Nickel doped rice husk activated carbon composites: Potential electrodes in H_2 generation

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Carbon–nickel (C-Ni) composite electrodes offer an alternative to conventional materials (platinum, ruthenium catalysts) for electrolytic hydrogen generation [1, 2]. In the field of electrochemical synthesis, developing new materials is increasingly critical as demand grows for cost-effective, sustainable energy technologies and circular economies.

We fabricated nickel doped rice husk activated carbon (Ni-RH-AC) composite electrodes and tested them on hydrogen and oxygen electrolytic generation via water electrolysis. Dried rice husk was impregnated with 85% orthophosphoric acid (H_3PO_4) at a 1:1 (w/w) ratio. The resulting paste was placed in an alumina crucible and heat treated at 500 °C for 2 h in an Ar atmosphere using a horizontal alumina tube furnace. After cooling to room temperature, the product was ground and washed with deionized water until neutral pH was reached. Doping with Ni was as follows: NiO mixed with RH-AC (20, 30 wt% RH-AC) was pyrolyzed in closed-loop reactor under an ethanol atmosphere at 700 °C for 1 h. During this process, NiO is reduced to metallic Ni, atoms of which nucleate on carbon defect sites and coalesce into nanoparticles. Figure 1 depicts SEM images and EDS spectra for samples of rice husk activated carbon and Ni doped RH-AC.

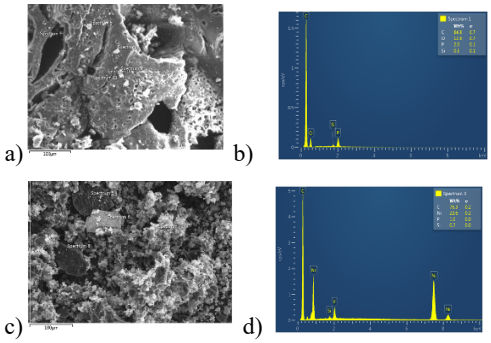


Figure 1. SEM images and EDS spectra of rice husk activated carbon before (a, b) and after doping with Ni (c, d)

The surface structure for doped Ni-RH-AC (a) is more developed compare to just rice husk activated carbon and clear Ni pick appears on EDS spectra (d).

The following electrode were prepared: (1) Ni-doped CNT on graphite electrodes with varying Ni content, (2) FTO-glass electrodes modified with a TiO_2/C/Ni/PEDOT coating using either rice-husk activated, or commercial carbon powders. Electrochemical characterization such as linear voltammetry, cyclic voltammetry and electrochemical impedance spectroscopy of prepared electrodes in alkaline solutions were used to assess intensity of the process of water electrolysis with electrochemical generation of hydrogen and oxygen gas. Preliminary measurements indicate that several of the tested Ni-RH-AC composite electrodes show promising current flows especially for oxygen evolution reaction pointing to the more favorable water oxidation process relative to Ni-doped CNT on graphite electrodes.

While full characterization is ongoing, these early trends suggest that nickel doped biowaste (rice husk) activated carbon composites may be viable cost-effective electrode materials for water splitting reaction and motivate further analysis of their properties, long-term stability, and the influence of fabrication variables on performance. We are also planning to investigate potential applications of fabricated electrodes in photoelectrochemical H_2 generation.

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