Synthesis and characterization of aluminium oxide nanoparticles from waste aluminium foil and potential application in aluminium-ion cell

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Abstract

Aluminium waste accumulated in landfills is a solid waste in abundance. Various methods have been employed to alleviate the waste only to yield secondary pollution effects. This study seeks to provide an alternative greener recycling procedure that is beneficial to society in terms of health and economics through energy storage materials. The study aimed to synthesize and characterize aluminium oxide nanoparticles from waste aluminium foil and its potential applications in fabricating aluminium-ion cell, FAIC.[1] Aluminium oxide nanoparticles were obtained by co-precipitation of waste aluminium foils at constant annealing room temperature followed by mechanical milling to nanoparticulate range. The particles were then characterized for particle size and phases (X-ray diffraction), functional groups and optical activity (infra-red and ultra-violet-visible spectroscopy respectively). Cell assembling of FAIC was done using a graphite anode while the cathode had a standard and the synthesized aluminium oxide nanoparticles. Sulfuric acid and magnesium sulfate electrolytes were used with two binders; polyacrylate and silicone adhesives. The average synthesis yield was 40.64 ± 19.69%. Most of the particles had a α-Al_2O_3 and γ-Al_2O_3 phase with an average size of 63.763 nm and 66.5144 nm for the two polymorphs respectively. There were several OH-groups coupled to Al–O bonds. The optimal absorption peak was λ_{max} = 237 nm corresponding to a band gap of 5.25eV. The synthesized nanoparticles exhibited great electrochemical potential, nearing the standard one in most of the parameters. The FAIC potential, current, power densities and polarization curves from sulfuric acid electrolyte and polyacrylate binder were significantly higher to those of magnesium sulfate and silicone binder ($P > 0.05$). This study seeks to address the national agenda on manufacturing and SDG 7 on affordable and clean energy.

Keywords: Aluminium wastes, Al_2O_3 nanoparticles Aluminium-ion cell