Self-assembly Synthesis Co@N-C sphere/N-graphene Nanocomposites Electrocatalyst for Oxygen Reduction Reaction

Dongdong Li, Liang-xin Ding, Haihui Wang*

School of Chemistry & Chemical Engineering, South China University of Technology,

Guangzhou 510640, China

* hhwang@scut.edu.cn

Catalyst for oxygen reduction reaction (ORR) is one of the key technologies in developing alkaline-based fuel cells and metal-air batteries. At present, developing a simple and cost-effective protocol for the production of non-precious-metal electrocatalysts for ORR is still a challenge. Herein, we reported a facile self-assembly method synthesis of Co@N-C sphere/N-graphene (Co@N-C/N-G) nanocomposites electrocatalyst. The synthesis involves the pyrolysis of graphene oxide, $CoCl_2$ and dicyandiamide at 900 ^oC for 2 h, and subsequent acide treatment of the pyrolysis product in order to dissolve the Co without protecting of carbon shell. The catalyst with the Co sphere encapsulated in N-C shell grown on N-G sheets was prepared，the N-C shell was used to protect the Co, the Co@N-C spheres on the graphene were used to prevent the stacking of graphene, and the N-graphene were used to enhance the electric conductivity of Co@N-C. In alkaline media, the nanocomposite catalyst exhibits higher catalytic activity than single materials containing only Co@N-C or N-G, and closing catalytic activity with the commercial Pt/C. In addition, the catalyst shows more superior stability and better suitability as a cathode catalyst for direct methanol than Pt/C for the ORR. The high catalytic activity and stability arises from the synergetic coupling effect between the Co@N-C sphere nanoparticles and graphene nanosheet. Furthermore, this material was synthesized through a simple procedure, which gives a great promise for large scale production.

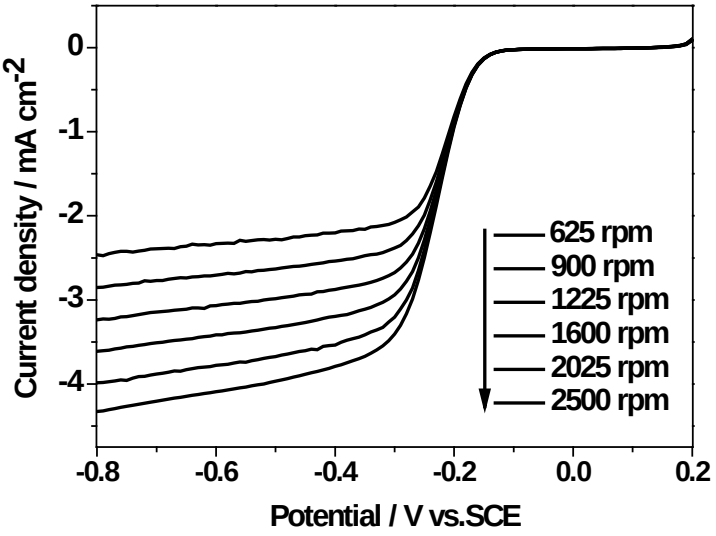


Fig.1 LSVs of the Co@N-C/N-G catalyst in an O_2-saturated 0.1 M KOH solution at various rotational rates at a scan rate of 5 mV/s.

References

[1] Zhang, S.; Zhang, H.; Liu, Q.; Chen, S., Fe–N doped carbon nanotube/graphene composite: facile synthesis and superior electrocatalytic activity. *J. Mater. Chem. A* **2013,** *1* (10), 3302-3308.

[2] Zhu, C.; Dong, S., Energetic Carbon-based Hybrids: Green and Facile Synthesis from Soy Milk and Extraordinary Electrocatalytic towards ORR. *Nanoscale* **2014,** 6, 2964-2970.

[3] Hu, Y.; Jensen, J. O.; Zhang, W.; Cleemann, L. N.; Xing, W.; Bjerrum, N. J.; Li, Q., Hollow Spheres of Iron Carbide Nanoparticles Encased in Graphitic Layers as Oxygen Reduction Catalysts. *Angew. Chem. Int. Ed.* **2014,** *53* (14), 3675-3679.

[4] Choi, C. H.; Park, S. H.; Woo, S. I., Binary and ternary doping of nitrogen, boron, and phosphorus into carbon for enhancing electrochemical oxygen reduction activity. *ACS Nano* **2012,** *6* (8), 7084-7091.