Growth of $LiNi_{0.5}Mn_{1.5}O_4$ crystals on reduced graphene oxide sheets for high energy and power density charge storage

V. Gajraj[a], *R. Jose*[b], *C. R. Mariappan*[a]

[a] Department of Physics, National Institute of Technology, Kurukshetra, Haryana, 136 119, India

[b] Nanostructured Renewable Energy Materials Laboratory, Faculty of Industrial Sciences & Technology, Universiti Malaysia Pahang, 26300, Kuantan, Malaysia

ABSTRACT

Spinel-type lithium manganates are actively considered to develop cost-effective energy/charge storage devices. In this article, we show the growth of $LiNi_{0.5}Mn_{1.5}O_4$ nanocrystals on reduced graphene oxide (rGO) sheets, which offer impressive improvements in their charge storage capability than that can be achieved using bare $LiNi_{0.5}Mn_{1.5}O_4$ nanocrystals. X-ray diffraction, Raman spectroscopy, Fourier transform infrared spectroscopy, X-ray photoelectron spectroscopy and electron microscopy techniques are employed to demonstrate the embedment of $LiNi_{0.5}Mn_{1.5}O_4$ particles on rGO sheets. As a single electrode, $LiNi_{0.5}Mn_{1.5}O_4$-rGO composite electrode deliver ∼3-fold enhanced charge storability (∼572 F g^{-1} /∼175 mA h g^{-1} at 3.75 A g^{-1}) in 5 M $LiNO_3$ electrolyte than the bare $LiNi_{0.5}Mn_{1.5}O_4$ electrode. The electrochemical charge storage processes are investigated via the Dunn's approach. The major charge storage mechanism of the samples is diffusion controlled at slow scan rate. A practical hybrid battery – supercapacitor device is fabricated in the $LiNi_{0.5}Mn_{1.5}O_4$-rGO//activated carbon configuration, which deliver energy density in the 60 – 23 Wh kg^{-1} range at a power density in the 1.2−13 kW kg^{-1} range with an output voltage of 0–2.0 V, excellent cycling stability, and rate capability.

KEYWORDS

Supercapacitors; Lithium ion capacitors; Asymmetric supercapacitors; Energy storage materials; Psuedocapacitors

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