Ceramics International 43 (2017) 8440–8448

Contents lists available at ScienceDirect

Ceramics International

journal homepage: www.elsevier.com/locate/ceramint

High performance MnO_2 nanoflower supercapacitor electrode by electrochemical recycling of spent batteries

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ARTICLE INFO

Keywords:
Spent batteries
Supercapacitance
Electrochemical conversion
MnO_2 nanoflower

ABSTRACT

MnO_2 nanoflower is prepared by electrochemical conversion of Mn_3O_4 obtained by heat treatment of spent zinc–carbon batteries cathode powder. The heat treated and converted powders were characterized by TGA, XRD, FTIR, FESEM and TEM techniques. XRD analyses show formation of Mn_3O_4 and MnO_2 phases for the heat treated and converted powders, respectively. FESEM images indicate the formation of porous nanoflower structure of MnO_2, while, condensed aggregated particles are obtained for Mn_3O_4. The energy band gap of MnO_2 is obtained from UV–Vis spectra to be 2.4 eV. The electrochemical properties are investigated using cyclic voltammetry, galvanostatic charge–discharge and electrochemical impedance techniques using three-electrode system. The specific capacitance of MnO_2 nanoflower (309 F g^{-1} at 0.1 A g^{-1}) is around six times higher than those obtained from the heat treated one (54 F g^{-1} at 0.1 A g^{-1}). Moreover, it has high capacitance retention up to 93% over 1650 cycles. Impedance spectra of MnO_2 nanoflower show very small resistances and high electrochemical active surface area (340 m^2 g^{-1}). The present work demonstrates a novel electrochemical approach to recycle spent zinc-carbon batteries into high value supercapacitor electrode.

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http://dx.doi.org/10.1016/j.ceramint.2017.03.195
Received 1 February 2017; Received in revised form 12 March 2017; Accepted 30 March 2017
Available online 31 March 2017