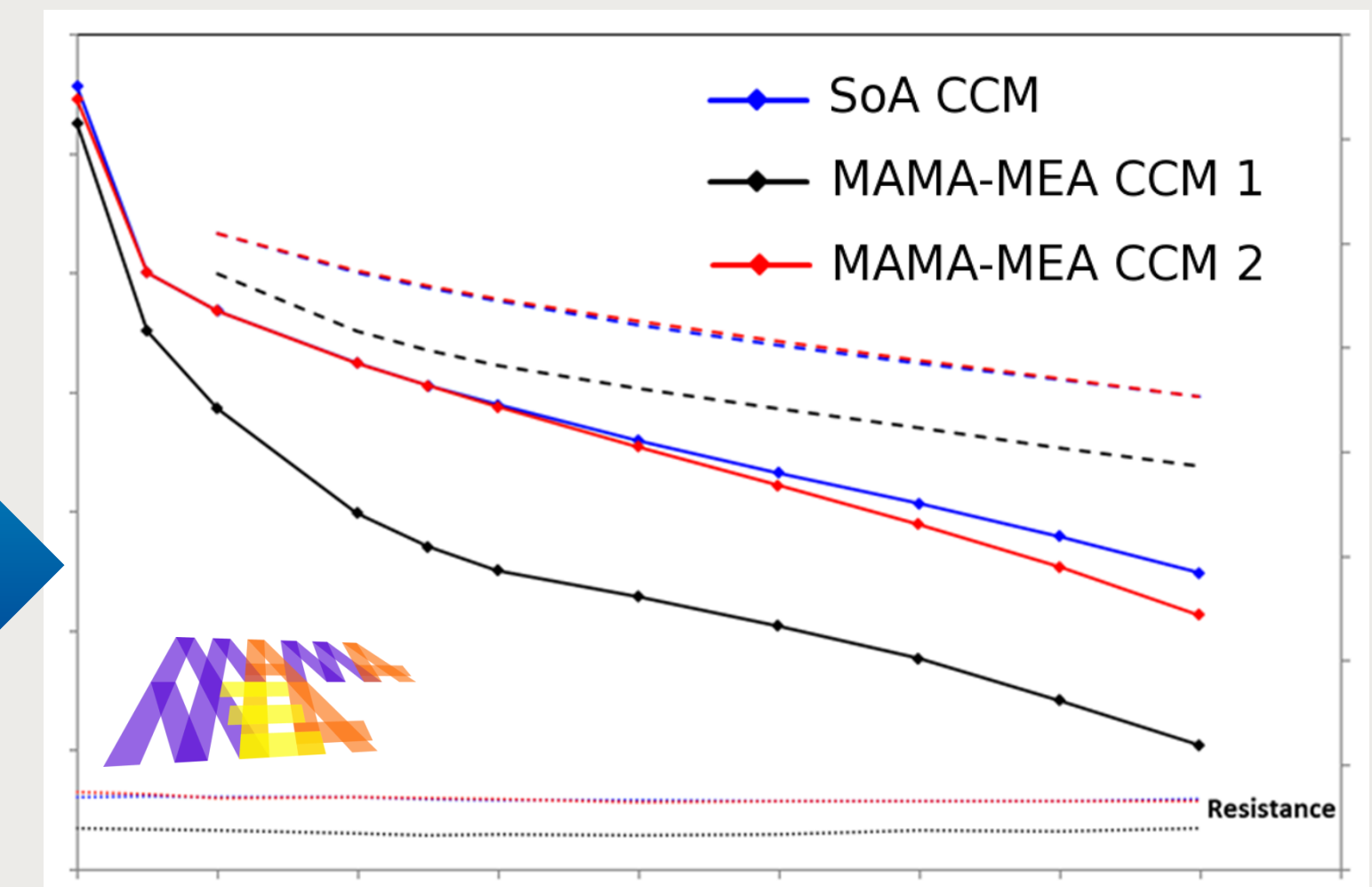
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Performance
parity of
MAMA-MEA CCMs

- Protocol definition and SoA component baselining
- Tests to confirm MEA functionality and reproducibility with stack relevant active area
- Durability testing in single cell and stack configuration
- Demonstration on two stacks with MAMA-MEA CCMs



cellFixture from balticFuelCells GmbH

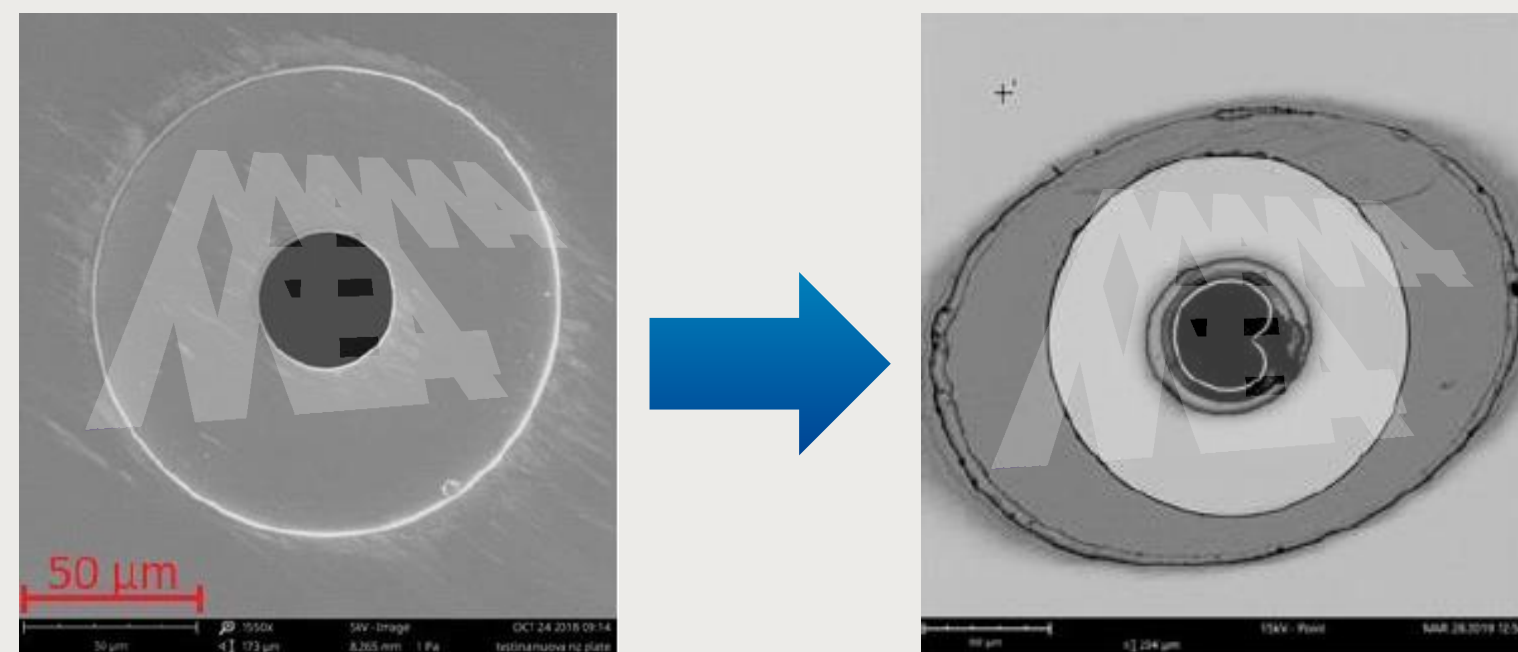


Risks and Challenges

Combination of mature manufacturing technologies from different industries poses challenges

Examples of mitigation strategies:

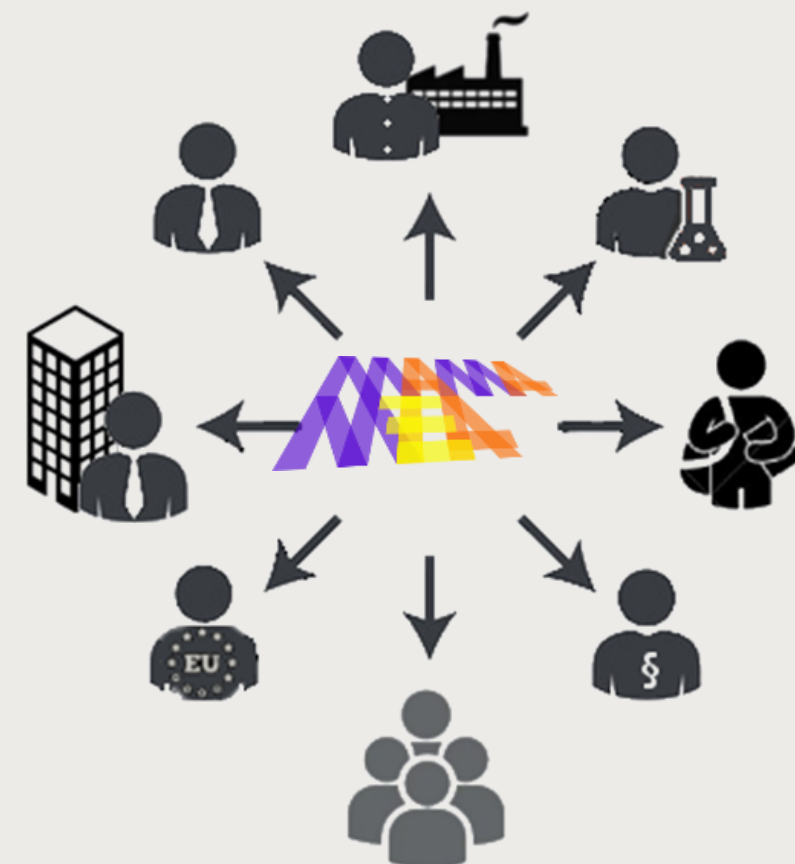
- Major challenge with one deposition technique encountered → modification/replacement by other technique
- Corrosion of industrial printheads by catalyst inks → compilation of material compatibility catalogue, collaboration with industrial printhead manufacturers
- Off-the-shelf inks are not printable → addition of non-contaminating agents / replacement of solvents



EXPLOITATION PLAN/EXPECTED IMPACT

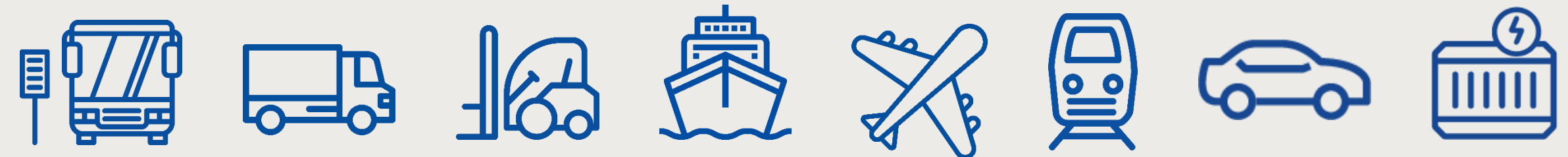
Exploitation

- Additive layer manufacturing is on the **JMFC**'s technology roadmap
- **SG** is planning inkjet manufacturing machines for “CCM-like” products
- **INEA** is offering upgrades to existing manufacturing lines (e.g. new QC)
- **TUC** and **UNIMORE** use the non-sensitive project outputs for academic and consultancy purposes



Impact

- MAMA-MEA's high volume additive layer deposition manufacturing addresses the growing demand for CCMs
- Higher utilisation of material – depositing only on the designated area → cost/scrap reduction



Communications Activities

(public, students, scientists, companies, stakeholders, politicians)



- Name ✓
- Project web-site ✓
- Social media ✓
- Flyers ✓
- Giveaways ✓
- Poster ✓
- Presentation ✓
- Articles ✓
- Chapters in books ✗
- Scientific papers ✓
- Patents ○
- Image video ○
- Lectures ✓
- Workshop ○

Dissemination Activities Tools (examples)



www.mama-mea.eu

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MAMA-MEA brings together world-leading and highly experienced industrial, institutional and academic partners with expertise in coating technologies and process design, from both within and outside the fuel cell industry.

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Flyer

Facts and Figures

Full name: Mass Manufacture of MEAs Using High Speed Deposition Processes

Acronym: MAMA-MEA

Start date: 1 January 2018

Duration: 36 months

Total budget: 3.1 M€

EC funding: 3.1 M€

Contacts

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Consortium

Technische Universität Chemnitz (TUC) Departments ALF and DPI Germany www.tu-chemnitz.de/mb/alf www.tu-chemnitz.de/mb/DigiTech

Università degli studi di Modena Reggio Emilia (UNI) Italy www.unimore.it

Fraunhofer-Institut für Elektronische Nanosysteme (ENAS) Germany www.enas.fraunhofer.de

Johnson Matthey Fuel Cells Ltd (JMFC) United Kingdom www.matthey.com

System S.p.A. (SG) Italy www.system-group.it

INEA d.o.o. (INEA) Slovenia www.inea.si

Nedstack Fuel Cell Technology B.V. (NFCT) The Netherlands www.nedstack.com

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Poster

IAF Institut für Automotive Research
Department of Advanced Powertrains
Prof. Dipl.-Ing. Thomas von Unwerth

MAMA-MEA
Mass Manufacture of MEAs Using High Speed Deposition Processes

H2020 RIA project

- Submitted within the call H2020-JTI-FCH 2017-1
- Duration: 36 months
- Start date: 1 January 2018
- EC Funding: 3.1 M€

Motivation

- Market for PEM fuel cells will increase to 10% GWs per annum from 2015
- For catalyst coated membrane, continuous manufacturing processes are currently being implemented by manufacturers worldwide
- Growing requirement for increased numbers of CCMs necessitates a manufacturing step-change in terms of cost and capacity
- Sealed CCM direct materials and manufacturing costs will be reduced by up to 50% in the new CCMs

Objectives

- Development of an innovative additive layer deposition process that integrates all the main CCM components (membrane, catalyst layers, sealing) in a single continuous roll-to-roll manufacturing process for the PEM fuel cell industry
- Enabling an increase in the volume manufacturing rate of over 10 times compared to state-of-the-art processes
- Increasing key material utilization and reducing materials and manufacturing costs
- Harmonising of advanced deposition techniques from the coating and printing industry

Project partners

- Technische Universität Chemnitz (TUC)
- Università degli studi di Modena e Reggio Emilia (UNIMORE)
- Fraunhofer-Institut für Elektronische Nanosysteme (ENAS)
- Johnson Matthey Fuel Cells Ltd (JMFC)
- System Group (SG)
- INEA d.o.o. (INEA)
- Nedstack Fuel Cell Technology B.V. (NFCT)

Concept, approach and project delineation

Consortium capabilities

Project progress so far

Consortium partners

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Activities	Amount
Conferences	6
Workshops	5
Scientific publications	1
Communication with other projects	6



SYNERGIES WITH OTHER PROJECTS AND PROGRAMMES



Interactions with projects funded under EU programmes

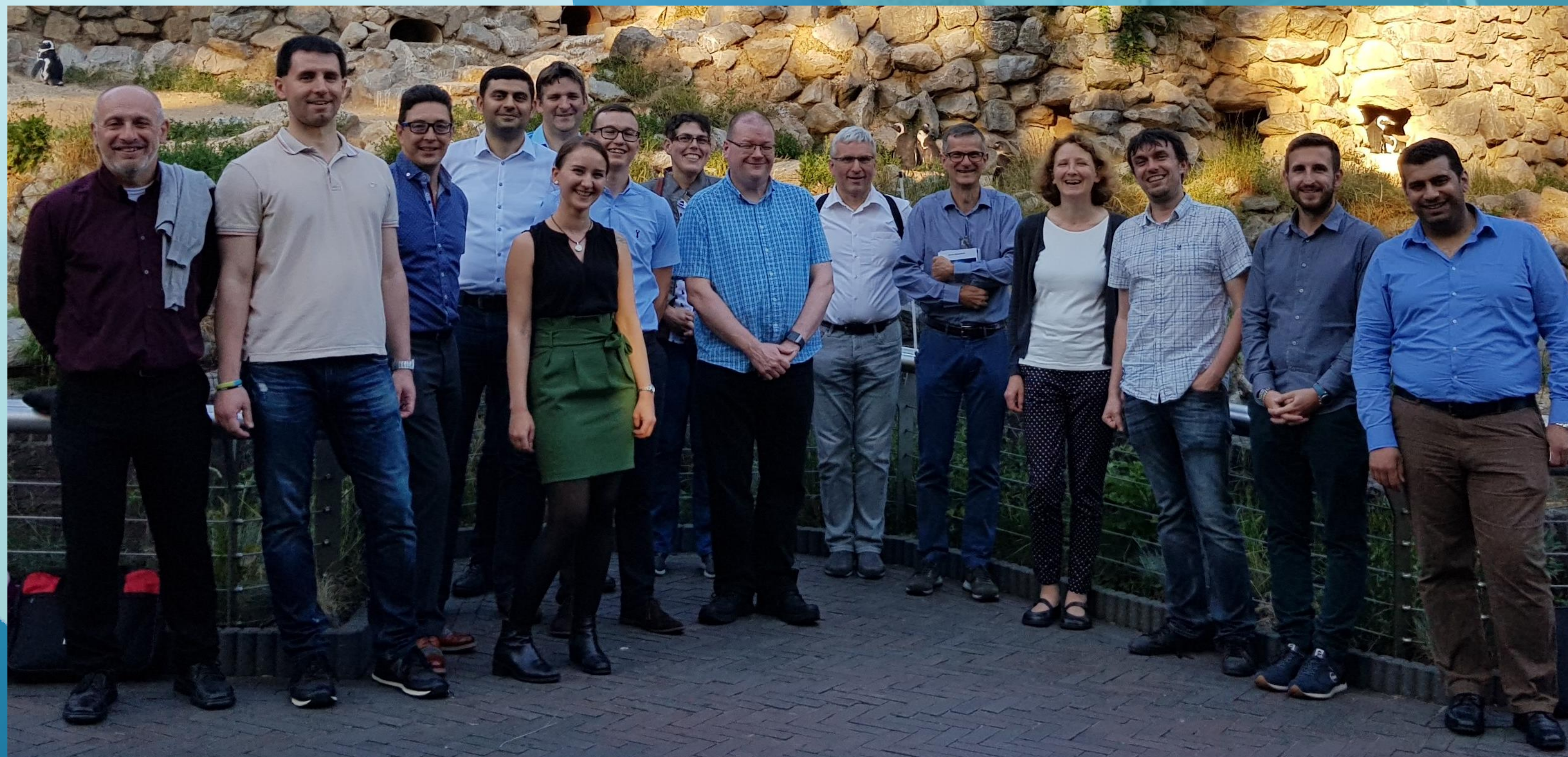
- FIT-4-AMANDA: Exchange of ideas regarding QC techniques; characterisation of FIT-4-AMANDA functional layers during demonstrations of QC hardware
- INSPIRE: Exchange of ideas during INSPIRE's FCH JU PEMFC development workshop
- GRASSHOPPER: Exchange of materials
- GAIA: Exchange of materials
- VOLUMETRIQ: Exchange ideas





FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

MAMA-MEA team thanks you for your attention!



Brussels, 19-20 November 2019



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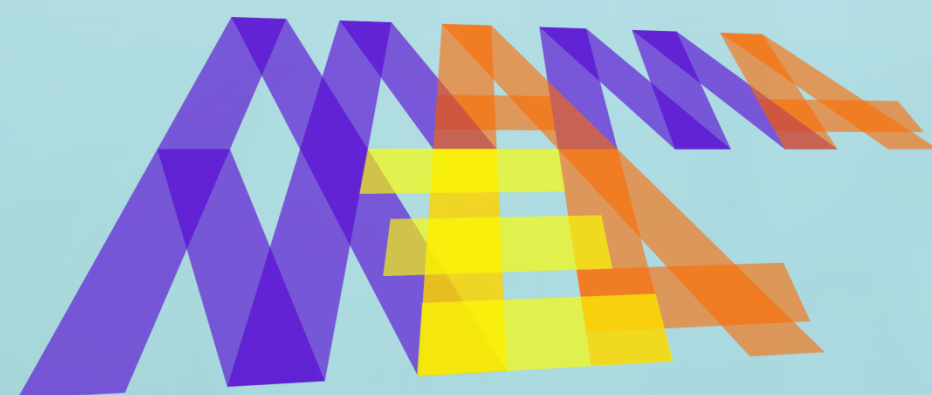
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JOINT UNDERTAKING

MAMA-MEA

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