Pt$_3$Ni Supported on Porous Carbon and Its Application for Oxygen Reduction Reaction

Binwei Zhang, Yanxia Jiang, Shigang Sun

(College of Chem. & Chem. Engin., Xiamen Univ., Xiamen, Fujian, 361000 E-mail: yxjiang@xmu.edu.cn)

The sluggish kinetics of the oxygen reduction reaction (ORR) at the cathode is one of the key challenges for the commercial viability of proton exchange membrane fuel cells. Recently, it is of great interest to explore more active catalysts, with superior performance and durability, than the traditionally employed carbon-supported Pt (Pt/C) nanoparticles. To achieve this target, the Pt-base bi- and tri-metallic electrocatalysts, such as alloying Pt with the 3d-transition metals (Fe,Co,Ni), have been rationally synthesized and shown with greatly enhanced activities for the ORR. Vojislav et al [1] found that the Pt$_3$Ni(111) with its outermost is Pt-rich, is more active for ORR than the Pt(111) and more active than Pt/C. DeliWang et al [2] synthesized core-shell structured Pt-Co nanoparticles, composed of Pt$_3$Co ordered intermetallic cores with 2~3-atomic-layer Pt shells (Pt$_3$Co@Pt), can exhibited the highest Pt mass activities for the ORR than Pt/C.

In this work, the Pt$_3$Ni nanoparticles supported on Porous Carbon (PC) was synthesized by a highly reliable synthetic strategy in which H$_2$PtCl$_6$ and NiCl$_2$ precursors were reduced by the high temperament H$_2$. The outermost of Pt$_3$Ni nanoparticles became Pt-rich after the heat treatment in high temperature. The TEM images of Pt$_3$Ni/PC clearly show the Pt$_3$Ni nanoparticles with well dispersing and the average diameter of Pt$_3$Ni nanoparticles was evaluated from 200 nanoparticles in the TEM image of PtBi/MPC, to be 3.36 ± 0.77 nm. These Pt$_3$Ni/PC (0.61 mA·µg$^{-1}$ Pt @ 0.9 V) exhibited excellent activity and stability towards ORR than Pt/C (0.18 mA·µg$^{-1}$Pt) (JM).

Fig.1a The TEM images of Pt$_3$Ni/PC, the insert Fig.1a shows histogram showing nanoparticles size distribution based on a count 200 nanoparticles in the sample areas. Fig.1b, ORR polarization curves for Pt/C and Pt$_3$Ni/PC in O$_2$-saturated 0.1 M HClO$_4$ at room temperature, 1,600 rpm and sweep rate, 10 mV s$^{-1}$.

References: