Characterization of Zeolitic Imidazolate Framework–derived Polyhedral Carbonaceous Material and its Application to Electrocatalyst for Oxygen Reduction Reaction

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doi: 10.20964/2016.11.27

Received: 1 July 2016 / Accepted: 26 August 2016 / Published: 10 October 2016

A porous carbonaceous material is synthesized by direct carbonization of zeolitic imidazolate framework-67 (ZIF-67). A series of analytical tools such as scanning/transmission electron microscopy, gas chromatography/mass spectroscopy, thermogravimetric analysis, nitrogen adsorption, X-ray diffraction, X-ray photoelectron spectroscopy and 3D tomography are conducted for the characterization of the prepared carbonaceous material (ZIF-C). ZIF-C has a well-defined concave dodecahedral shape, and its chemical composition, surface area and electrical conductivity substantially depend on carbonization temperature. ZIF-C heat-treated at 800°C (ZIF-C-800) shows a typical nitrogen adsorption-desorption isotherm of mesoporous materials with unimodal pores around 2 nm and sufficiently high electrical conductivity comparable to that of carbon nanotubes. ZIF-C-800 has Co metal particles wrapped by graphene layers on the walls of the interior open channels, and its framework is composed of Co-N, C-N species and C-C networks. ZIF-C-800 also displays the highest oxygen reduction reaction catalytic activity among ZIF-C treated at various temperatures, and its feasibility as cathode electrocatalysts for fuel cells is demonstrated by confirming the single cell performance.

Keywords: zeolitic imidazolate framework, mesoporous material, fuel cell, electrocatalyst, oxygen reduction

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