Material Architecture and Charge Transport in Nano-Crystalline Rechargeable Li Ion Batteries

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Rechargeable lithium ion batteries based on polymeric electrolyte would be able to store up to five times as much energy per unit weight and volume as a conventional lead acid battery and they possess high battery voltage, flat discharge, and long shelf life. Nano-crystalline electrode materials, due to their smaller diffusion distance are expected to have better Li ion intercalation capacity and rate capability. However, to date the potential of using nano-sized electrode materials have not been fully realized due to the problem of particle agglomeration leading to a larger effective size and also it remains challenging to grow these materials with uniform nano-size distribution. In the present work we have synthesized various nano-structured cation doped spinel type lithium manganate and Li-based layered oxide compounds as cathode material. A polymer based nano-crystalline ceramic is used as electrolyte. Additionally, carbon nano-tubes as well as a-Si were used as alternate to Li or lithiated graphite anodes. The commercially available single wall carbon nano-tubes were purified and shortened by chemical modification and by ball milling, and their surfaces were modified to be aligned on Cu or Pt based current collectors. The electrode materials were characterized in terms of their phase formation behavior, surface morphology and composition. Micro-Raman spectroscopy was used to investigate Li ion intercalation behavior and to understand the electrode-electrolyte interaction. These studies helped us to identify the effect of the nano-crystalline cell components on the voltage, charge –discharge capacity, rate capability, and cycleability of the constructed cell.

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