

Surface segregation of Pt-Ru nanoparticulate electrocatalysts in anodic processes

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Replacement of the hydrogen as a fuel in advanced fuel cell applications represents a major challenge in the anodic electrocatalysis. A vigorous research activity aiming at new catalysts / co-catalysts development the field has experienced recently turned out not only a new class of complex multi-component catalysts, but also outlined the need of fundamental understanding of the underlying interactions of the organic molecules with catalyst surface if a rational catalyst design is to be achieved.

Metal based catalysts with more than one species present in the surface such as alloys, a bifunctional mechanism is generally assumed to operate in concert with the d-band center shift affecting the electronic structure of the catalyst. The bifunctional mechanism implies a works-sharing between the different surface atoms of the catalyst. This mechanism is highly relevant for oxidation processes involving organic molecules namely aliphatic alcohols and diols.

Pt-Ru based catalysts represent state of the art catalysts intended for CO tolerant anode fuel cell materials. The actual mechanism of the Ru-connected improvement can be attributed either to weakening of the Pt-CO bond [1] or to water activation enabling a formation of OH used in adsorbed CO oxidation [2]. Practical importance of the Pt-Ru based catalysts inspire numerous reports focusing basically on an improvement of the catalytic behavior of the PtRu catalysts in fuel cell reactions focused on the optimization of the synthetic procedures and actual implementation of the catalyst in the fuel cell.

This paper summarizes results of a systematic EXAFS study of the PtRu alloy operation in the presence and absence of strongly adsorbing CO. We combine the local structure parameters obtained from Pt L3 and Ru K edge EXAFS functions to outline the interactions of both alloy components during polarization in acid media. The observed structural changes are interpreted in terms of catalyst breathing and are discussed in terms of catalyst's stability.

References:

- [1] J. X. Wang, S. R. Brankovic, Y. Zhu, J. C. Hanson, R. R. Adzic, *Journal of the Electrochemical Society* 150 (2003) A1108.
[2] P. Waszczuk, G. Q. Lu, A. Wieckowski, C. Lu, C. Rice, R. I. Masel, *Electrochimica Acta* 47 (2002) 3637.

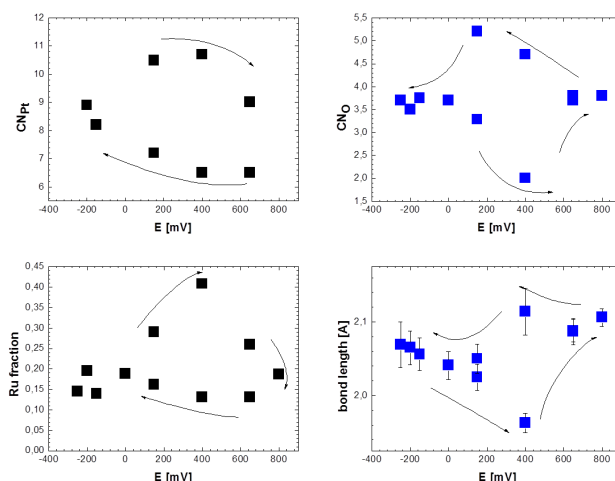


Figure 1 Local structure visualization of the oxygen transfer on PtRu electrocatalysts extracted from XAS spectra of a Pt Ru nanoparticulate electrode polarized to different potentials in acid media. Figure shows Pt average coordination number (top left), Ru fraction in the Pt vicinity (bottom left), average number of oxygen bonded to Ru (top right) and average Ru-O bonding distance (bottom right).