Institute of Engineering Thermodynamics

Cost Reduction of large scale PEM electrolyzers by New Electrocatalysts and Bipolar Plates

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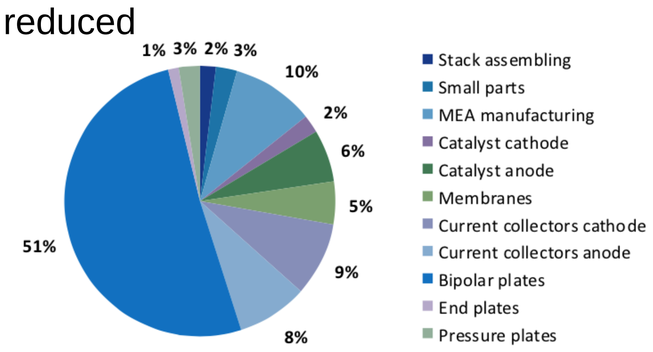
Motivation

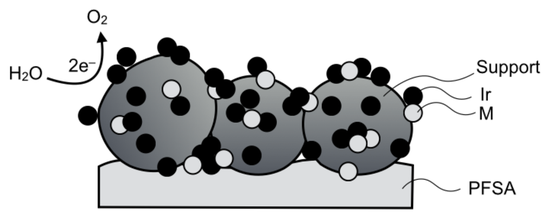
Hydrogen can be used as a storage medium for renewables. PEM electrolysis is the platform for large scale H_2 production from surplus electricity thanks to its rapid response under dynamic operation and high specific energy density. However, it is an expensive technology. The cost of the precious electrocatalyst and the bipolar plates has to be reduced



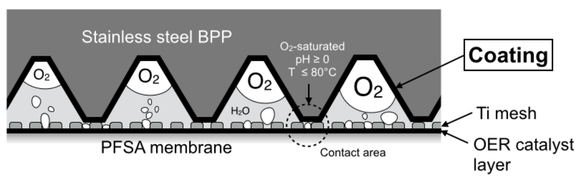
PEM-Electrolyzer cost breakdown[1]

Approach

Electroceramic supports allow reducing the content of Ir_xM_{1-x} by increasing its electrochemical surface area (ESA)

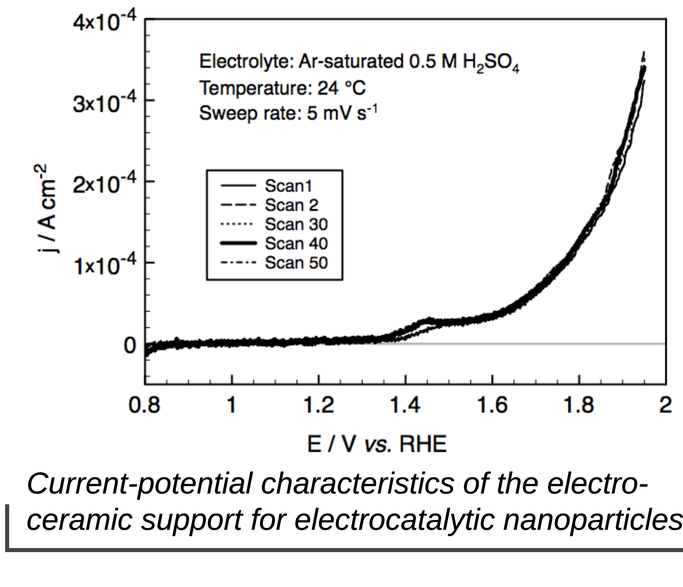


Coated stainless steel is a more suitable material for bipolar plates (BPP) as it is cheaper and easier to machine than Ti

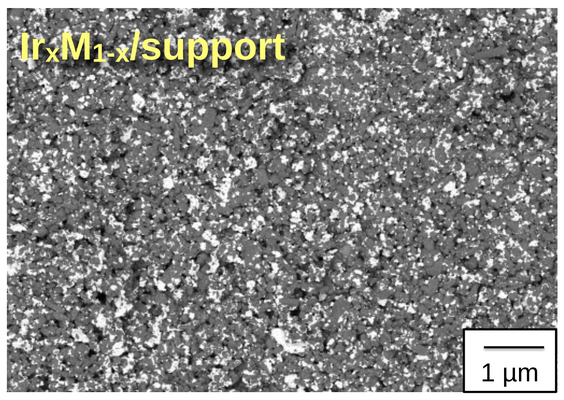


Supported Ir_xM_{1-x} electrocatalysts

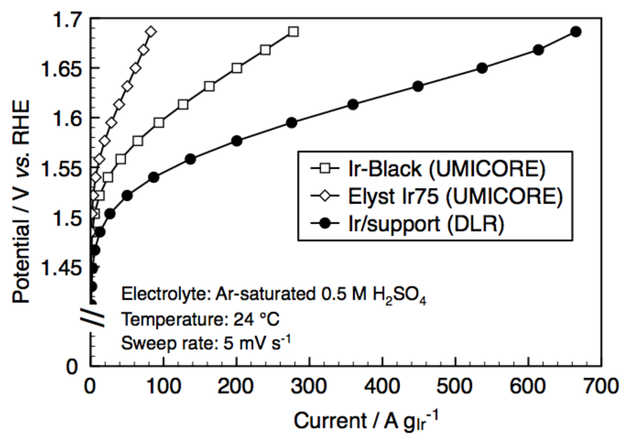
Nanoparticles of Ir_xM_{1-x} were synthesized and deposited on an electroceramic support which is conductive and corrosion resistant. Cyclic voltammetric measurements showed that the support is stable at high potentials



Current-potential characteristics of the electro-ceramic support for electrocatalytic nanoparticles



SEM image of supported Ir_xM_{1-x} electrocatalyst for PEM electrolyzer .



Normalized current-potential curves of commercial Ir-Black, Elyst Ir75 and the the Ir supported catalysts

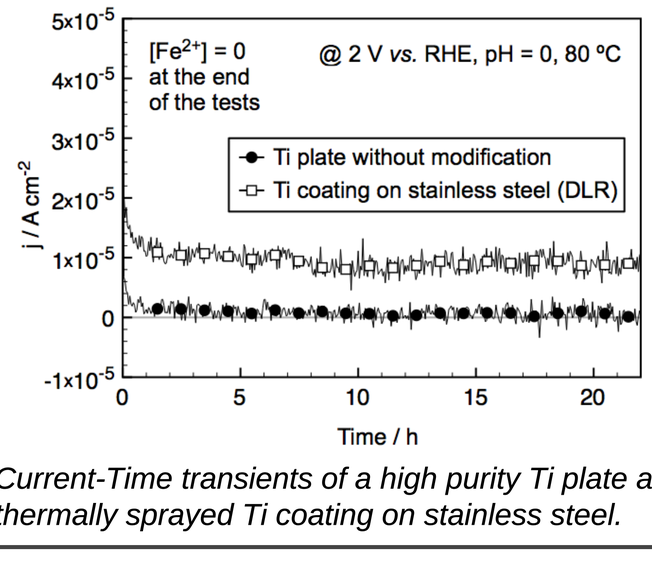
The resulting catalyst has a mass activity more than two times higher than Ir-black

Low cost bipolar plates

Titanium coatings were deposited on stainless steel substrates by Vacuum Plasma Spraying (VPS) technique. Several parameters were optimized to achieve a plasma enthalpy of (*h*) of 21.3 MJ kg^{-1} thus producing very dense coatings[2]

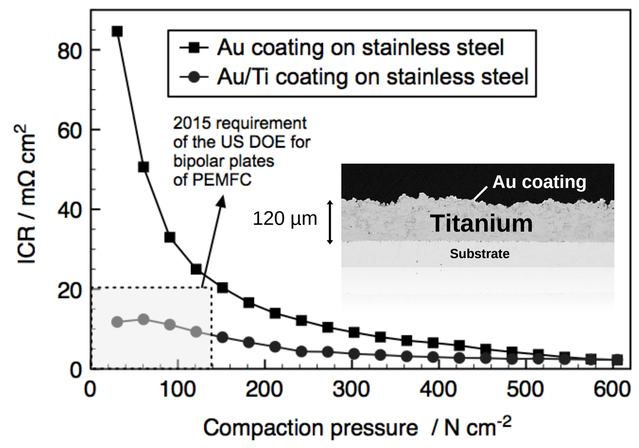
Vacuum plasma spraying chamber

Chronoamperometric measurements at 2 V *vs.* RHE demonstrated that the Ti coatings protect the substrate from corrosion over extended periods of time



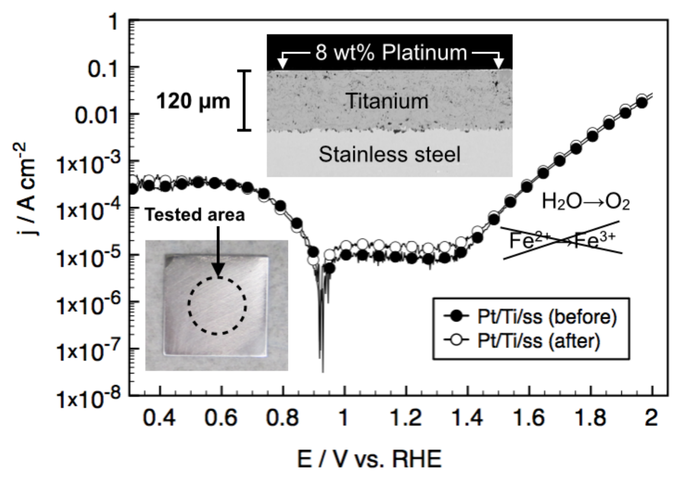
Current-Time transients of a high purity Ti plate and the thermally sprayed Ti coating on stainless steel.

Further modification of the surface of the Ti coatings with Au resulted in a very low interfacial contact resistance (IRC)[3]



ICR of Aut/Ti coating under different compaction forces

Pt/Ti coatings were produced by successive steps of VPS and magnetron sputtering PVD of Ti and Pt (8 wt%), respectively



Potentiodynamic characteristics of Pt/Ti coatings before an after chronoamperometric test at 2 V vs. RHE for 6h

It did not experience significant degradation after corrosion measurements, although the ICR increased 6% under 240 N cm^{-2} (not shown)

Conclusions and Outlook

1. The content of precious metal content of the anode catalyst has been reduced by using an electroceramic support and synergetic interactions with the support will be investigated in future
2. The developed coatings showed superior stability. Stainless steel as base material for the manufacture of bipolar plates is possible.

References

1. L. Bertuccioli, A. Chan, D. Hart, F. Lehner, Ben Madden, E. Standen, Study on Development of Water Electrolysis in the EU, Final Report, E4tech Fuel Cells and Hydrogen Joint Undertaking, 2014
2. Patent pending, filed on July, 2013.
3. A.S. Gago, A.S. Ansar, P. Gazdzicki, N. Wagner, J. Arnold, K.A. Friedrich, ECS Trans. 64 (2014) 1039.

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