Session: TS2

Constitution, Microstructure, and Battery Performance of Magnetron Sputtered Li-Co-O Thin Film Cathodes for Lithium-Ion Batteries as a Function of the Working Gas Pressure

Abstract # 383

Author(s)	***Presenter***	***Correspond***
Carlos Ziebert; Karlsruhe Institute of Technology, Germany	***X***	***X***
Bernt Ketterer; Karlsruhe Institute of Technology, Germany		
Monika Rinke; Karlsruhe Institute of Technology, Germany		
Christel Adelhelm; Karlsruhe Institute of Technology, Germany		
Sven Ulrich; Karlsruhe Institute of Technology, Germany		
Karl-Heinz Zum Gahr; Karlsruhe Institute of Technology, Germany		
Sylvio Indris; Karlsruhe Institute of Technology, Germany		
Thomas Schimmel; Karlsruhe Institute of Technology, Germany		

Abstract:

Despite of their widely use in mobile communication and portable electronic equipment there is a strong need for further development and optimization of the components for lithium-ion batteries, especially for the positive electrode (cathode). Nanocrystalline thin film cathode materials are of increasing interest due to their potential to provide both high power and high energy density.

Li-Co-O thin film cathodes have been deposited onto Si and stainless steel substrates by RF magnetron sputtering from a ceramic $LiCoO_2$ target at various working gas pressures ranging from 0.15 to 25 Pa. The composition, crystal structure and thin film morphology were examined using inductive coupled plasma optical emission spectroscopy (ICP-OES), carrier gas hot extraction (CGHE), X-ray diffraction (XRD), Raman spectroscopy (RS), atomic force microscopy (AFM) and scanning electron microscopy (SEM). Thin film properties such as intrinsic stress, conductivity and film density were determined. As deposited films at 0.15 Pa as well as in the range between 5 Pa and 10 Pa working gas pressure showed a nanocrystalline metastable rocksalt structure with an unordered cation arrangement and were nearly stoichiometric.

With increasing annealing temperature a cation ordering process was observed by XRD. Heat treatment of the films deposited at 10 Pa Argon gas pressure at 600 °C leads to the formation of the hexagonal high temperature phase HT-$LiCoO_2$ with a layered structure. The Raman spectrum of the films deposited at 0.15 Pa and annealed at 400°C indicates the formation of the low temperature phase LT-$LiCoO_2$ with a cubic spinel-related structure, which is assumed to be stabilized due to high compressive stress in the film.

The battery performance of the as grown and the annealed thin film cathodes was studied and it was revealed that the discharge capacity strongly depends on the crystal structure of the films. Thin Li-Co-O films with a perfect layered HT-$LiCoO_2$ structure showed the highest discharge capacities.

Note: Requested an Oral Session.