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Title: Anode Materials for Lithium-Ion Batteries

Abstract: Lithium-ion battery (LIB) have been dominating the development of electronics, electric vehicles, and grid storage applications due to their high specific and volumetric energy densities. However, the technological advancement calls for even higher energy, safer, lower cost, and large scale manufacturing batteries. Different materials have been investigated as anode to increase the energy density of LIBs. Lithium metal is found to be an excellent candidate for anode material. This is due to: (1) it has high theoretical capacity of 3860 mAh/g, (2) it has low potential of -3.04V vs SHE, and (3) it has low density of 0.53 gm/cc. However, using lithium anodes raises many challenges; (1) lithium dendrite formations, (2) significant volumetric changes, and (3) safety hazards due to reactivity with organic liquid electrolytes (OLE).

Previous studies showed that lithium dendrite formation could be mitigated by using porous substrate for lithium deposition. Porous anode structures provide space where lithium can be diffused and confined away from the electrolyte thus reducing the dendrite formation and short-circuiting hazards. This concept has also been proven in lithium sulfur battery systems, where the microstructure porous layers serve as electrode supports and increase the mechanical strength by ~9 times, making the cells strong enough to handle with ease.

This study focuses on lithium metal batteries where pure lithium is an anode. The electrochemical performance of lithium metal battery with different configurations is studied and compared. Lithium Nickel Manganese Cobalt Oxide (NMC) 111 Cathode Lithium ion battery showed capacity fading after 4 cycles indicating loss of material and aggravated side reactions. However Lithium cobalt oxide cells showed more cycling stability at different charging rates. Lithium anode surface is analyzed by different techniques; nuclear reaction analysis (NRA). The concept of using porous nanofibers as substrate for lithium deposition coupled with solid state electrolytes is demonstrated.