November 2014

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, EC project reference 303449, is a cooperation project between SINTEF (Norway), MIBA Teer Coatings Limited (UK), ElringKlinger (Germany), Fraunhofer Institute for Solar Energy Systems (Germany), University of Birmingham (UK) and Fronius (Austria). It is dedicated to the goal of developing coatings for PEM fuel cell metallic bipolar plates.

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 coating 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 stacks annually. Properties after extrapolated 10 000 hours from AST single cell testing shall still be within the AIP specifications. The main parameters are interfacial contact resistance (ICR) (< 25 ohm cm^2) and corrosion resistance (< 10 µA/cm^2).

Second year summary

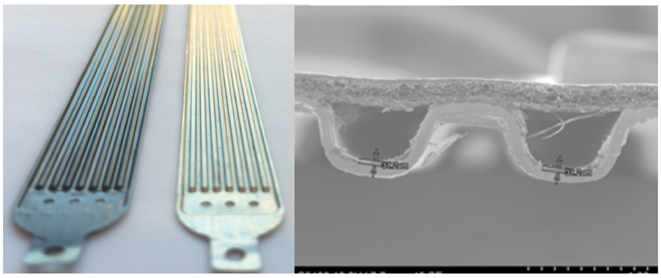
The STAMPEM project has passed its second year of operation. Our results show that there are coatings with high performance and durability both in small scale single cell and full size cell testing. In small scale fuel cell accelerated stress tests, these coatings have properties comparable to gold.

Manufacturing and processing issues of complete BPPs are also included in the project, where pre-treatment of substrate, coating, stamping and plate cutting/ joining are the most important steps.

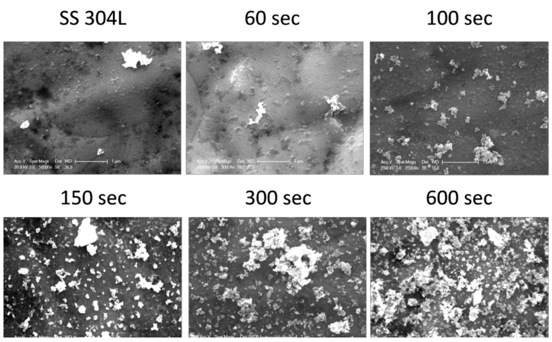
The final applied coating must conform to all these processes, in addition to maintaining the above mentioned required properties. Current calculations of the best coating indicate a cost of around € 8-14 /kW, depending on type of application, operating parameters and performance of the stack.

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 and totally new concepts are being developed and tested. Gold on stainless steel is used as a reference, and some of the developed materials already perform the same or better than this.



PVD coated and uncoated small scale BPPs (left), and combined GDL/BPP concept on stamped small size BPPs, where the GDL can be glued to the BPP with a non-conductive glue (right). SEM images for TiN-PANI coating with different coating time (below).



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

Cleaning and coating of substrates

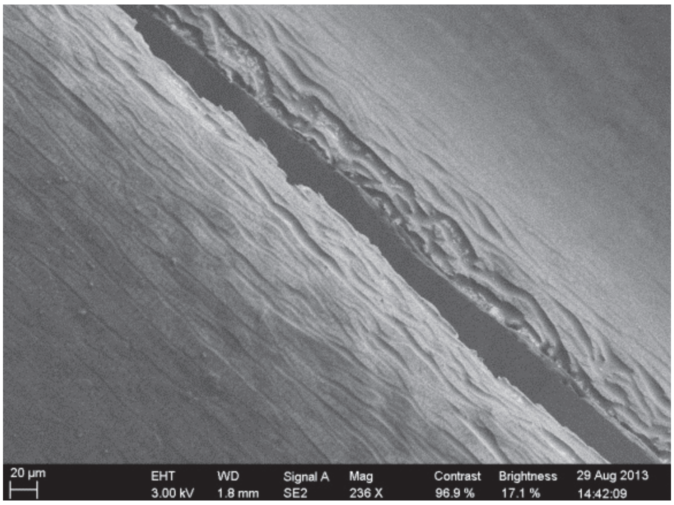
To achieve good adhesion and low contact resistance between the BPP metal substrate and the coating, organic residue and oxides on the stainless steel surface must be removed prior to coating. A variety of methods and techniques are being investigated and further developed within STAMPEM, e.g. Atmospheric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

Atmospheric pressure steam and air plasma cleaning prototype by Fronius.

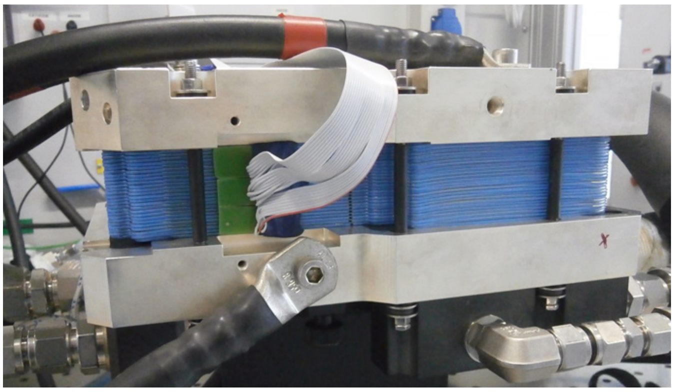
TCL in-line coating system for BPP to enable the coating of cleaned BBPs in semi-continuous process rather than a batch process, reducing process time and cost while increasing volume capacity.

Stamping of bipolar plates - metal BPP stack

First stacks with metal plates from galvanically gold-coated platines were produced and operated during the second year. The metal BPP stack performs better than previous stack design with graphite based BPPs, and no significant irreversible degradation has been seen after more than 1000 hours of operation.



Stamping of pre-coated plates, where the coating still adheres but cracks when the metal is stretched up to the elongation limits.

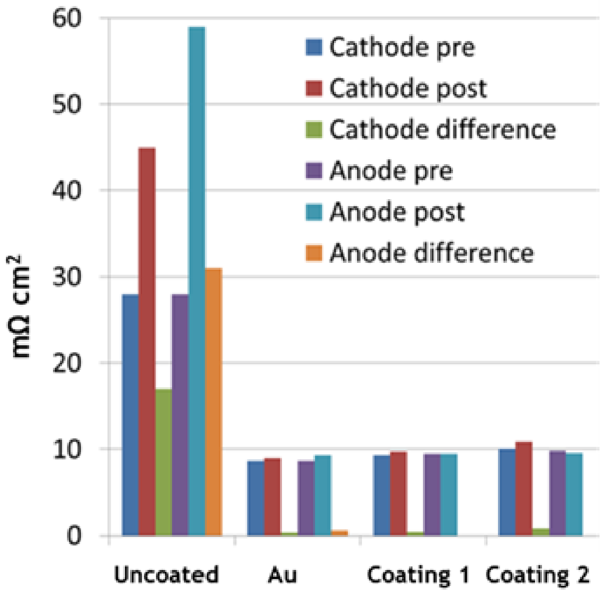


48-cell stack from partner ElringKlinger with galvanically coated metal BPPs.

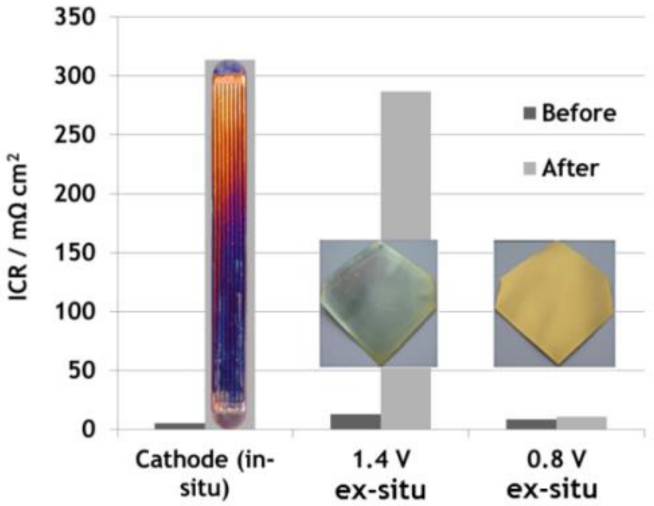
Ex- and in-situ tests of coatings/BPPs

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. In-situ tests are performed on the most promising materials to further investigate the suitability in a real fuel cell. Structured metallic plates (BPPs with flow fields) are coated and put in a small scale test cell, where an accelerated stress test (AST) degrades the BPP materials.

Together with the corrosion current measured in the ex-situ experiments, the interfacial contact resistance towards a carbon-based gas diffusion layer (GDL) is one of the most important properties of BPPs to distinguish between suitable and unsuitable materials. ICR is measured before and after testing and should remain more or less unchanged.



Status of best coatings after small scale in-situ AST, 100 hours cycling between OCV and 0.4 V.

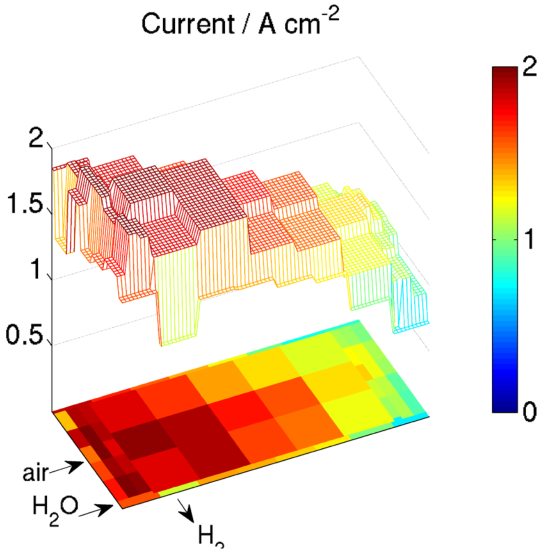


Comparing in-situ and ex-situ results, adjusting ex-situ test parameters (applied potential in ex-situ test 0.8 and 1.4 V for one hour).

Segmented cell for local characterization

A segmented cell is used for the local characterization of the processes in the final cell design. For the first spatially resolved characterization setup, the segmented side of the cell was realized in a segmented graphitic plate, while on the other side the unchanged metallic BPP was used.

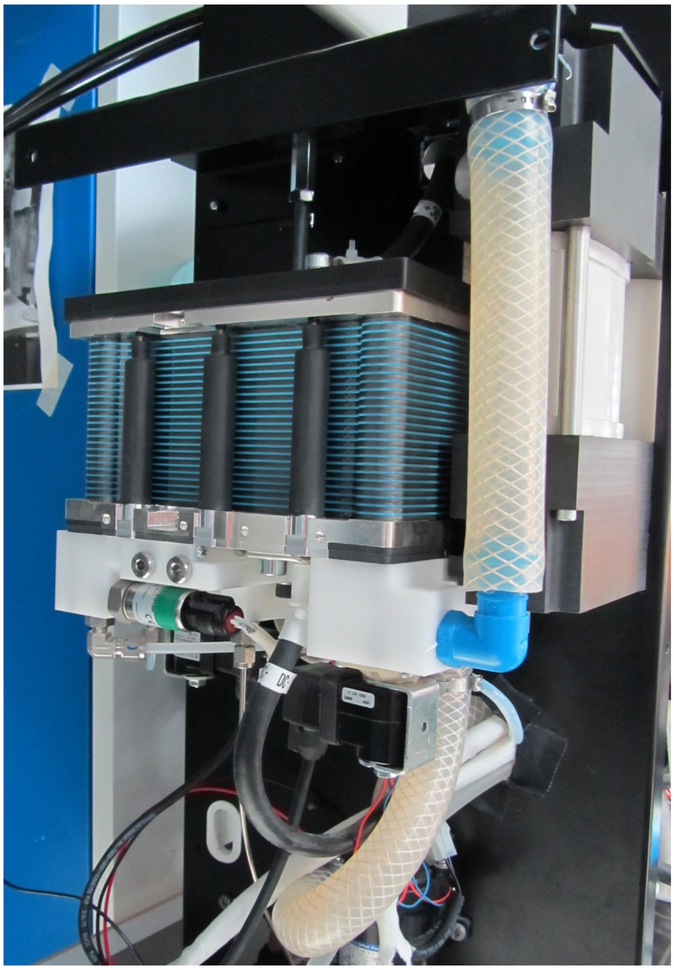
A segmented, automotive size graphitic test cell (LxWxH= 300x150x2 mm) and cell housing with compression unit and electrical cell contacts for the integration of the segmented cell.



Preparing for test and validation in system design

The suitability of the best coatings will be verified in a complete fork lift fuel cell system environment. Adapted and relevant industry load cycles and ASTs will be applied, and comparisons will be made to both carbon composite and gold coated metal BPPs.

Fronius HyLOG Fleet 26F (above), inside of HyLOG system (right).



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