

Ultra-low load PEM anodes

Introduction

PEM fuel cells are a promising and clean source of electric power that presently uses Pt as catalyst for hydrogen oxidation and oxygen reduction. In the last 30 years the Pt load has been reduced from several grams per kilowatt to about 200 mg/Kw. The price of this precious metal is expensive to get a wide commercialization and very dependent of the fluctuation of the markets. Despite the efforts in avoiding its use there are not clear alternatives to Pt in acidic media so its content must be reduced. One way to get this reduction is by concentrating the catalyst close to the membrane in a very thin layer and in this line PVD (Physical Vapor Deposition) can help to control it.

Pt deposition procedure



PVD (Physical Vapor Deposition) is a well-known technology in other sectors such as microelectronics that could be applied to concentrate the catalyst layer closer to the membrane and reduce the Pt specific load.

Under vacuum atmosphere, a Pt target is sputtered by Ar⁺ ions generated by a DC electromagnetic field. The sputtered Pt is then deposited on the samples to be coated in form of a thin layer (few nm).

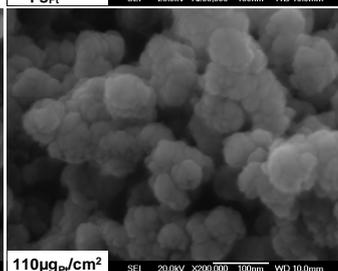
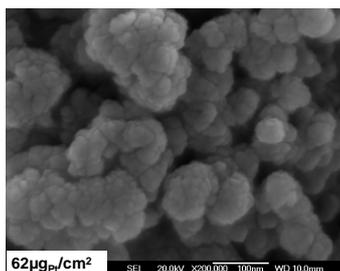
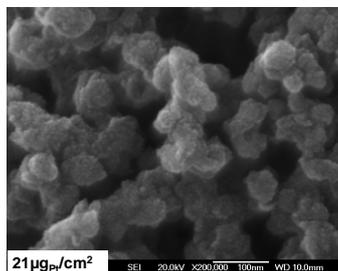
Tested Pt loadings: 21, 62 & 110 $\mu\text{g}_\text{Pt}/\text{cm}^2$.

Results

Morphology

In the lowest loaded electrodes the Pt clusters just start to coat the carbon aggregates of the MPL.

When the Pt content is increased a continuous layer of Pt is coating the external surface of the MPL.

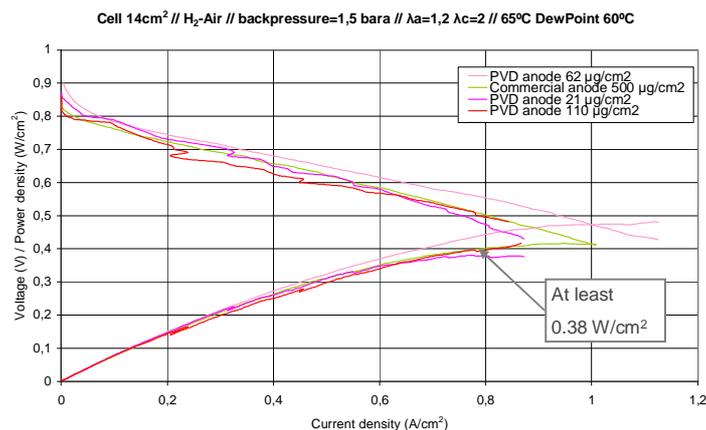


VI curves

Test protocol

- H₂-air in stoichiometric mode $\lambda_a=1.2$ & $\lambda_c=1.2$
- 14cm² single cell at backpressure of 1.5 bara
- Temperature 65°C & dew points at 60°C

Despite the differences in catalyst load, VI curves show a similar performance among the tested electrodes.



Conclusions

- It has been proved that PVD technology is feasible technology to manufacture PEM fuel cell electrodes.
- The Pt catalyst loading in the anode can be reduced up to 55 mg/Kw by the use of PVD.
- The particle size of these PVD electrodes is in the range of nanometres and concentrated close to the membrane.



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