Electrocatalytic Ethanol Oxidation on Cobalt–Bismuth Nanoparticle-Decorated Reduced Graphene Oxide (Co–Bi@rGO): Reaction Pathway Investigation toward Direct Ethanol Fuel Cells

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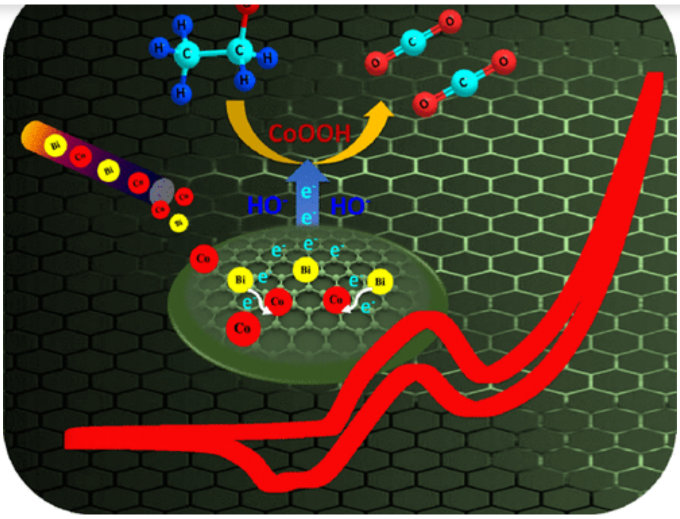

Direct ethanol fuel cells (DEFCs) are one of the resourceful and sustainable technologies for energy applications. Ethanol oxidation has been used to construct cost-effective and proficient electrocatalysts to substitute noble-based electrocatalysts like Rh, Pd, Ir, and Ag. Here in, we have presented a surface modification approach of doping a crucial oxophilic character metal onto a transition metal with carbon support. Noble metal-free cobalt–bismuth bimetallic nanoparticle-decorated reduced graphene oxide (Co–Bi@rGO) electrocatalysts were fabricated for enhanced ethanol oxidation reaction from their synergetic effect of rGO, Co, and Bi. A highly active, cost-effective, and efficient approach has been developed for the preparation of Co–Bi@rGO (Co NPs; ~2 nm), initially Bi@rGO (Bi NPs@rGO; ~50 nm), by a simple reduction method followed by Co, by Galvanic exchange of Bi atoms with Co. The as-synthesized nanocomposites were characterized by transmission electron microscopy, Fourier transform infrared spectroscopy, X-ray diffraction, thermogravimetric analysis, Raman spectroscopy, X-ray photoelectron spectroscopy (XPS), and BET surface area measurement studies. Cyclic voltammetric studies show an ultralow onset potential of 0.28 V with a high current density of 10.25 mA/cm^2, having a higher enhancement factor for Co–Bi@rGO compared to other individuals, including Bi NPs, Bi@rGO, and rGO under similar electrolyte conditions, which could be due to their synergetic cooperative interactions at electrified interfaces. Combined results from chronoamperometry (*i*–*t*) and electrochemical impedance spectroscopy show that Co–Bi@rGO is highly durable and sensitive toward the ethanol oxidation reaction compared to individual counterparts. This work also provides the noble metal-free bimetallic electrocatalysts for ethanol oxidation and assists in hydrogen production from an agricultural base.

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- Synthesis of cobalt reduced graphene oxide, characterization and electrochemical results related to the electrocatalyst; SEM, TEM, and HR-TEM images; FTIR spectra; Raman spectra; XPS spectra; CV for concentration of the ethanol oxidation; CV for the scan rate of ethanol oxidation; chronoamperometric study on the ethanol oxidation; and CV of (i) Pt/C and (ii) Co−Bi@rGO (PDF)

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