22Bp05

PE-PLD 法による $LiCoO_2$薄膜電極の作製と性能評価

Fabrication and performance evaluation of Lithium Cobalt Oxide ($LiCoO_2$) thin film electrodes by PE-PLD method

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1. Background and purpose

Recently, flexible batteries are expected to be applied in the healthcare field because they are lightweight and do not contain hazardous substances. In order to realize high-performance flexible batteries, electrode thin film materials and processes are very important and are being actively studied. $LiCoO_2$ is also used as a cathode material in lithium-ion batteries. However , a problem with $LiCoO_2$ cathode thin films is that they have a rough surface morphology and low crystallinity unless they are heated to high temperatures during deposition or annealed. In addition, high-temperature annealing limits the use of many substrate materials in flexible batteries, so it is desirable to keep the annealing temperature as low as possible [1-3].

My purpose is to prepare $LiCoO_2$ cathode thin films using the previously unstudied Plasma-Enhanced Pulsed Laser Deposition (PE-PLD) method to study the electrochemical performance and effect of lower heating temperatures on crystallinity

2. Experiment

First, $LiCoO_2$ thin films are deposited by PE-PLD and PLD methods. The laser is Nd:YAG, λ=1024 nm, laser density ~40 J/cm², target-substrate distance 50 mm, and substrate temperatures at room temperature, 300°C, 500°C, and 700°C. In the PE-PLD method, plasma is generated by the magnetron principle. The RF power was 20 W.

Next, the crystal structure of the thin film was analyzed by XRD and the surface state of the thin film was observed by SEM. In addition, coin cells were prepared in an Ar atmosphere, and cyclic voltammetry and charge-discharge measurements were performed to investigate the electrochemical performance of the films.

3. Result

Fig 1 shows the XRD results of thin films prepared by the PE-PLD and PLD methods. In the PE-PLD method, the (003) orientation peak was observed only for films deposited at 700°C, but almost no crystallization peak was observed for films deposited at 500°C and 300°C. Therefore, it was suggested that crystallization of thin films at low temperatures in the PE-PLD method is difficult.

Fig 2 shows surface SEM images of $LiCoO_2$ films deposited by the PE-PLD and PLD methods at 700°C. The crystal grains deposited by the PE-PLD method were larger by several hundred nm. It is thought that the reaction between active oxygen and ablation plume proceeded well and the plume formed large clusters.

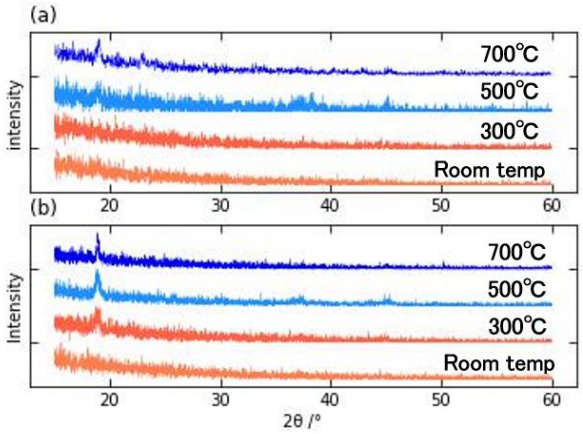

Fig1. XRD spectrum prepared by (a)PE-PLD (b)PLD

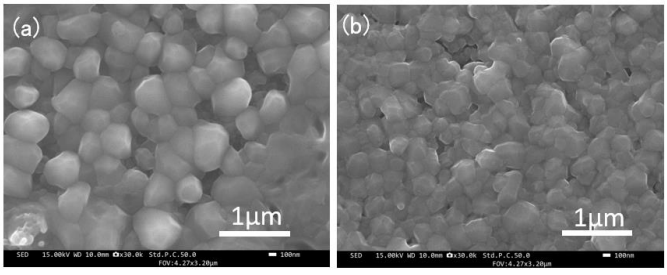

Fig2. SEM image prepared by (a)PE-PLD (b)PLD

[Reference]

[1] Seungwoo Yu *et al*, Thin Solid Films 661 (2018) 46-52

[2] Min Koo *et al*, Nano Letter (2012) 12,4810-4816

[3] Seung Hyun Lee *et al,* Nano Energy (2015) 14,111-125