DENSE CERAMIC CATHODES FOR LITHIUM AND SODIUM BATTERIES

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Electrodeposition of dense ceramic electrode materials has the potential to enhance secondary battery performance and mechanics, and broaden the scope of available electrode form factors. I will present our work on the electrodeposition of high performance $LiCoO_2$, $NaCoO_2$, $LiMn_2O_4$, and Al-doped $LiCoO_2$-based Na and Li-ion cathodes as well as related materials. The electrolytically active materials were formed as solid films, with densities as high as 95%, and in thicknesses as great as 200 µm. The capacities are near-theoretical and the crystallinities and electrochemical capacities are comparable to powders synthesized at much higher temperatures. By using electrodeposition to grow the materials, the growth temperature was reduced from 700-1000 °C, the typical temperature for the solid-state synthesis of most cathode materials to 200-300 °C, which both enabled the direct growth of the nearly solid cathode on a metal current collector, and reduces the overall energy input required to grow the cathodes. We also find the electrodeposited films can be high textured, and in some cases, the crystals can be oriented such that the fast ion and electron diffusion pathways are normal to the substrate, which results in electrodes with unexpectedly good rate performances.

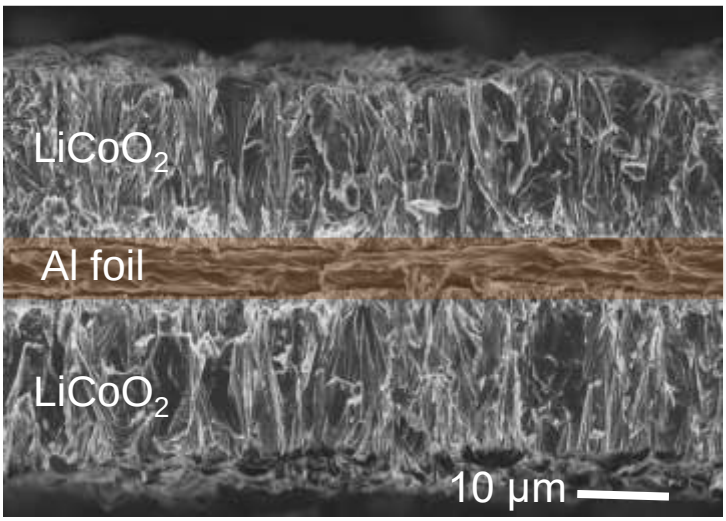

Figure 1 – $LiCoO_2$ electrodeposited on both sides of an aluminum current collector.

Figure 1 shows $LiCoO_2$ layers on both sides of an Al foil current collector. The $LiCoO_2$ was formed via electrodeposition in a molten salt and could be grown with a porosity as small as 5%. The appearance of the other solid cathodes formed via electrodeposition is similar. Because there is no binder or conductive additive, the energy density of the electrodeposited layer is greater than that of a conventional electrode, and because it is nearly dense and binder-free, the electrodeposited film also serves to enhance the mechanical properties of the Al film.