High Capacity Three Dimensional Anodes for Li-Ion Batteries

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In order to me the needs of current and future technologies, secondary batteries will require increased energy and power densities. Current Li-ion batteries contain graphitic carbon anodes which are limited by their theoretical maximum capacity (372 mAh/g) and slow Li insertion rate. Alloying and conversion anodes have significantly higher capacities than carbon, but often suffer from aggregation during electrochemical cycling which leads to poor capacity retention. In this presentation, we will demonstrate that atomic layer deposition (ALD) can be used to hierarchically fabricate 3-D electrodes with alloying and conversion anodes that achieve high capacities and excellent rate capabilities. ALD is a self limiting vapor phase process that can be used to coat 3-D structures with conformal, uniform thin films. By utilizing a vapor phase process, high aspect ratio 3-D structures can serve as current collectors. Thin films of SnO_2 and CoO were deposited by ALD on Ni nanofoams and will be shown to significantly improve electrochemical cycling performance compared to conventional 2-D thin film anodes. By employing a high surface area 3-D current collector, thin film electrodes will be shown to achieve significant specific (>900 mAh/g) and areal (>1 mA/cm^2) capacities with high capacity retention. The effect of the thickness of nanometer scale alloying and conversion anode thin films on electrochemical performance was also systematically studied, and it will be demonstrated that there is a critical film thickness in order to maximize electrochemical performance of the different electrode systems.