Lithium Cobalt Nickel Oxide Thin-Film Cathode Prepared by RF Sputtering

Cheng-Lung Liao, Ho-Chieh Yu, and Kuan-Zong Fung

Department of Materials Science and Engineering,
National Cheng Kung University
Tainan 70101, Taiwan, Republic of China
TEL: 886-6-2756402
FAX: 886-6-2346290
Email: kzfung@mail.ncku.edu.tw

Lithium cobalt nickel oxide has been widely studied as a cathode material in lithium batteries due to its lower cost and higher working voltage compared to $LiCoO_2$ and greater stability compared to $LiNiO_2$. Therefore, various compositions of $LiCo_{1-x}Ni_xO_2$ films were prepared by RF sputtering in this work. $LiCo_{1-x}Ni_xO_2$ (x=0, 0.2, 0.5, 0.8, 1) powders were synthesized at 700℃ for 12 hours in oxygen atmosphere from the mixture of Li_2CO_3, $CoCO_3$ and NiO. To prepared sputtering target, the powders were pressed into 2-inch pellets and sintered at 900℃ for 6 hours in oxygen atmosphere. The lithium cobalt nickel oxide films were deposited under the condition of 100W power, 20mTorr pressure, and 12sccm flow rate. The structure of the sputtered films was analyzed by XRD, Raman and TEM. The morphology and the grain size of the films were observed by SEM and TEM, respectively. The composition of the films was analyzed by ICP. The electrochemical measurements of the films were conducted using the charge-discharge test and cyclic voltammetery.

From the XRD analysis shown in Fig.1, the as-deposited $LiCo_{1-x}Ni_xO_2$ films were all crystalline structure with (104) preferred orientation of the HT-$LiCoO_2$ structure (R3m). As a result of the Ni addition, the position of (104) peak was shifted to lower 2θ angle because of the presence of larger of divalent nickel ions. The XRD patterns of the as-deposited and annealed $LiCo_{0.5}Ni_{0.5}O_2$ films were shown in Fig.2. The crystallization of $LiCo_{0.5}Ni_{0.5}O_2$ film was enhanced as the increasing annealing temperature. Beside the (104) reflection, the (003) and (110) diffraction peaks were also observed after 600℃－annealing for 2 hours. In addition to the XRD analysis, the layered structure of the $LiCo_{0.5}Ni_{0.5}O_2$ films was further confirmed by TEM analysis. From TEM images, nanocrystallite grains of $LiCo_{1-x}Ni_xO_2$ were observed.

The discharge curves of annealed $LiCo_{0.5}Ni_{0.5}O_2$ film was shown in Fig.3. The discharge rate was 10 μA/cm^2. The capacity obtained was about 40 μA/μm-cm^2.

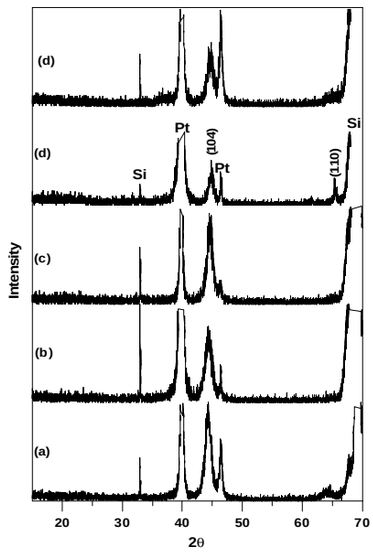

Fig.1 XRD pattern of as-deposited film (a) $LiNiO_2$, (b) $LiCo_{0.2}Ni_{0.8}O_2$, (c) $LiCo_{0.5}Ni_{0.5}O_2$, (d) $LiCo_{0.8}Ni_{0.2}O_2$, (e) $LiCoO_2$

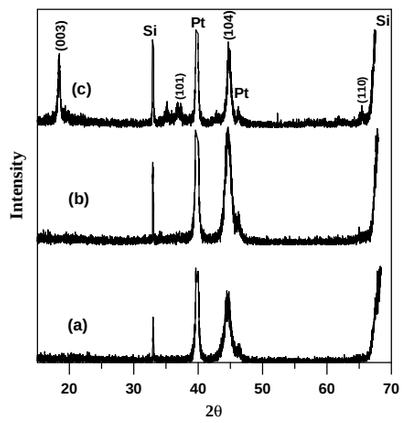

Fig.2 XRD diffraction pattern of (a) as-deposited, (b) 250℃ annealed, (c) 600℃ annealed $LiCo_{0.5}Ni_{0.5}O_2$ film

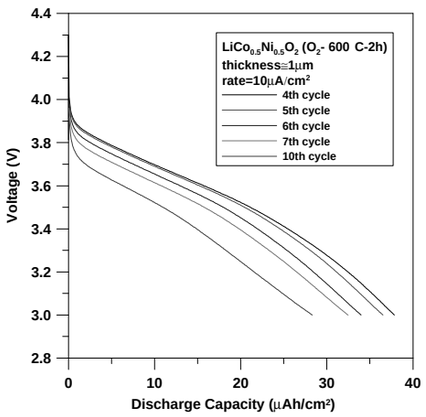

Fig.3 Discharge curve of 600℃ annealed $LiCo_{0.5}Ni_{0.5}O_2$ film