Effect of Pt particle size and shape on ORR activity and catalyst durability

Pieter Levecque, Olaf Conrad
HySA/Catalysis Centre of Competence, Centre for Catalysis Research, Department of Chemical Engineering, University of Cape Town
Private Bag X, 7701 Rondebosch, South Africa

An important aspect of getting Polymer Electrolyte Fuel Cells (PEFC) closer to commercial applications is stable performance over extended periods of time. Furthermore it is of utmost importance that performance losses are not only small but constant over the device's lifetime in order to design systems according to the specifications needed. An important aspect to achieve this is gain insight in the behaviour of the Pt/C catalyst during long periods of operation and then controlling this behaviour through the catalyst preparation method. It is well known that different platinum crystal facets [1] and particle shapes [2] show significantly different electrochemical responses.

The method presented in this work allows for careful control of platinum particle size and shape under wet impregnation conditions. Using different ligands, platinum particles of different size and shape in various loadings were deposited on a carbon support. Figure 1 underneath clearly shows that the preparation method used allows for control particle size and shape

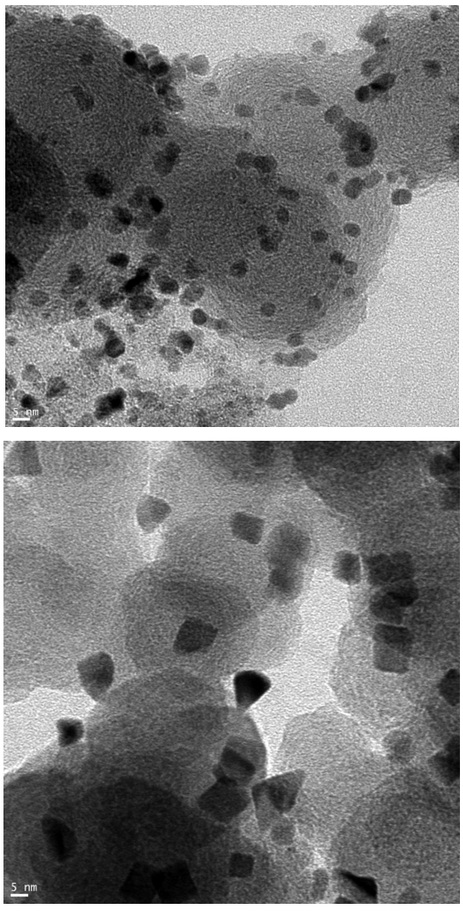

Figure 1: Comparison of TEM analysis (both at 5 nm scale) of particles deposited under different conditions indicating range from dispersed spheres (top) to large octahedral/cubic shaped particles (bottom).

Important benefits of the developed reaction pathway are its simplicity, scalability and its potential towards more environmentally benign manufacturing of Pt/C materials.

The resulting materials were tested for their activity towards the oxygen reduction reaction (ORR) and the dependence of activity on particle size and shape was investigated. In a further study the catalysts were subjected to an accelerated durability protocol to unveil the influence of the particle size and shape on the stability of the materials.

It was found that within a certain range the particle size doesn't significantly influence the overall activity. However, as can be seen from Figure 2 underneath, the particles synthesised with the said method yield platinum particles with a much higher initial stability. The more predictable decay pattern resulting from that allows for more accurate catalyst lifetime estimations.

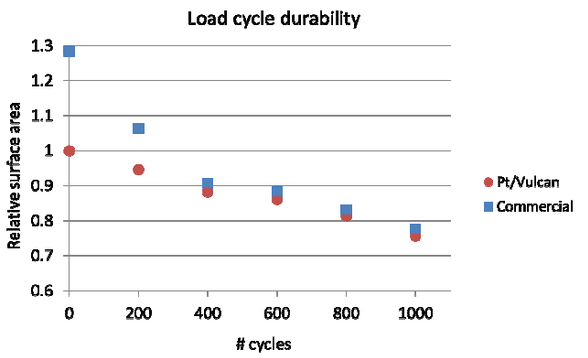

Figure 2: Comparison of load cycling stability of Pt particles on commercial catalyst compared to particles prepared by in –house developed method

References

[1] N.M. Markovic, T.J. Schmidt, V. Stamenkovic and P.N. Ross, *Fuel Cells* **2001**, *1*, 105.

[2] F.J. Vidal-Iglesias, R.M. Arán-Ais, J. Solla-Gullón, E. Herrero and J.M. Feliu, *ACS Catal.* **2012**, *2*, 901.