

Brown Mud-Derived Fe₃O₄ as a Bifunctional Electrode for Supercapacitor and Oxygen Evolution Applications

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ABSTRACT

Brown mud (BM), an iron rich residue from alumina production, can serve as a secondary source for the recovery and preparation of value-added iron oxide materials. In the present work, Fe₃O₄ was recovered from BM by acid leaching under refluxing condition, followed by ammonia-assisted precipitation and hydrothermal treatment at 160°C for 8, 16, 24, and 32 hours. The prepared samples were denoted as FE1, FE2, FE3, and FE4, and their phase composition and magnetic properties were examined by X-ray diffraction and hysteresis measurements. The samples were then deposited on 1 cm² nickel foam and subjected to preliminary electrochemical screening for supercapacitor and oxygen evolution reaction (OER) applications. Among the four samples, FE4 showed the most favourable overall response. It exhibited an OER overpotential of 304.5 mV at a current density of 10 mA/cm² and a Tafel slope of 68.68 mV/dec, together with 24 hours stability in alkaline solution at the corresponding operating condition. For supercapacitor application, FE4 delivered a specific capacitance of 280 F/g at 100 mV/s and an areal capacitance of 3.935 mF/cm² at 0.1 mA/cm². FE4 also showed the highest saturation magnetization of 53.17 emu/g. These preliminary results identify the 32 hours hydrothermal sample as the most promising candidate for further optimization and reproducibility studies.

Keywords: bifunctional electrode; brown mud; hydrothermal synthesis; oxygen evolution reaction; supercapacitor.

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