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Al^{3+} doped Fe_3O_4 Nanoparticles: A Novel Preparation Method, Structural, Magnetic and Electrochemical Characterizations

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Aluminum doped magnetite (Fe_3O_4) nanoparticles were synthesized through one-pot facile electrochemical method. In this method, products were electro-deposited on a stainless steel (316L) cathode form an additive-free 0.005M $Fe(NO_3)_3/FeCl_2/AlCl_3$ aqueous electrolyte. The structural characterizations through X-ray diffraction (XRD), field emission electron microscopy (FE-SEM) and energy-dispersive X-ray (EDX) indicated that the deposited material has Al doped magnetite particles with average size of 15 nm. Magnetic analysis by VSM showed the super-paramagnetic nature of the prepared nanoparticles (Ms = 18.37 emu g^{-1}, Mr=0.13 emu g^{-1}, and H_{Ci}=8.73 G). The charge storage capability evaluation of the prepared nanoparticles through cyclic voltammetry (CV) and galvanostat charge-discharge (GCD) confirmed that these materials are capable to deliver specific capacitances as high as 236.1 F g^{-1} (at 0.2 A g^{-1}) and 180.2 F g^{-1} (at 1 A g^{-1}), and capacity retentions of 95.6% and 89.4% after 2000 cycling at 0.2 and 1 A g^{-1}, respectively. The results confirmed that the applicability of the electro-synthesized nanoparticles in supercapacitors. Besides, the study shows a simple electrochemical method for preparation of metal doped magnetite nanoparticles.

Keywords: Nanoparticles; Magnetite; Al doping; Cathodic electrosynthesis; Charge storage

FULL TEXT