Ultra-refined cavitary Pt_3Co@Pt@porous C based core@skin@shell nanostructure as a High-Performance ORR Catalyst

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Electrocatalysis plays a pivotal role in electrochemical energy conversion and storage technologies, including water electrolysers, metal-air batteries, and proton-exchange membrane fuel cells1-4. Exploring low-cost and high-performance electrocatalysts is playing the most essential and imperative role in the development of fuel cells. Platinum-based bimetallic nanomaterials have been considered as efficient catalysts for the oxygen reduction reaction (ORR)[1-2].

Herein, we firstly demonstrate the synthesis of a novel core@skin@shell nanostructure: Pt_3Co alloy with internal voids and a Pt skin, which, in turn, is coated with zeolitic imidazolate framework-67 (ZIF-67)-derived nitrogen-doped porous carbon (C-PtCo@Pt@zNPC). In combination with the Pt skin, the Pt_3Co intermetallic core with its internal cavities can expose more active sites and efficiently achieve higher ORR activity. More importantly, the ZIF-derived porous carbon (zNPC) shell is critical, which not only can provide accessible tunnels for electrolyte penetration and fast electron diffusion, but also stabilizes the cavitary structure in the core and protects these highly active small particles from agglomeration. The transmission electronic microscope (TEM) image of C-PtCo@Pt@zNPC in Figure 1a shows the well-constructed cavity-containing structure with a carbon shell (3-5 nm) coated on the particle surface. The typical high-angle annular dark-field (HAADF) scanning transmission electron microscope (STEM) image (Figure 1b) shows that the particle size of C-PtCo@Pt@zNPC is approximately 13 nm. Also, the high resolution TEM (HRTEM) image shows the lattice spacing of 0.225 nm, which is attributed to the (111) planes of Pt3Co alloy. The STEM-energy dispersive spectroscopy (EDS) element mapping (Figure 1c) shows the Pt and Co projected distributions within the particle.

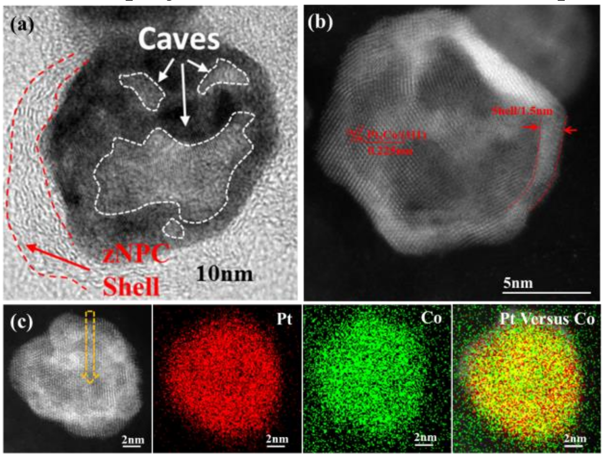

Figure 1. (a) TEM image, (b) HAADF-STEM image, and (c) STEM-EDS maps of elemental distributions for C-PtCo@Pt@zNPC.

References:

[1] K. Jiang, D. Zhao, S. Guo, X. Zhang, X. Zhu, J. Guo, G. Lu, X. Huang, Sci. Adv. 3 (2017) e1601705.[2] X. Huang, E. Zhu, Y. Chen, Y. Li, C. Y. Chiu, Y. Xu, Z. Lin, X. Duan, Y. Huang, Adv. Mater. 25(2013) 2974.