Application of *in-situ* dilatometry to investigate the effect of single-walled carbon nanotubes on the performance of Ni-rich cathodes

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Abstract

Production of high-power lithium-ion batteries (LiBs) is considered to be crucial for world-wide use of electric vehicles. There have been many attempts to increase power density of LiBs by addition of highly conductive materials such as carbon nano tubes (CNTs) to the anode and the cathode. In this research, we investigated the electrochemical performance of the LiNi0.6Mn0.2Co0.2O2 (NMC622) positive electrode modified with single-walled carbon nanotubes (SWCNTs). SWCNTs content in the composite electrode is optimized and then the optimum sample has been analyzed by *in-situ* dilatometry. The volume change of the composite electrode (caused by lithium ions (de-)insertion) potentially contributes to the faster ageing of the positive and negative electrodes. Monitoring such volume changes to apply strategies to impede harsh expansion/contraction of the electrodes will help to increase LiBs cycle life. Nickel rich cathodes typically expand during charge up to approximately 4.0 V, which is followed by a sudden contraction with continued charging. The behaviour is reversed during discharge. In this research we have used differential analysis of the cathode’s height changes during galvanostatic cycling and found that SWCNTs cause a positive shift in contraction behaviour of the Ni-rich cathode. This could explain improved cycle life of the SWCNT modified cathodes. The presence of SWCNTs in a Ni-rich cathode compared to a conventional composite conductive carbon containing cathode, decreases irreversible height change occurring during a formation cycle from 276 nm to 86 nm and decreases overall electrode height change ~5.5 times. Coulombic and energy efficiencies of the ozonated SWCNT NMC electrodes are improved by 1.2 % and 6.4 %, respectively, compared to the reference NMC electrode after 250 cycles in a three-electrode assembly, showing great potential of SWCNTs to be used in LiBs.