Dual Metal Phthalocyanine anchored on Heteroatom-doped Carbon nanocomposites for synergistic electrocatalytic oxygen reduction reaction

Akshay Parmar
Anuj Kumar
Nano-Technology Research Laboratory, Department of Chemistry, GLA University, Mathura, Uttar Pradesh 281406, India
Contact@ anuj.kumar@gla.ac.in

Abstract

A novel non-precious metal catalyst based on iron phthalocyanine (FePc) and cobalt phthalocyanine (CoPc) anchored onto nitrogen–boron–sulfur (NBS) doped carbon dots/multi-walled carbon nanotube/graphene oxide (MWCNT/GO) nanocomposites was synthesized and systematically investigated for the oxygen reduction reaction (ORR). The hybrid nanocomposite exhibits remarkable ORR activity with a positive onset potential, high limiting current density, and excellent methanol tolerance, outperforming conventional Pt-based catalysts. Structural and compositional characterization using X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), elemental color mapping, and transmission electron microscopy (TEM) verified the successful anchoring of FePc–CoPc molecules and the homogeneous distribution of active sites within the NBS-doped carbon framework. The synergistic effect of dual metal phthalocyanines, heteroatom doping, and conductive carbon nanostructures contributes to outstanding stability under prolonged electrochemical operation. This study highlights the potential of FePc–CoPc/NBS-doped carbon dots/MWCNT/GO nanocomposites as durable, methanol-tolerant, and cost-effective electrocatalysts for next-generation fuel cell technologies.

References

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