Nanostructured $LiCoO_2$ cathode material used for enhanced Li ion battery performance

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Li ion batteries have emerged as the preferred energy storage device used to power numerous electronic applications. Advances in and miniaturization of electronic devices continue to demand a more capable power source. Materials at the nanometer scale, that is 10^{-9} meters, tend to exhibit different properties when compared to their bulk structure. Many of these properties are enhanced when on the nanometer scale.

$LiCoO_2$ is a commonly used cathode material used in Li ion batteries today. Nanoscale $LiCoO_2$ exhibits unique electrochemical properties not expressed in the bulk material. Careful production and synthesis of this nanomaterial is necessary in order to obtain and utilize the enhanced properties exhibited. Thin film technology has allowed for the production of materials in films that are nanometers in thickness. These thin films can be applied to the electrode materials in battery research. Electrode materials made into thin films allows for quicker Li ion diffusion and removal leading to faster charge and discharge rates than when in a bulk form.

RF magnetron sputter coating is a commonly used line of sight, thin film deposition technique where the substrate that is exposed will be coated with the target material. We have used RF sputtering on nanoporous substrates to make nanostructured thin films.[1] Depositing in a line of sight manner allows for the sputtered target material to template on such substrates.

Using a porous Whatman anodisc filter containing pores 200 nm in diameter as a substrate, nanostructured electrode materials can be produced (see Figure 1). These columnar, nanostructured electrodes have the added benefits of thin film materials with the additional surface area of the porous template. Assuming the porosity of the filter is 40%, the calculated unit surface area of a 700 nm deposited nanostructure is increased by about a factor of 6, compared to the flat surface of a thin film. In this manner, nanostructured $LiCoO_2$ cathodes can be produced from sputtering a $LiCoO_2$ target on a nanoporous substrate.

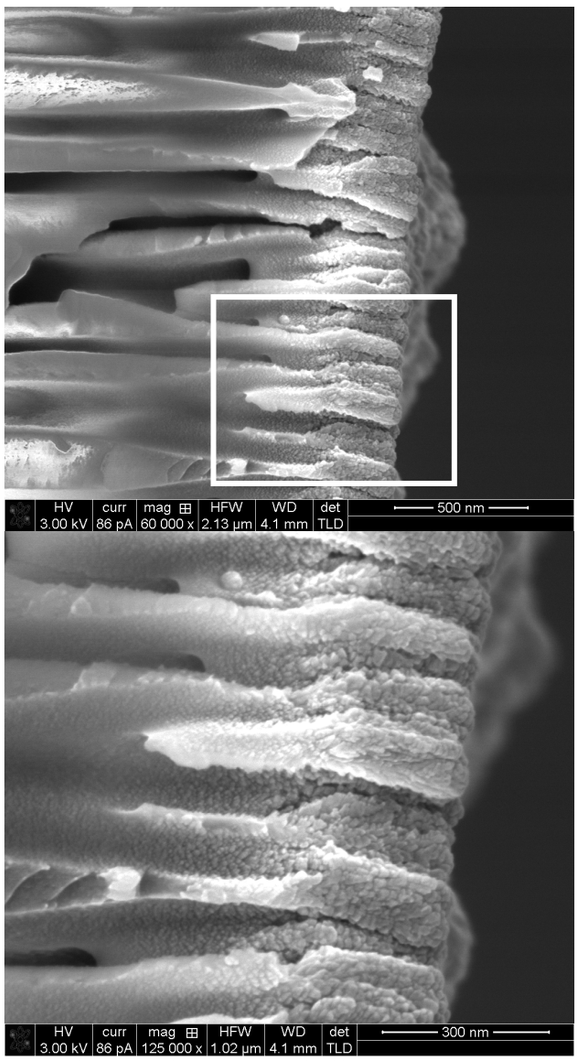

Figure 1 (top) 700 nm thick $LiCoO_2$ sputtered nanostructure. The whitish, rougher areas are the columns of $LiCoO_2$ sputtered on top of the alumina membrane. (bottom) Higher magnification of highlighted box region from top image.

The increased surface area generated can allow for more electrode-electrolyte contact, permitting more Li ions to intercalate and deintercalate from the material. Quicker Li ion insertion and removal can enhance the battery charging abilities and would enhance the overall battery performance that could be utilized for future commercial battery systems. Incorporating this nanostructured cathode material in Li ion battery systems will be discussed.

1. P. L. Johnson and D. Teeters, "Formation and Characterization of SnO_2 Nanobaskets," *Solid State Ionics*, **177**, 2821 (2006).