Lithium Metal vs. Lithium Ion Charging Rates

Matthew Coon, Dalhousie University
Supervisor(s): Dahn, Jeff
Other authors: Louli, Alexander

One of the longstanding issues surrounding electric vehicles is price vs. range; consumers want a car that is affordable but are not interested in frequent stops for recharging. Replacing conventional lithium-ion (Li-ion) cells used in today's electric vehicles with lithium metal (Li-metal) cells results in an increase in energy density of the battery. This in turn means a cheaper battery pack which can travel a greater distance. However, a new problem arises in the form of cycle life. Li-ion technology has been optimized over the past 30 years, resulting in a battery that can be cycled thousands of times. The same cannot be said for Li-metal technology. The difference between Li-ion and Li-metal cells comes at how charge is stored. In a Li-ion cell the lithium ions travel from the positive electrode and are stored in a negative electrode host. In contrast, in a Li-metal cell the negative electrode host is removed and the lithium ions are plated directly onto the current collector. Ideally this plating remains smooth during cycling however, in reality as the cell cycles the morphology of the plated lithium becomes increasingly porous resulting in a high surface area "mossy" structure. This high surface area lithium precipitates capacity loss and decreases cycle life, therefore, maintaining smoothly plated lithium is critical. In this work we examine how changing the cycling rate of lithium-metal cells affects lithium morphology and cycle life. Finally, we propose an optimized cycling protocol which results in a smooth lithium morphology and increases cycle life by 60%.