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ELECTROCHEMICAL PERFORMANCE OF YTTRIUM-DOPED NIOBIUM MOLYBDENUM OXIDE NANOWIRES FOR LI-ION BATTERIES

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ABSTRACT

Niobium-based oxides have attracted widespread research enthusiasm in the field of energy storage systems, including lithium-ion batteries (LIBs). Most recently, niobium molybdenum oxide was reported as a promising material for LIBs due to their long-term cyclability, high theoretical/practical capacities, safe operating potential, and excellent structural stability. Nevertheless, the kinetics of electrochemical reactions in niobium oxide-based compounds are hindered by their intrinsically poor electronic conductivity and electron transfer properties. This tends to be a significant flaw restricting their practical use in LIBs. Hence, we propose the combination of nanostructure and yttrium doping strategies to enhance the electronic conductivity and electrochemical reactions kinetics of niobium molybdenum oxide for improved electrochemical performance. In this study, pristine and yttrium-doped (Y = 2 wt.%, 4 wt.%, 6wt.%) niobium molybdenum oxide nanowires were fabricated using the electrospinning technique, followed by annealing at 900˚C for four hours. The pristine and yttrium-doped niobium molybdenum oxide nanowires were characterized by the combination of cyclic voltammetry (CV), galvanostatic charge-discharge tests, scanning electron microscopy (SEM), Raman spectroscopy, X-ray photoelectron spectroscopy (XPS), X-ray diffractometry (XRD), and scanning transmission electron microscopy (STEM). The results obtained from the electrochemical test show that the doping and nano-size effects in niobium molybdenum oxide nanowires lead to outstanding electrochemical properties, including the high average discharge capacity of 287 $mAhg^{-1}$, 298 $mAhg^{-1}$, 311 $mAhg^{-1}$, and 307 $mAhg^{-1}$ for undoped, 2 wt.%, 4 wt.%, and 6wt.%. yttrium-doped samples respectively at 0.5 C. Moreover, the yttrium doped samples also exhibit excellent long-term cycling stability (over 500 cycles) at a high current rate of 10 C compared to the pristine molybdenum oxide nanowires. In addition, the results obtained from the electrochemical impedance and cyclic voltammetry tests confirm that the yttrium doping significantly enhanced the electronic conductivity and lithium-ion diffusion coefficient of the samples compared with the pristine condition. This study affirms that the combination of nanostructure and yttrium doping strategies considerably improved the electronic conductivity and electrochemical reactions kinetics of niobium molybdenum oxide nanowires, which is beneficial for developing new anode materials for LIBs.