

FILM THICKNESS EFFECT ON
ELECTROCHEMICAL PROPERTIES OF SPUTTERED
 $\text{Li}_x\text{Mn}_2\text{O}_4$ THIN FILMS

Hee-Soo Moon^a, Ki Lyung Lee^a, Seung Won Lee^a,
Wonhee Lee^b, Yoo-Kee Lee^c and Jong-Wan Park^{a,d}

^aDivision of Materials Science and Engineering
Hanyang University
17, Haengdang-dong, Seongdong-gu, Seoul 133-791,
Korea

^bDepartment of Advanced Materials Engineering
Sejong University
98 Kunja-dong, Kwangjin-gu, Seoul 143-747, Korea

^cDepartment of Semiconductor Engineering
Uiduk University
Kangdong, Kyongju 780-713, Korea

^dResearch Center for Energy Conversion and Storage
San 56-1, Shilim-dong, Kwanak-gu, Seoul, 151-742,
Korea

The thin film rechargeable microbattery, serving as an independent power supply in micro-electro-mechanical systems (MEMS) and a backup source for electronic circuits, has been given much attention[1]. The major difficulty in fabricating a microbattery is to prepare layers of electrodes in thickness less than one micrometer by using processes compatible with the microelectronics fabrication techniques. During cycling, neither the electrode nor the electrolyte materials should undergo a morphology change that might lead to the formation of chemically unstable, high surface area materials, even at the high rate of cycling desirable in some on-chip microbattery applications. The fabrication of such a multilayer system would allow integration of power units for MEMS. In this work, lithium manganese oxide was deposited using a rf magnetron sputter and the effect of film thickness on its microstructure, surface morphology, and electrode characteristics was investigated.

LiMn_2O_4 thin films were deposited using rf magnetron sputtering. The film composition was determined by inductively coupled plasma emission spectrometer and Rutherford backscattering spectroscopy. The crystal structure of the samples was characterized by X-ray diffraction and transmission electron microscopy. Surface morphology was analyzed using scanning electron microscopy and atomic force microscopy. For electrochemical tests, half cells were made with the lithium manganese oxide thin film as the cathode, the lithium metal as the anode, and a 1-M solution of LiPF_6 in EC-DMC(1:1) as the electrolyte. Charge-discharge experiments were performed with various cut-off voltages and current densities.

As shown in Fig. 1, LiMn_2O_4 thin films had almost same structure and (111) of preferred orientation. As thickness increased, the deposited films had other orientation peaks such as (531), (511) and (410) and impurity phase such as Li_2MnO_3 . Fig. 2 shows charge/discharge capacity of the films. The voltage window and current density were 4.2 ~ 3.8 V and 100 $\mu\text{A}/\text{cm}^2$, respectively. Initial discharge capacity of 600 nm-thick LiMn_2O_4 was the largest. However, its Coulombic efficiency was lower than that of thinner films. So, thicker film showed poor cycleability.

We will present the film-thickness effect on

microstructure, surface morphology and electrochemical properties of thin films.

AKNOWLEDGEMENTS

This work was supported by KOSEF through the Research Center for Energy conversion and Storage.

REFERENCES

1. J.B. Bates, G.R. Gruzalski, N.J. Dudney, C.F. Luck, and Xiaohua Yu, *Solid State Ionics*, **70/71**, 619 (1994)

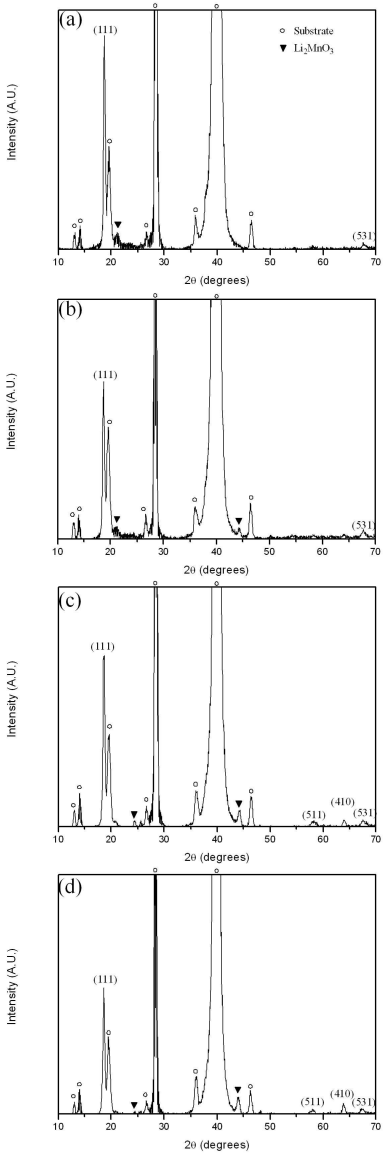


Figure 1. XRD patterns of the deposited films;

(a) 100 nm, (b) 200 nm, (c) 400 nm and (d) 600 nm

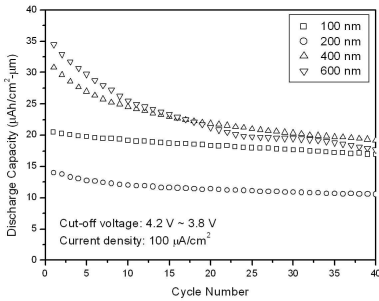


Figure 2. Discharge capacities of the deposited films.