ELECTROCHEMICAL PROPERTIES OF COBALT-SUBSTITUTED $LiMn_2O_4$ THIN FILMS

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Advances in the miniaturization of electronic devices and MEMS (Micro-Electro-Mechanical Systems) technology have reduced the current and power requirements of some of these devices to extremely low levels. This has made possible the use of thin film solid-state microbatteries as power sources for these devices. Therefore, it is important to develop long lasting and high-energy efficient thin film batteries that can be as an integral part of MEMS. $LiMn_2O_4$ is particularly interesting cathode material for microbattery, since it can reversibly intercalate one Li ion per mole, without altering the MnO_2 framework. In other to prevent Mn dissolution in liquid electrolyte and Jahn-Teller distortion of $LiMn_2O_4$, we substituted cobalt for manganese.

$LiMn_2O_4$ thin films were deposited by radio frequency magnetron sputtering with 2-inch diameter of $LiMn_2O_4$ target (99.97% purity). Si wafers were used as substrate on which Pt was deposited in thickness of 200 nm as a current collector by D.C. sputtering. To substitute cobalt ion, Co_3O_4 pellets were placed on $LiMn_2O_4$ target during sputtering. Compositions of films were analyzed by ICP and AES. Surface roughness of the film before and after the heat treatment was measured by AFM. Surface morphologies of the films were obtained by FE-SEM. For electrochemical analysis, half cells were made with the lithium manganese oxide as cathode, the lithium metal as anode, and 1 M solution of $LiPF_6$ in EC-DMC(1:1) as electrolyte.

Before annealing, sputtered thin films had amorphous structure. To get spinel structure, post-annealing process was done in air[1]. The annealed $LiMn_2O_4$ and cobalt substituted $LiMn_2O_4$ thin film have the same structure, spinel structure, and (111) preferred orientation. As cobalt was substituted, grain size and surface roughness of substituted thin film larger than that of $LiMn_2O_4$ film (Fig. 1). Fig. 2 is the cyclic voltammetry of cathode thin films. Cathode area of cell was 0.86 cm^2 and voltage rage and scan rate was 4.5-3.5 V and 1.0 mV/s, respectively. The potentials of the anodic and cathodic peaks were almost same. However, the intensity ratio of the first anodic or cathodic and the seond anodic or cathodic peaks was changed by cobalt-ion substition, respectively. This results suggested that cobalt ions was improved the stability of the spinel frameworks during intercalation process.

AKNOWLEADGEMENTS

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REFERENCES

1. H. -S. Moon, K. -S. Ji, W. I. Cho, Y.S. Yoon, and J. -W. Park, *J. Korean Phys. Soc.*, **40**, 22 (2002)

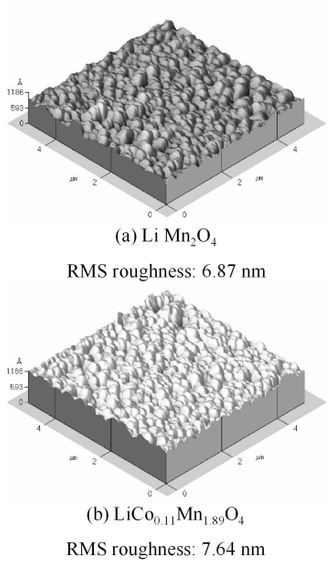

Figure 1. AFM images of the deposited films; (a) $LiMn_2O_4$ and (b) $LiCo_{0.11}Mn_{1.89}O_4$

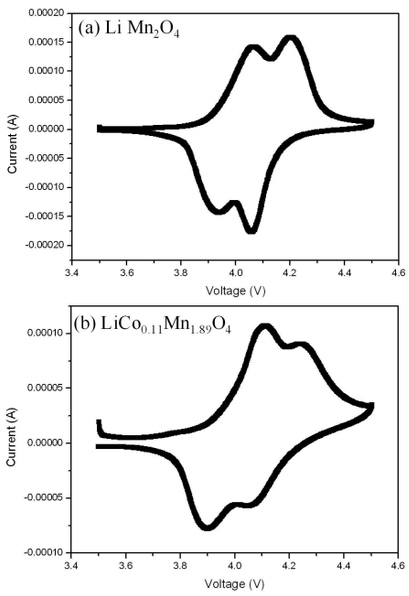

Figure 2. Cyclic Voltammetry of the deposited films.