Core/Shell Co/Fe_3O_4 Nanoparticles as an Active and Durable Catalyst for the Oxygen Reduction Reaction in Alkaline Media

Chen-Hao Wang[1*], Chih-Wei Yang[1], Sun-Tang Chang[1], Hsin-Chih Huang[1], Hsin-Cheng Hsu[1].
[1]Department of Materials Science and Engineering, National Taiwan University of Science and Technology, Taipei, 10607, Taiwan
* E-mail address: chwang@mail.ntust.edu.tw

Alkaline-based polymer electrolyte fuel cell (PEFC) has lower cost than acid-based PEFC [1]. In this study, the core/shell electrocatalyst has been synthesized to show high efficiency and durability during oxygen reduction reaction (ORR) in alkaline media. Dodelet et al. used iron-based electrocatalysts at pyrolyzed temperature of 1050°C, They showed that their catalyst had good performance and high open circuit voltage (OCV)[2]. On the other hand, Wu et al. utilized polyaniline as a precursor for a carbon–nitrogen template treated in high-temperature (1050 °C) pyrolysis and incorporated by iron and cobalt, which exhibited high activity and remarkable stability[3]. In this study, we develop a Core-shell structural catalyst process which offers a low temperature synthesis process and without the need of further pyrolysis step.

The resulting Co/Fe_3O_4 core/shell catalyst was characterized by X-ray photoelectron spectroscopy (XPS) and X-ray absorption (XAS) to confirm its core/shell structure. Rotating disk electrode (RDE) results reveals that the ORR catalyzed by Co/Fe_3O_4/C core/shell presented high ORR activity with current density of 5 mA cm^{-2} at 0.2 V (vs. RHE, 0.1 M KOH) and electron transfer number of 3.95 which indicates a direct four-electron pathway for the reduction of O_2 to H_2O over the Co/Fe_3O_4 core/shell catalyst.

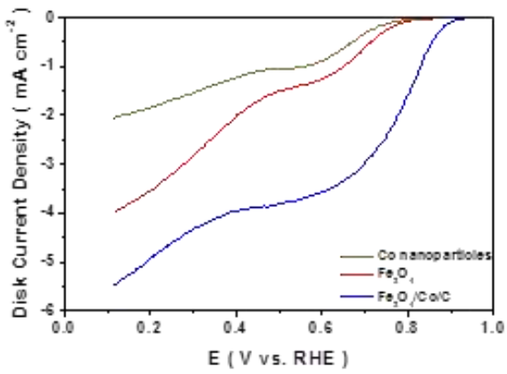

Figure 1 The ORR curves of Co nanoparticle, Fe_3O_4, and Co/Fe_3O_4 core/shell electrocatalyst in saturated oxygen, 0.1 M KOH. Scan rate: 10 mV/s; rotation speed: 1600 rpm.

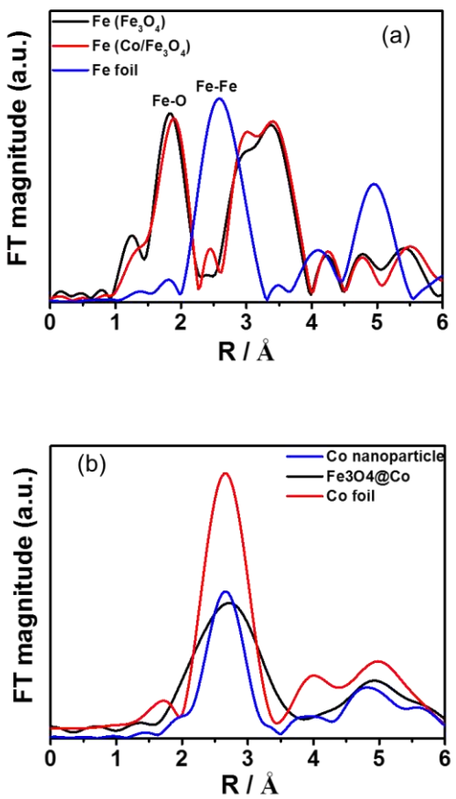

Figure 2 Fourier transforms of k^3-weighted EXAFS data at the (a) Fe and (b) Co K-edge for Co nanoparticle, Fe_3O_4, and Co/Fe_3O_4 core/shell electrocatalyst.

Reference

(1) McLean, G. F.; Niet, T.; Prince-Richard, S.; Djilali, N. Int. J. Hydrogen Energy **2002**, 27, 507.
(2) Proietti, E.; Jaouen, F.; Lefevre, M.; Larouche, N.; Tian, J.; Herranz, J.; Dodelet, J. P. Nature communications **2011**, 2, 416.
(3) Wu, G.; More, K. L.; Johnston, C. M.; Zelenay, P. Science **2011**, 332, 443.

Acknowledgements

The authors would like to thank for NSRRC (Beam-line 17C1), the NSC of Taiwan for financially supporting this research under Contract No. NSC-100-2221-E-011-065.