STAMPEM

STAMPEM - STAble and low cost Manufactured bipolar plates for PEM Fuel Cells

Project overview

The FCH JU funded project "STAble and low cost Manufactured bipolar plates for PEM Fuel Cells" - STAMPEM (303449), is a cooperation project between SINTEF (Norway), Teer Coatings Limited, Miba Coating Group (UK), ElringKlinger (Germany), Fraunhofer Institute for Solar Energy Systems ISE (Germany), University of Birmingham (UK) and Fronius (Austria). It is dedicated to the goal of developing coatings for PEM fuel cell metallic bipolar plates (BBPs).

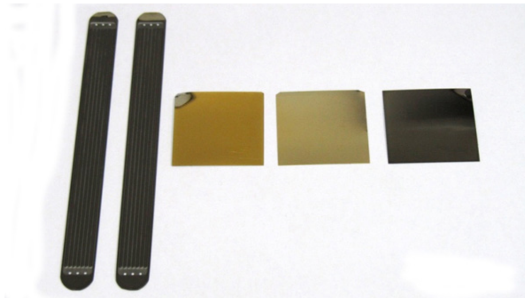
Recent developments have showed that metallic bipolar plates for PEMFCs have many advantages including their high strength, mechanical durability, electrical conductivity, and the minimum thickness. The main objective of the STAMPEM project is to develop durable coatings materials for metal based bipolar plates, that can be mass produced for less than 2.5 € /kW of rated stack power at mass production volumes of 500 000 pieces annually. Properties after extrapolated 10 000 hours from AST single cell testing shall still be within the AIP specifications. The main parameters are contact resistance (< 25 ohm cm^2) and corrosion resistance (< 10 µA/cm^2).

First year summary

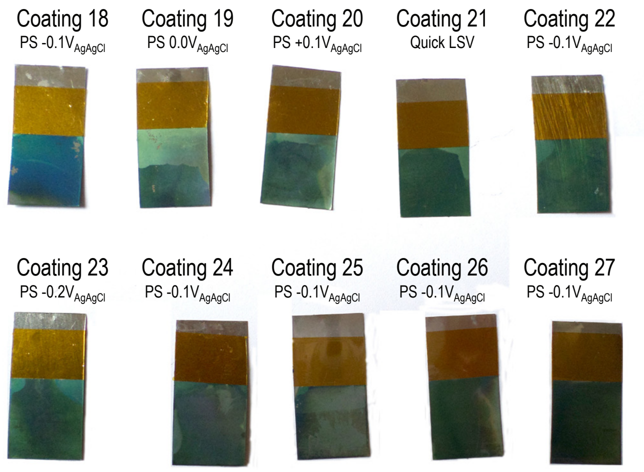
The STAMPEM project has recently passed its first year of operation. Our results already show that there are coatings with high performance both in the ex-situ and in-situ testing. Accelerated stress tests of BPPs in fuel cells indicate that there are coatings/concepts that have comparable properties to gold coated stainless steel. Work on manufacturing and processing issues are also progressing along with the project, where pre-treatment of substrate, coating techniques and the stamping process, including plate joining, are the most important steps.

Coating materials/concepts

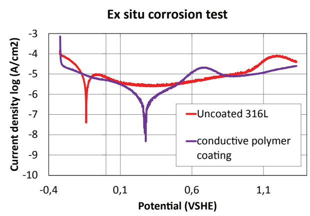
We are working on different materials and concepts to come up with a low cost, high performance BPP that fulfils both technical and economical requirements. Metal nitrides, conductive polymers, carbon composites, multilayer coatings and totally new concepts are being developed and tested. Gold on stainless steel is used as a reference, and some of the tested materials already perform the same or better than this.



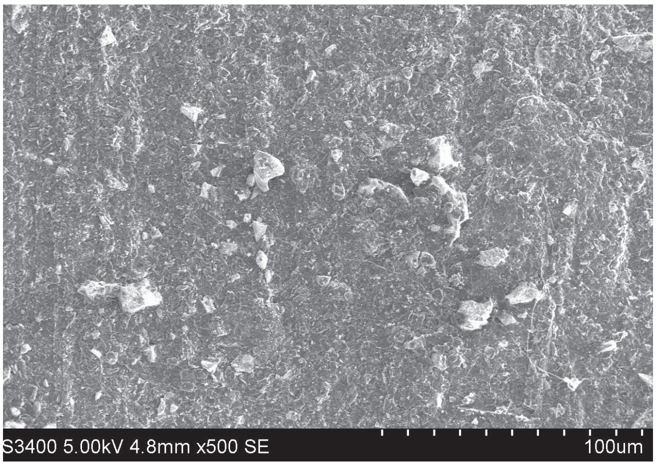
PVD coated sample BPPs and coupons

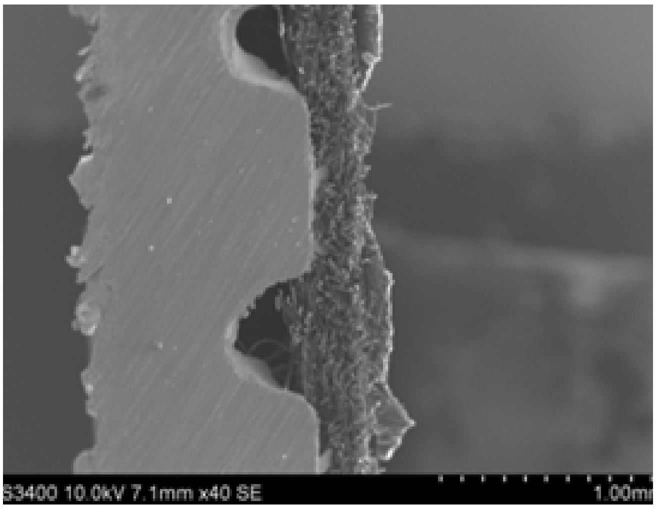


Conductive polymer-based coatings and ex-situ corrosion analysis



CO-FUNDED BY THE EUROPEAN UNION
SEVENTH FRAMEWORK PROGRAMME
New Energy World JU
fuel cells & hydrogen for sustainability
The Research Council of Norway

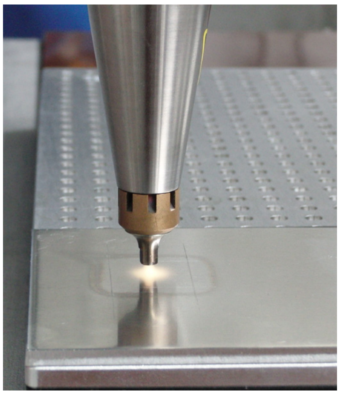




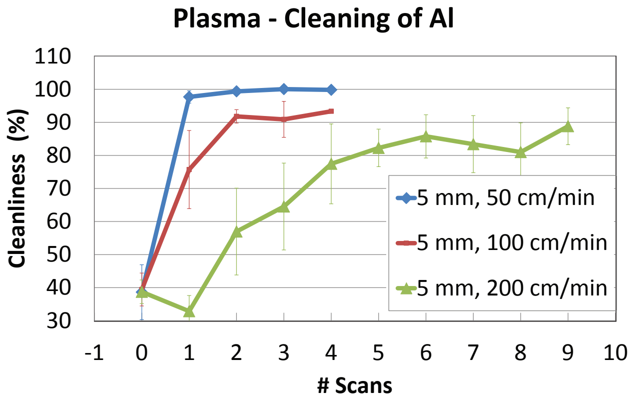
Carbon-based coating (top) and combined GDL/BPP concept.

Cleaning of substrates before coating

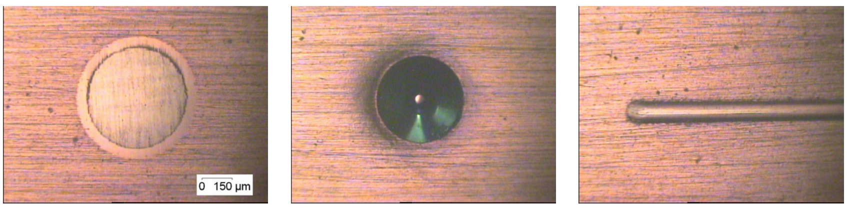
To achieve good adhesion and low contact resistance between the BPP metal substrate and the coating, organic residue and oxides on the stainless steel surface must be removed prior to coating. A variation of methods and techniques are being investigated and further developed within STAMPEM, e.g. Atmospheric Air Plasma and Linear Ion Source cleaning.



Atmospheric Air Plasma.



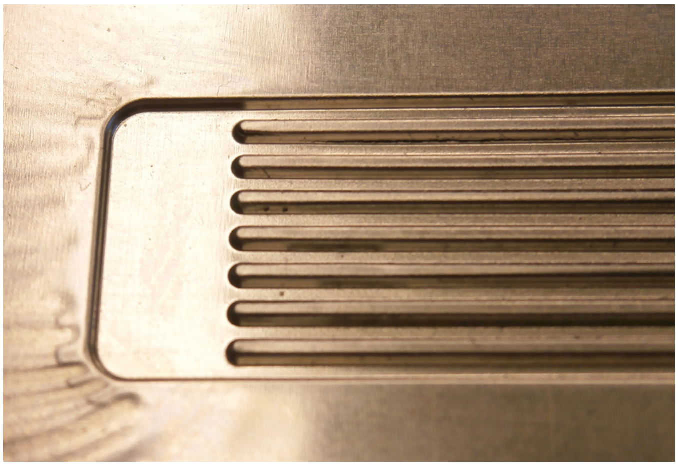
Linear Ion Source cleaning of substrates.



Thickness and tribological tests of coatings.

Stamping of bipolar plates

Stamping of bipolar plates for both full scale and small scale is also a part of the project. Thin SS plates are used when forming flow field structures for SINTEFs test cell, see parts of a stamped plate below.

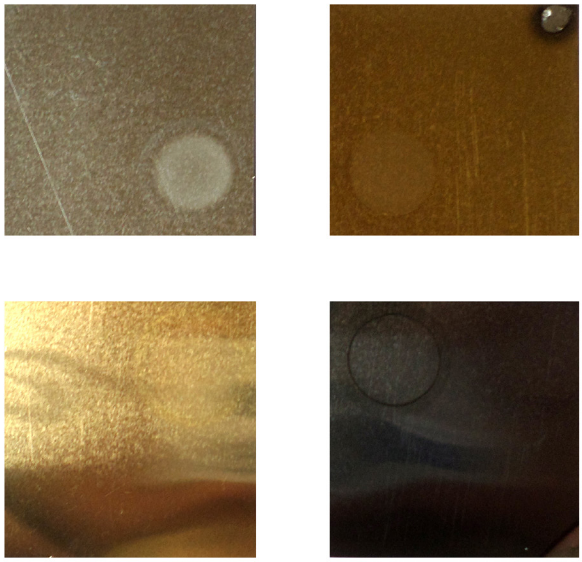


Result after first stamping test of small-scale single cell test plate.

Ex- and in-situ test of coating/BPP performance

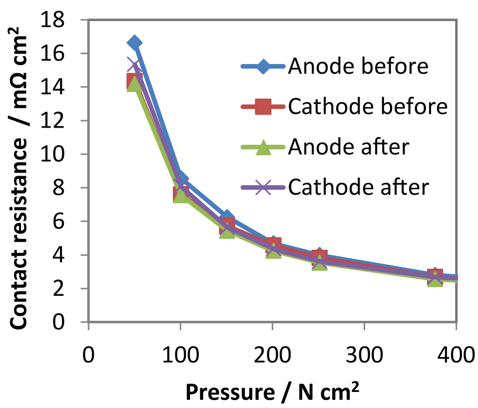
Promising coatings are initially being tested ex-situ in a three-electrode electrochemical set-up. Linear sweeps (polarisation) and potentiostatic (constant voltage) experiments are designed to mimic real fuel cell performance. This is performed on coated flat coupons and gives an indication about the technical properties of the coating. If the material is promising, in-situ tests are performed to further investigate the suitability in a real fuel cell. Structured metallic plates (flow fields) are coated and put in a small scale test cell, where an accelerated stress test degrades the BPP materials.

In-situ tested BPPs with coatings



Ex-situ tested coatings (coupons).

Together with the corrosion current found in the ex-situ experiments, the interfacial contact resistance (ICR) towards a carbon-based gas diffusion layer (GDL) is one of the most important properties of BPPs. Especially the difference between the original Beginning of Life (BoL) and the End of Test (EoT) values are important to distinguish between suitable and unsuitable materials. Below an example with gold coated plates is shown. There has been some discrepancies between the findings in the in-situ and ex-situ tests, thus there is a need for some more fundamental work to improve the understanding of the processes occurring during operation.

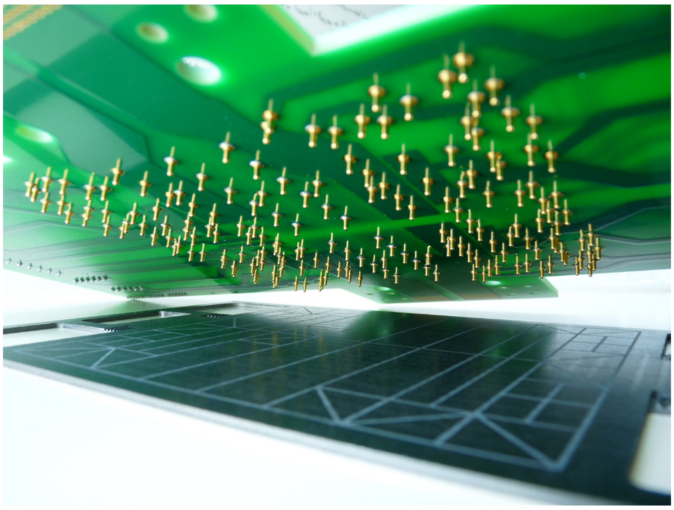


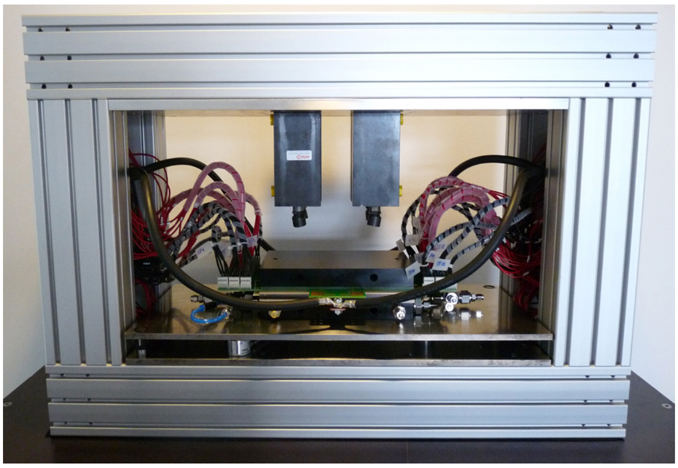
ICR for gold coated BPPs

Segmented cell for local characterization

In a later stage of the project, a segmented cell is used for local characterization of the processes in the final cell design. Therefore, a segmentation procedure for a graphitic BPP has been developed and demonstrated on a first dummy cell. For the first spatially resolved characterization setup, the segmented side of the cell (anode or cathode) will be realized in a segmented graphitic plate while on the other side the unchanged metallic BPP is used.

For the integration of the BPP in a test bench, a cell housing, consisting of 4 hydraulic cylinders for the cell compression, connectors for the inlet gases and coolant as well as the electrical contacting for the segmented cell has been finalized.





First version of a segmented graphitic test cell (top, 200 cm² active area) with contact pins and cell housing with compression unit and electrical cell contacts for the integration of the segmented cell (bottom).

Coordinator:

Anders Ødegård
SINTEF Materials and Chemistry
e-mail: anders.odegard@sintef.no, phone: +47 943 56 595

SINTEF

Consortium:

Innovation in Motion Miba | elringklinger | Fraunhofer ISE | University of Birmingham | Fronius

The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for the Fuel Cells and Hydrogen Joint Technology Initiative under grant agreement n° 303449 10, and the Research Council of Norway.

CO-FUNDED BY THE EUROPEAN UNION | SEVENTH FRAMEWORK PROGRAMME | New Energy World JU fuel cells & hydrogen for sustainability | The Research Council of Norway