

Enhanced capacitive performance of cathodically reduced titania nanotubes pulsed deposited with Mn₂O₃ as supercapacitor electrode

ABSTRACT

A facile and simple pulse electrodeposition method was employed to deposit Mn₂O₃ nanoparticles on cathodically reduced titania nanotubes (R-TNTs) at different deposition time in the range of 3-15 min to investigate the influence of mass loading of Mn₂O₃ on the electrochemical performance of Mn₂O₃/R-TNTs nanocomposite for supercapacitor application. Mn₂O₃ nanoparticles were deposited on circumference of R-TNTs as well as in the nanotubes as revealed by FESEM images for all the deposited time. XPS result confirmed the presence of MnO₂ (Mn⁴⁺) and MnO (Mn²⁺) on the Mn₂O₃/R-TNTs composite which provide pseudocapacitive behaviour for the electrode. Mass loading of Mn₂O₃ increased linearly with deposition time as confirmed by EDX analysis. The sample deposited for 12 min exhibits the highest areal capacitance of 51 mF cm⁻² (which is 22 times enhancement over R-TNTs) at a current density of 0.1 mA cm⁻² and specific capacitance of 325 F g⁻¹ at 6 A g⁻¹. The sample also show a high-rate capability by retaining 80% of its capacitance even at higher current density of 30 A g⁻¹. Interestingly, it retained 98% of the capacitance over 5000 charge discharge cycles at 10 A g⁻¹ after initial drop to 95% at 200th cycles suggesting an excellent long-term chemical stability. A considerably low equivalent series resistance (ESR) and charge transfer resistance (R_{ct}) of 9.6 Ω and 0.4 Ω respectively was deduced from electrochemical impedance spectroscopy (EIS) analysis indicating good conductivity and improved charge transfer efficiency of Mn₂O₃/R-TNTs nanocomposite.