A Novel Hard/Soft Spinel Ferrite Nanocomposite as Potential Electrode Material for a Supercapacitor

AlDahmash, Dana (School: AlBassam Schools)

Modern-day supercapacitors have problems including lack of good dynamic performance, low power rates and insufficient energy storage. Features such as voltage malfunction can occur when the capacity is increased. This may affect the performance of various electrical machines as well as increase the cost of supercapacitors. This research project focuses on developing a cost-effective, environmentally friendly, and simple fabrication of a novel hard/soft spinel ferrite nanocomposite. $CoFe_2O_4/x(NiSc_{0.03}Fe_{1.97}O_4)$ nanocomposite for different values of x as ($0.0 \leq x \leq 5$) is obtained by a single-pot citrate combustion technique. The composites have been characterized through XRD, which revealed a pure spinel structure without any undesired phase. This indicated the homogeneity of hard/soft NCs. SEM and EDX reflected the composed element without any impurity and high-resolution TEM imitated the pure spinel ferrite phases. The performance was tested using VSM, which produced well exchanged coupled ferrite magnets. The synthesized materials were used to modify the carbon electrodes in different percentages to get higher specific energy and improve capacitance. Based on the studied 5 samples while using chemical impedance spectroscopy, galvanotactic charge/discharge and cyclic voltammetry, the 1:3 ratio gave the best results in enhancing supercapacitors. The addition of metal ferrites to supercapacitors would likely to improve their potential window to 1.2V, which will enhance their energy density significantly, reaching 494.7 W/kg. This is one of the biggest hurdles in replacing batteries with supercapacitors. The other prepared composites in this study also exhibit potential for other applications, owing to their properties.