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Highly efficient metal-free ethylenediamine-functionalized fullerene (EDA@C_{60}) electrocatalytic system for enhanced hydrogen generation from hydrazine hydrate †

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Abstract

A synthesized non-precious metal-free electrocatalyst is demonstrated using the hydrazine hydrate oxidation reaction as a model reaction of hydrogen production. The C_{60} nanocomposite functionalized with ethylenediamine (EDA@C_{60}) was fabricated using a simple chemical approach. The EDA@C_{60} composites were characterized using field emission scanning electron microscopy, energy dispersive analysis of X-rays, Fourier-transform infrared spectroscopy, Raman spectroscopy, X-ray diffraction, and electrochemical techniques. In this study, the nitrogen lone pairs from the ethylenediamine surface-functionalized on C_{60} are responsible for the further enhancement of electrocatalytic activity towards the hydrazine oxidation reaction. Comparative electrochemical studies with acid-treated C_{60}, *i.e.*, O–C_{60}, and the further-functionalized ethylenediamine catalysts (EDA@C_{60}) demonstrated high performance, which was ascribed to their inferior onset potential and better stability. The electrochemical measurements indicate that the EDA@C_{60} composites demonstrate twice the current density (20 mA cm^{-2}) and a better onset potential (0.2 V *vs.* SCE) than O–C_{60} for hydrazine oxidation. The electrocatalytic hydrogen evolution reaction (HER) performance of the O–C_{60} and EDA@C_{60} electrocatalysts indicate onset potentials of 0.37 V *vs.* SCE and 0.20 V *vs.* SCE, respectively. The

experimental and analytical studies found that the nanocomposites with ethylenediamine, *i.e.*, EDA@C_{60}, not only extend the surface area compared to that of O–C_{60}, but also promote the self-decomposition of hydrazine molecules.

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