ABSTRACT

To improve the cycling performance and rate capability of the promising layered lithium-rich cathode materials, we substitute Co^{3+} in $LiCoO_2$ with unusually large La^{3+} using Sol-Gel technique. We synthesis $LiCo_{1-x}La_xO_2$ (with $0 \leq x \leq 0.20$) and calcined the obtained powders at 850°C for 6h. The influences of lanthanum content on the electrochemical properties of the lithium-rich materials are investigated by X-ray diffraction (XRD), Scanning electron microscope (SEM), Transmission electron microscope (TEM), Fourier transformation infrared spectroscopy (FTIR), Galvano static charge–discharge tests and cyclic voltammetry (CV) techniques. X-ray diffraction results confirmed the formation of hexagonal lattice of α-$NaFeO_2$ structure of $LiCoO_2$ and having space group R-3m. Composites results also revealed the existence of minute quantities of lanthanum-rich perovskite phase tetragonal $La_2Li_{0.5}Co_{0.5}O_4$ (14/*mmm*), along with rhombohedral $LiCoO_2$ (R-3m). SEM shows a distinct grain growth with increasing Lanthanum contents. Transmission electron microscope (TEM) confirms the hexagonal shape of grains and also confirm the grain size. FTIR confirms the chemical bonding. La doped material shows maximum discharging capacities of 182.38 $mAhg^{-1}$ and 56.2 $mAhg^{-1}$ at 0.1C, and 5 C respectively and on average, this is more then 5% higher as compared to the pure $LiCoO_2$. After 5C, the discharge capacity of doped material at 0.1C can again reach 163.83 $mAhg^{-1}$, about 89% of the discharge capacity obtained in the first cycle. An excellent cycling performance with capacity retention by a factor of ~2 in comparison to the pristine $LiCoO_2$ was observed for the composite cathode containing 4.0 mol% La, when 2032 type coin cells were cycled at constant rate. This has been ascribed to the structural stability induced by La doping. Cyclic voltammetry showed a remarkable improvement in reversibility and stability of the La-doped electrodes. These composite cathodes might be very useful for high rate power applications.