Freeze Tape Casting: A Promising Fabrication Technique for High Energy Density Electrodes for Li-Ion Batteries

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Abstract: Rechargeable batteries are important components of many systems and devices and a high capacity battery that can be rapidly charged remains a top research and development priority. Important performance factors like capacity, energy density, and power density strongly depend on chemical nature and the microstructure of the porous electrodes. Highly tortuous porous electrodes and long lithium ion pathway due to pore blockage by inactive material are detrimental to the energy and power density.

Our goal is to investigate the potential of fabricating low tortuosity, controlled porosity Li- ion battery electrodes by taking advantage of the hierarchical ordered porous microstructure, which can be obtained using freeze tape casting technique.

For this research, $Li_4Ti_5O_{12}$ (LTO) cathode material was modified with Molybdenium (Mo) dopant to enhance its electronic/ionic conductivity. A slurry of the synthesized Mo doped LTO powder, graphite additive and binder was tape cast followed by unidirectional freezing of the solvent and subsequent sublimation of ice. The obtained microstructure contains hierarchical aligned porosity, leading to easy migration of electrolyte through the entire electrode. We show that these engineered porous electrodes have improved energy and power density compared with randomly oriented uniform porosity electrodes – feature of the current generation of battery electrodes.