ABSTRACT

Rechargeable lithium ion batteries have emerged as the dominant energy storage source for consumer electronics, automotive and stationary applications because of their high energy density, high open circuit voltage, low cost with long cycle life. Also sodium ion batteries (SIBs) featuring similar electrochemistry to lithium ion batteries are emerging as a promising low-cost alternative for large scale storage applications due to their truly earth abundant resources. In commercial lithium ion batteries, the most common anode material is graphite with a theoretical specific capacity of 372 $mAhg^{-1}$. However, due to low capacity and poor performance at higher specific currents, graphite cannot meet the requirement of high energy and high power batteries. Also the larger size of sodium ion rules out the use of graphite as anode in SIBs. Thus, developing high performance anodes following sustainable and economic approach is the key to address these issues. In spite of having high storage capacity, the rapid capacity fading caused by the large volumetric fluctuations during cycling remain as a major challenge for transition metal oxide anodes. Therefore, in pursuit of a simple and economical alternative to circumvent these drawbacks and to improve the electrochemical properties of such conversion type anode materials, electrophoretic deposition (EPD) technique can be a suitable approach. In this present work, we report the effectiveness of EPD technique to fabricate CuO-carbon black (CB) film as negative electrodes for lithium and sodium-ion rechargeable cells. The obtained EPD films are found to be porous and strongly adherent to underlying current collector with a uniform distribution of CB and CuO. These films are observed to retain reversible specific capacities of 500 $mAhg^{-1}$ at 0.5 Ag^{-1} and 256 $mAhg^{-1}$ at 0.1 Ag^{-1} after 100 cycles as Li- and Na-ion battery anode respectively. Here we report the facile sol-gel synthesis of perovskite $NiTiO_3$ (NTO) and explored its potential as anode for Li- and Na- ion batteries through EPD. These electrodes sustain stable reversible specific capacities of 281 $mAhg^{-1}$ and 131 $mAhg^{-1}$ at a specific current rate of 50 mAg^{-1} against lithium and sodium respectively. The impact of making carbonaceous composites with NTO has also been studied in detail where multi-walled carbon nanotubes and graphene oxide have been used as carbon sources. The optimized samples exhibit enhanced electrochemical performance. For NTO-CNT composite, the optimized electrode is able to deliver reversible capacities of ~417 & 177 $mAhg^{-1}$ against lithium and sodium respectively. On the other hand, NTO-GO electrodes deliver reversible specific capacities of 506 & 290 $mAhg^{-1}$

against lithium and sodium because of the synergistic effects between CNT/GO and NTO nanoparticles. CNT and GO help in buffering the volume fluctuations by giving structural stability and enables good cycle life and rate performance. The improved electrochemical performance can be attributed to the porous microstructure, superior adherence property and uniform active material distribution of the EPD grown film. Therefore, this simple and cost effective fabrication process (EPD) is a suitable approach to fabricate conversion type anode materials with superior electrochemical properties.

Keywords: Electrophoretic deposition, Conversion anode, Copper oxide, $NiTiO_3$, Lithium-ion cell, Sodium-ion cell.