CONTROLLING AND CHARACTERIZING MICROSTRUCTURE IN LITHIUM-ION BATTERY ELECTRODES

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Lithium-ion battery electrodes consist of a functional composite containing electroactive solid particles where redox reactions occur, conductive additives, a polymeric binder to provide mechanical support, and void regions filled with electrolyte during cell fabrication. While much of the focus in the battery materials field is on the chemistry of the electroactive materials that dictate the fundamental limits on the energy density of the cell, the morphology of the electroactive materials and the microstructure of the electrode also have a significant influence on the resulting electrochemical properties. An example of an electrode microstructure is shown in Figure 1. For certain operating conditions and electrode architectures the transport of ions through the electrode microstructure can limit the performance of the cell, which means that controlling and understanding the microstructure can open up battery designs that improve the performance and energy density at the cell level. This strategy should be broadly applicable to multiple battery materials. In this paper, we will describe progress in our lab in synthesizing battery electroactive particles of controllable morphology and processing these particles into composite electrodes. The size, shape, and polydispersity of the particles results in different packing in the electrode and thus different electrode microstructures, while the active material composition is kept constant. Characterization of these electrodes to elucidate microstructure effects on electrochemical performance will also be described, in particular how different transport limitations become relevant for different electrode geometries. Measurements of the tortuosity of the electrodes will be detailed, and the conditions will be determined where transport is limited either within the electroactive particles or through the electrode microstructure. The electrodes described in this paper are functional composites for energy storage applications which is of relevance to the topical theme of this conference.

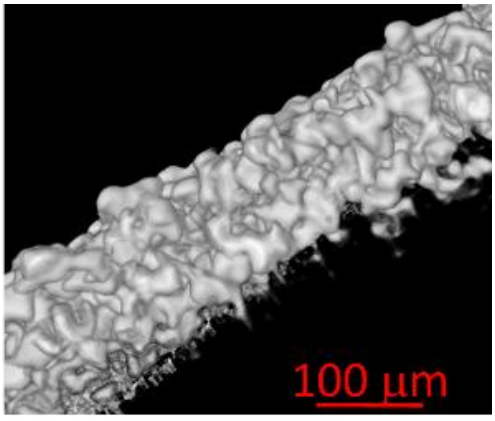

Figure 1 – Three-dimensional X-ray computed tomography image of a composite battery electrode. Bright areas are the electroactive material.