

Relaxation Analysis of $\text{Li}_x(\text{Ni}_{0.874}\text{Co}_{0.090}\text{Al}_{0.036})\text{O}_2$ ($x = 0.06$)

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Introduction

In recent years, LiNiO_2 -based cathode materials have been intensively developed for enhanced charge-discharge capacities. While NCA (Co and Al doped LiNiO_2) exhibits good high-temperature stability as well as excellent electrochemical properties, H3 phase still appears at the higher potential region as LiNiO_2 . We have investigated the structural variation of $\text{Li}_x(\text{Ni}_{0.933}\text{Co}_{0.031}\text{Al}_{0.036})\text{O}_2$ after the termination of lithium insertion using X-ray diffraction coupled with the Rietveld analyses [1]. This technique named “Relaxation Analysis” indicates the transient state from kinetic into the equilibrium structures, providing valuable information for the electrode reactions [2-9].

To consider the effect of Co and Al substitution, we started the relaxation analysis on the Co-rich composition, $\text{Li}(\text{Ni}_{0.874}\text{Co}_{0.090}\text{Al}_{0.036})\text{O}_2$, comparing the previous results [1]. In the present report, relaxation time variation of XRD patterns of $x = 0.06$ for $\text{Li}_x(\text{Ni}_{0.874}\text{Co}_{0.090}\text{Al}_{0.036})\text{O}_2$ has been investigated.

Experiment

Lithium was electrochemically extracted from $\text{Li}(\text{Ni}_{0.874}\text{Co}_{0.090}\text{Al}_{0.036})\text{O}_2$ using two electrode test cell (Hohsen Co.) at a constant current of 0.01C to form $\text{Li}_{0.06}(\text{Ni}_{0.874}\text{Co}_{0.090}\text{Al}_{0.036})\text{O}_2$. After the termination of Li extraction, we immediately removed the working electrode from the cell in a glove box to avoid the local cell reaction between the electrode material and the current collector.

XRD data were collected from 15° to 75° in 2θ with $\text{CuK}\alpha$ radiation at various relaxation time, which were served for the Rietveld structure analysis using RIEVEC program [10].

Results and discussion

Fig. 1 shows the potential variation at the lithium extraction up to $x = 0.06$ of $\text{Li}_x(\text{Ni}_{0.874}\text{Co}_{0.090}\text{Al}_{0.036})\text{O}_2$ with the constant rate of 0.01 C. Relaxation time variation of XRD patterns after the lithium extraction are represented in Fig. 2. 003 diffraction peak in the inset gradually shifts toward the lower 2θ direction with the relaxation time. We have analyzed the XRD pattern assuming two phase co-existence. At the presentation, we report the relaxation behavior compared with those of the previously reported Ni-rich NCA and LiNiO_2 .

References:

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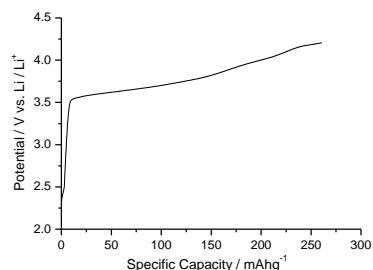


Fig. 1 Charge curve of $\text{Li}_x(\text{Ni}_{0.874}\text{Co}_{0.090}\text{Al}_{0.036})\text{O}_2$ cathode material up to $x = 0.06$ (0.01C).

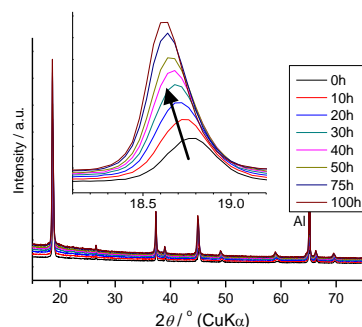


Fig. 2 Variation of XRD patterns of $\text{Li}_{0.06}(\text{Ni}_{0.874}\text{Co}_{0.090}\text{Al}_{0.036})\text{O}_2$ after the termination of lithium extraction.