

Platinum Monolayer on Au-Ni Nanoparticles Electrocatalysts for the Oxygen Reduction Reaction: The Effect of Au-Ni Nanostructures

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The commercialization of the proton exchange membrane fuel cell (PEMFC) is impeded by the sluggish kinetics of the oxygen reduction reaction (ORR) occurring at the fuel cell cathode. Platinum is the most efficient monometallic catalyst for the ORR; however, the associated high cost and the insufficient activity and stability of current Pt catalysts are main obstacles¹. One approach of layering a Pt monolayer (one atom thick layer) on the substrates of a second metal or metal alloy is a promising way of designing improved ORR electrocatalysts, and also reducing Pt content. The synthesis of active, durable and cheap substrate for the Pt monolayer is one of the urgent needs for developing ORR catalysts. It is generally accepted that the substrates induced lateral strain in Pt monolayer plays an important role in alter the catalysts' catalytic properties^{2,3}.

Here we reported on a new class of Pt-monolayer-shell on Au-Ni core nanoparticle electrocatalysts, which were facilitated by a Pt monolayer deposition using displacement of the underpotential deposited Cu monolayer.⁴ To understand the effect of substrates on the Pt monolayer we prepared an AuNi alloy and Ni@Au core-shell nanoparticle substrates using various synthetic techniques.

The x-ray diffraction patterns from AuNi alloy and Ni@Au core-shell nanoparticles show distinct features. The alloying of AuNi has shifted the Au and Ni peaks to higher angles indicating a decrease in lattice parameter whereas a no shift in the peak was observed from Ni@Au core-shell nanoparticles. The formation of AuNi alloy and Ni@Au core-shell nanoparticles has been verified by scanning transmission electron microscopy (STEM) coupled with electron energy-loss spectroscopy (EELS) and *in situ* x-ray absorption spectroscopy (XAS). The Pt mass activities for the Pt_{ML}/AuNi/C electrocatalyst are higher than Pt_{ML}/Ni@Au/C and commercial Pt/C electrocatalyst. The high activity observed can be ascribed to the structural- and electronic interaction between the Pt monolayer and the Au-Ni nanoparticles. The results have demonstrated the approach using Pt monolayers on alloy nanoparticles can resolve key ORR problems while minimizing the Pt loading.

Further discussion of these results will be presented at meeting.

References

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Acknowledgement

This research was performed at Brookhaven National laboratory under contract DE-AC02-98CH10886 with the US Department of Energy, Division of Chemical Sciences, Geosciences and Biosciences Division. Financially support is also from National Natural Science Foundation of China (Grant No. 50872027, 21106024 and 21173062). G.Y. Chen acknowledges a fellowship from the China Scholarship Council and BNL to perform this work at BNL.

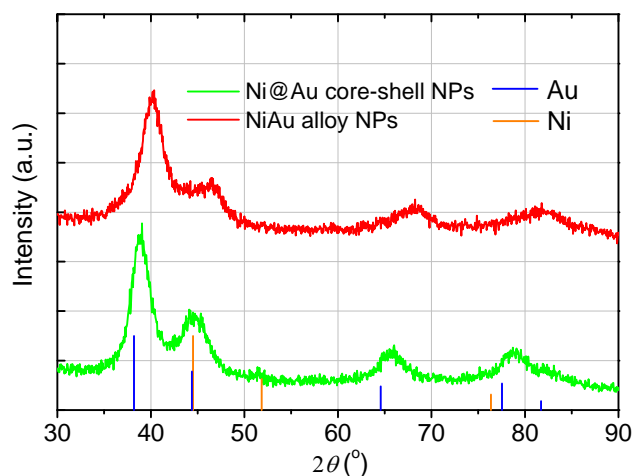


Fig.1. X-ray powder diffraction from AuNi alloy and Ni@Au core-shell nanoparticles.

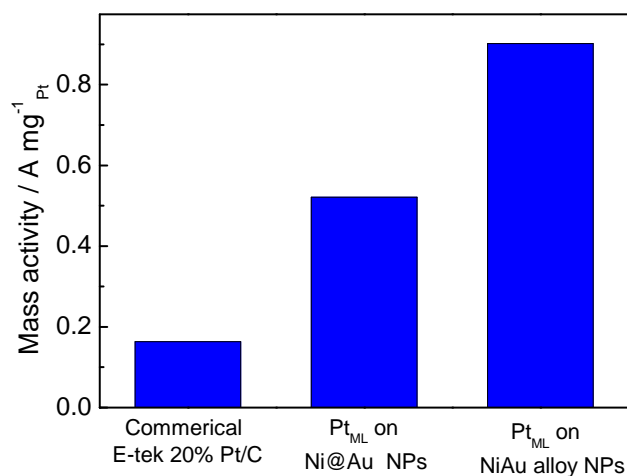


Fig.2. Comparison of Pt mass activity at 0.9V.