Investigation of the electrochemical properties of Vanadium-based oxides for thin film electrodes

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Vanadium oxide ($V_2O_5$) thin films are of considerable interest for their extensive application as electrodes for rechargeable thin film batteries, optical electrochromic devices, and gas sensors due to their characteristic structural, electrochemical, and optical properties. In particular, because of promising developments with respect to microelectronic mechanical systems, micro-devices, smart card, and small sensor, the fabrication of high-quality thin film batteries become increasingly important. Rechargeable thin film batteries have been developed with anode materials such as graphite, SnO$_2$, and WO$_3$ and cathode materials such as MoS$_2$, LiCoO$_2$, LiMn$_2$O$_4$, and $V_2O_5$. Among the oxide cathode films, $V_2O_5$ is a promising candidate for active cathode materials for use in rechargeable thin film batteries, because of its high volumetric capacity, high voltage range, and easy insertion and extraction.$^{1-3}$

In this work, to improve the cyclic behaviour and capacity of the $V_2O_5$ cathode, other oxides such as Mo-oxide were incorporated into $V_2O_5$ by a co-sputtering system. The electrochemical properties of the V-based oxide thin film electrodes were investigated and compared with that of the $V_2O_5$ films. The microstructures of V-based oxide electrodes were examined using X-ray diffraction, scanning electron microscopy, high resolution electron microscopy, and X-ray photoelectron spectroscopy. Electrochemical tests were performed using cycler (WBCS 3000) in a 0.75 M LiCF$_3$SO$_3$ (PC:DME=1:2) solution. Cycling tests were carried out for up 100 cycles in the range of 1.5 V to 3.6 V at constant current density was 20μA/cm$^2$.

Figure 1 shows XRD plots obtained form the V-based oxide thin films. It is shown that all the oxide films have amorphous structure. It is further shown that the electrochemical behaviors of the microstructure-controlled thin film electrodes for lithium insertion and extraction are dependent on the microstructure and hence the amount of MoO$_3$ that were incorporated into the $V_2O_5$ films. The relationship between the electrochemical and structural properties are described and discussed.

References