Graphene Oxide Decorated with Rh Nanospheres for Electrocatalytic Water Splitting

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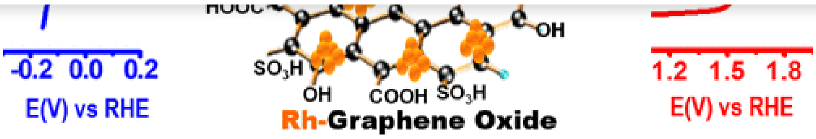
SUBJECTS: Composites, Electrocatalysts, Evolution reactions, Nanocomposites, Radiology

Abstract



In this study, we report a method for fabrication of rhodium nanoparticles decorated on graphene oxide (Rh–GO) with high coverage of active sites of Rh nanospheres (NSs) on GO. It is one of the most pivotal aspects in the development of novel systems having high electrocatalytic performance toward overall water splitting reactions and is found to be better than universally acceptable Pt-based nanoelectrodes. The synthesis of nanohybrids shows the well-dispersed Rh NSs (~50 nm) on a few layers of graphene oxide sheets. These as-synthesized nanomaterials were confirmed by scanning electron microscopy (SEM), high-resolution transmission electron microscopy (HR-TEM), X-ray photoelectron spectroscopy (XPS), Fourier transform infrared (FT-IR) spectroscopy, Raman spectroscopy, Brunauer–Emmett–Teller (BET) surface area measurements, thermogravimetric analysis (TGA), and X-ray diffraction (XRD) analysis. Furthermore, Rh–GO exhibits significantly improved electrochemical performance toward electrocatalytic water splitting reactions, that is, hydrogen evolution reaction (HER) and oxygen evolution reaction (OER), and it shows exceptionally an ultrasmall overpotential of 2 mV for the HER, reaching a current density of 10 mA cm^{-2} with a smaller Tafel slope 10 mV dec^{-1}, and the OER overpotential reaches 0.23 V at 10 mA cm^{-2} with a Tafel slope of 27 mV dec^{-1}. The reduced charge transfer resistances after Rh NSs decoration on GO which lead to simultaneous enhancement in feasibility toward interfacial electron transfer, result in an increase in activity toward overall water splitting reactions (both HER and OER).

KEYWORDS: Rh nanospheres (NSs), graphene oxide (GO), rhodium nanoparticles decorated on graphene oxide (Rh–GO), hydrogen evolution reaction (HER), oxygen

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- Characterizations using TGA, XRD, and BET data; electrochemical studies of the material; LSV comparison of Rh–GO, Rh nanospheres, and GO, LSV polarization curve comparison of Pt/C and Rh–GO; electrochemical impedance spectra of GO and Rh–GO for both HER and OER; rotating ring-disk electrode (RRDE) of Rh–GO composite materials in 0.5 M H_2SO_4 for HER at 0–2500 rpm and in 0.5 M KOH for OER at 0–4000 rpm; electrochemical activity comparison with the literature table; and detailed calculation of the Tafel slope and overpotential (PDF)

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