The Effect of pH on Nb_2O_5 Nanoparticle Synthesis as a Negative Electrode for Lithium-Ion Batteries

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According to the Global Energy Perspective published by McKinsey in 2024, global electrical energy demand is expected to triple by 2050. This dramatic increase in electrical usage cannot be sustained using current Li-ion battery (LIB) technology or fossil fuel dependent technologies. A transition to more renewable energy sources and high performing LIBs will be necessary to meet growing demand. The current standard for anodes in LIBs, graphite, suffers from issues such as dendritic growth, limited supply, and international dependency. An attractive alternative material, niobium pentoxide (Nb_2O_5), operates at a higher potential range preventing lithium plating and thermal runaway. Given the potential of Nb_2O_5, this study explores whether the modified nanoparticles could improve cell capacity and retention via surface medication during nanoparticle synthesis. This study assessed if modifying the pH during synthesis of the nanoparticles will alter the surface area, functional groups on the nanoparticles, and/or the water composition of the altered nanoparticles. Additional characterization was completed by FTIR, SEM, and XRD to identify the surface modifications. XRD indicated no significant structural changes of the altered nanoparticles. FTIR showed signs of change in the surface functional groups while SEM provided evidence of significant morphology changes. These findings demonstrated that Niobium Pentoxide nanoparticles can be modified at varying pH levels resulting in significant changes in morphology. This research provides insight into the potential of pH modification to optimize Nb_2O_5 nanoparticles for high-performance LIBs. Continued analysis on the modification of Nb_2O_5 nanoparticles could yield results contributing to improved lithium-ion battery performance.

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