Student Seminar Program, NIMS Joint Graduate School Programs with Hokkaido University-NIMS graduate School Program

& The 112th GREEN Seminar

Fast Crystal Growth Process of Cathode Active Materials for Li-ion Batteries at Low Temperatures

Coordinating Chair: Dr. Takuya Masuda (GREEN)

Prof. Masaki Matsui

(Department of Chemistry, Hokkaido University)

Layered $LiCoO_2$ (LCO) is usually synthesized at high temperatures ≥ 800 °C by conventional solid-state process. The LCO has another polymorph with a spinel structure, which is synthesized around 400 °C. Hence, the layered LCO and the spinel LCO have been called HT-LCO and LT-LCO, respectively.[1] Conversely, first-principles calculations predicted that the layered LCO is thermodynamically stable even at low temperatures.[2] Here, we propose an effective synthesis approach called the "hydroflux process" to synthesize a highly crystalline layered LCO at low temperatures of ≤ 300 °C within a short duration of ≤ 1 h.[3] A series of XRD studies revealed that the layered $LiCoO_2$ formation occurs even at 150 °C. We also confirmed that the water molecules in the molten mixed hydroxides significantly accelerate the crystal growth of layered LCO. The soluble $HCoO_2^-$ anion species under strong alkaline conditions, enable the low-temperature fast crystal growth of $LiCoO_2$ without spinel Co_3O_4 formation. In the present study, we successfully proved that the layered $LiCoO_2$ can be synthesized as the thermodynamically stable phase even at low temperatures. Furthermore, the hydroflux process could be a rapid and scalable production process for the layered LCO and other cathode active materials for Li-ion batteries.

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Contact: SHINOHARA.Yoshikazu@nims.go.jp