European Fuel Cell Car Workshop | March, 1st - 3rd 2017, Orléans, France

New evidences ofplatinum-yttrium alloyed nanoparticles formation on carbon support and catalytic activity for oxygen reduction reaction

C. Durante, R. Brandiele, G.A. Rizzi and A. Gennaro
Department of Chemical Sciences, University of Padova, Via Marzolo 1, 35131 Padova, Italy.

christian.durante@unipd.it

Keywords: Pt catalyst, Pt_xY alloy, half cell test, stability test.

In the past years, intensive research activities have been conducted for searching active Pt structures to reach the DOE targets, which led to the development of many different types of alloys, often identified as skin-layer, core−shell, and thin film electrocatalysts. Among many, Nørskov and coworkers identified by a density functional theory (DFT) computational screening a skin-type Pt_xY catalyst as a very promising cathode material for the ORR [1]. In this paper Pt_xY NPs, where *ca* 41% of the Y atoms are alloyed with the Pt, were synthesized via a solid state method involving the chemical reduction of $Pt(acac)_2$ and $Y(NO_3)_3 \cdot 6H_2O$ salt precursors by H_2/N_2 flow at high temperature[2].Temperature and time exposure to the reducing environment play a pivotal role in obtaining the alloy and a narrow size NPs dispersion. The best performing sample is actually the one containing the maximum amount of alloyed Y atoms $Pt_xY600h5$, which gives 2 and 3-fold enhancements in specific and mass activity for the ORR, respectively, when compared to the standard Pt/C Tanaka catalyst with 50% Pt loading. In the adopted experimental condition, the specific activity and the mass activity determined for $Pt_xY600h5$ are 1.570 mA/cm^2_{Pt} and 0.586 A/mg_{Pt}, which are very good values for the 2015-2017 DOE Stack Targets (0.860 mA/cm^2_{Pt} and 0.44 A/mg_{Pt}, respectively). Furthermore, 60% of the initial specific activity measured at E = 0.90 V vs. RHE is retained after an accelerated stress test composed of 10000 potential cycles between 0.60 and 1.05 V vs. RHE. The effect of different carbon (Vulcan XC72, nitrogen doped mesoporous carbon, multiwall carbon nanotubes) support will be also discussed.

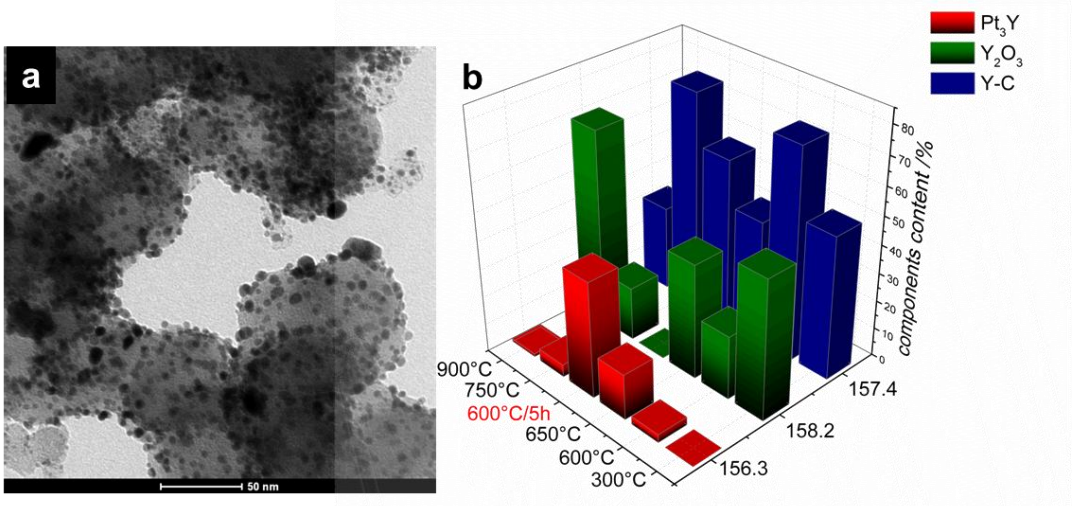

Figure 1: a) TEM images of Pt_xY@MC samples obtained from $Pt(acac)_2$ and $Y(NO_3)_3$ at 600 °C for 5 h, b) percentage of metallic Y, Y carbide and Y oxide in Pt_xY samples prepared at different temperatures and determined from the multicomponent fits of the Y 3d XPS peaks.

Acknowledgements
University of Padova (PRAT CPDA139814/13) and the Hydrogen Initiative-Joint Undertaking (FCH-JU) within the CathCat project under contract No. 303492, are gratefully acknowledged.

REFERENCES

1 J. Greeley, I. E. L. Stephens, A. S. Bondarenko, T. P. Johansson, H. A. Hansen, T. F. Jaramillo, J. Rossmeisl, I. Chorkendorff and J. K. Nørskov, *Nat. Chem.*, , **1**, 552–556 (2009).

2 Brandiele R, Durante C, Grądzka E, Rizzi GA, Zheng J, Badocco D, P. Centomo,P. Pastore, G. Granozzi and A. Gennaro,*J Mater Chem A*, **4**:12232–40 (2016).