Characterization of SnO_x-Coated Lithium Manganese Oxide Thin Film

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Lithium manganese oxide ($LiMn_2O_4$) is promising material for Li-ion rechargeable batteries and thin film batteries (TFBs). However, poor properties, such as instability in elevated temperature and lower practical capacity, interfere with commercialization. To improve the electrochemical properties of $LiMn_2O_4$, transition-metal substitution method has been performed [1]. However, this method induced discharge capacity reduction, because of diminution of Mn^{3+} ions, which was reacted with Li^+ ions when intercalation process. To improve the properties without capacity reduction, anion doping method [2] and surface treatment, such as oxide coating [3], was introduced. In our previous study, we introduced protective layer for cathode thin film by ECR-CVD [4]. In our work, we introduced SnO_x thin film as protective layer for cathode thin film.

Lithium manganese oxide cathode was deposited by rf magnetron sputter on Pt deposited $TiO_2/SiO_2/Si(100)$ wafer. In order to make spinal phase, post-annealing process introduced. The annealed film thickness was about 200 nm. SnO_x film was deposited by using same sputtering system with stoichiometric SnO_2 target. The SnO_x film thickness on the spinel film was controlled by the deposition time.

Surface roughness and morphologies of the film was measured by AFM and FE-SEM. The chemical bonding was analyzed by XPS. The elements on the surface were measured by AES depth profile method. For electrochemical analysis, half-cells were made with the deposited film as cathode, the lithium metal as anode, and 1 M solution of $LiPF_6$ in EC-DMC(1:1) as electrolyte.

As shown in Fig. 1, $LiMn_2O_4$ was covered totally covered by SnO_x film. Fig. 2 and Fig. 3 showed that cycleability in high C-rate and in the elevated temperature was improved by the SnO_x-protective layer due to avoid direct contact between $LiMn_2O_4$ and liquid electrolyte.

The more results will be presented in the meeting.

ACKNOWLEDGEMENT

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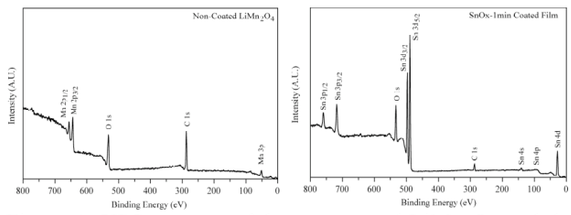

Figure 1. XPS surveys of the non-coated $LiMn_2O_4$ and the SnO_x – 1 min coated $LiMn_2O_4$.

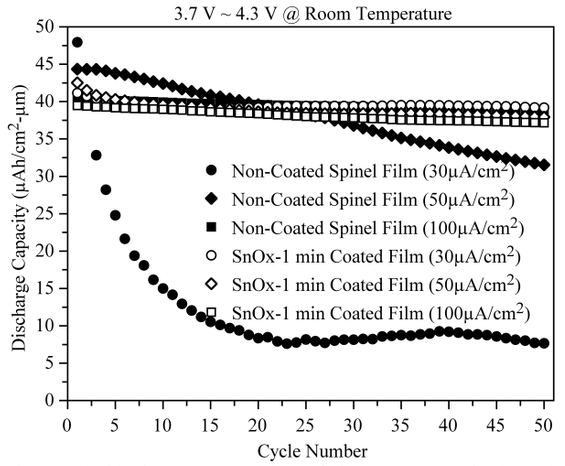

Figure 2. Discharge capacities of the non-coated $LiMn_2O_4$ and the SnO_x – 1 min coated $LiMn_2O_4$.

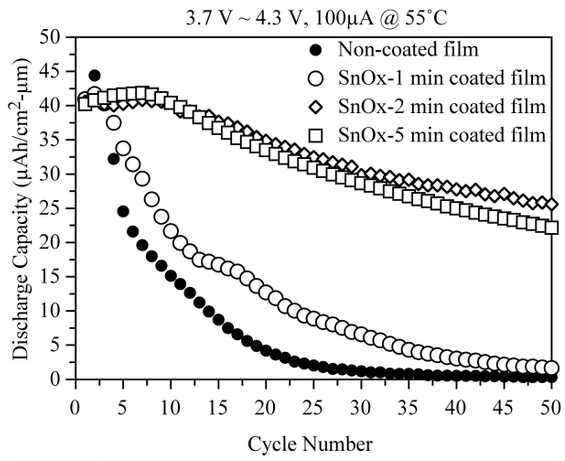

Figure 3. Discharge capacities of the non-coated $LiMn_2O_4$ and the SnO_x-coated $LiMn_2O_4$ in the elevated temperature.