Lithium Ion Battery Cathodes Using Hollow Co_3O_4 Nanoparticles

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In spite of the ubiquitous use of the lithium ion batteries (LIB) in consumer electronics, these batteries are still in their infancy and significant amount of research is still left to bring out the full potential of the LIBs [1]. The electrode materials of the current state of the art LIBs are mostly dense laminates of tens to hundreds of μm in thickness, composed of electrochemically active materials few μm in size, conductive additives, and polymeric binders. These "bulk materials" experience kinetic limitations that hinder the diffusion of mobile charge carriers and lowers energy delivery rate, or power. In addition to the rate limitation, LIBs suffer from significant longevity issue due to the inability of bulk material's to accommodate Li insertion/deinsertion during discharging and charging of the batteries [2].

We propose to alleviate many of these problems by using electrophoretically deposited hollow Co_3O_4 nanoparticles thin films as the cathode [3.4]. Preliminary results show that these systems do have significant advantages over the current state of the art, as shown in figure 1 below. We believe these are due to three main advantages inherent to ordered and interconnected microporous geometry: first, the 3D interconnected pore structures facilitates mass transport through the electrodes, providing mobile species ready access to active material; second, short diffusion lengths, typically few nms, offer high rate performance; and third, the porous architecture creates relatively large specific areas that provide more exposed sites readily available to react with diffusing mobile species.

References

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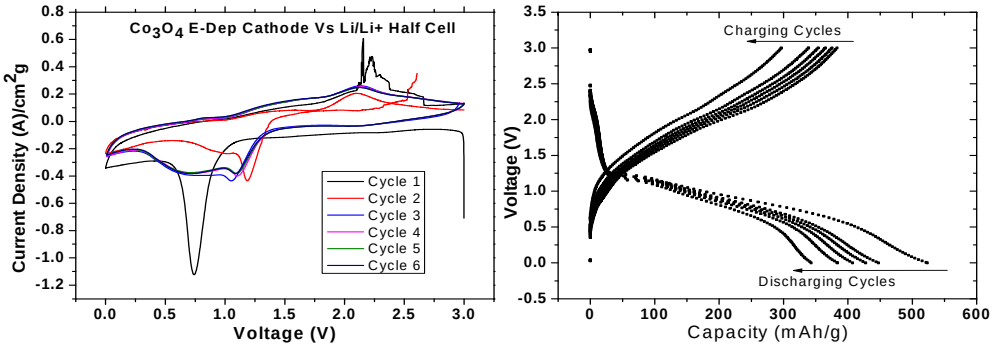

Figure 1: Left: Cyclic voltammograms of the battery and Right: Discharging and charging capacity of the battery.