



Pt based supported catalysts with high/atomic dispersion-The effect of the substrate

E. Zagoraiou^{1#} and M.K. Daletou¹

¹Institute of Chemical Engineering Sciences, FORTH-ICE/HT Stadiou Str., Platani, Patras, 26504, Hellas

Presenting author: Eirini Zagoraiou, ezagoraiou@iceht.forth.gr

* Corresponding author: Maria K. Daletou, riadal@iceht.forth.gr

ABSTRACT

Hydrogen is an ideal source of energy due to its high energy density. Also, its environmental friendly electrochemical combustion in fuel cells is the main reason for the development of hydrogen fuel cell technologies. Polymer electrolyte membrane fuel cells (PEMFCs) are considered as the ideal clean energy power source for many applications because of their high power density, high efficiency, constructive simplicity, quick start-up and zero emission¹. Pt supported on carbon electrocatalysts are the most efficient and stable materials for both the oxygen reduction reaction (ORR) at the cathode and the hydrogen oxidation reaction (HOR) at the anode. In this respect, there is the increasing demand to reduce cost, therefore the amounts of Pt used resulting from increased catalyst activity and/or utilization². Towards the goal, there are three approaches which can be followed separately or combined: (a) Enhance the specific activity by using additives or co-catalysts and/or by influencing the electronic properties of the catalyst, (b) Development of catalytic layers with structures and architectures that lead to more active, extended and stable electrochemical interfaces with minimal Pt loads, (c) Increase the specific surface area of the catalyst by forming a fine dispersion. High dispersion catalysts can be achieved by altering/modifying the high surface area support and/or optimizing the metal deposition method. Reducing the size of the metal in atoms or small groups of atoms can significantly increase both the active surface and the activity of the catalyst through diversification or strengthening of the metal-support interactions³.

The performance and stability of the (electro)catalysts strongly depend on the physicochemical characteristics, such as the surface area, the crystalline structure, size and shape of the particles and the interactions with the support. In this work, the development of Pt/f-MWCNTs (f-MWCNTs=covalently functionalized MWCNTs) based electrocatalysts with different surface functionalities and Pt loadings took place. The deposition of the metal was realized through the reduction of metal precursor salts in a solution. Through a physicochemical characterization of the materials, the introduction of certain groups on the sidewalls of the carbon support resulted in differentiation of the properties, not only in terms of dispersion, but also with respect to metal-support interactions, platinum crystal properties and/or oxidative state. The electrochemical activity of these catalysts was studied towards ORR in 0.1 M HClO₄ solution using rotating disk electrode technique (RDE). The correlation between physicochemical or surface properties and the electrocatalytic performance showed that it is possible to tune the structural and electronic properties of Pt in order to enhance its electrocatalytic activity towards the ORR.

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