# Developing Vein Graphite Anode Materials for Li-ion Batteries by Optimizing and Scaling up of Chemically Mild Oxidation

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Vein graphite has emerged as a potential intercalating anode material for rechargeable Li-Ion Batteries (LIBs). However, the formation of Solid Electrolyte Interface causing a large irreversible capacity loss during the first lithium intercalation is still a challenging obstacle. To address this obstacle, it is crucial to eliminate structural imperfections in graphite that hinder the electrolyte decomposition, block intercalation of solvated Li-ions, and prevent graphene planes from migrating along the a-axis direction. Therefore, surface modification methods have been introduced by primarily focusing on mild oxidation, alkali carbonate coating and Li-doping methods. Among the various surface modification approaches for vein graphite, chemically mild oxidation using HNO3 acid method (NO method) was selected as the most promising technique after a thorough optimization of critical factors and parameters. Prior to scaling up, the NO method was further optimized to enhance surface modification and ensure the purity of graphite. Following successful optimization, this study was extended to investigate the feasibility of scaling-up at the laboratory level, as possible. The outcome of the optimization process revealed that the volume of 50 ml of 69.0% HNO3 acid as the optimum condition for the scaling-up. The scaled-up vein graphite samples obtained using the NO method showed similar characteristics to the initial laboratory sample, with a purity level of 99.0%, rendering their suitability for LIB anodes. Moreover, the electrochemical performance of the scaled-up graphite samples is promising by behaving in a manner consistent with the initial laboratory sample, despite a low discharge capacity initially. These findings confirm the effective scaling-up of the NO method at the laboratory level. The successful laboratory scale implementation of this method represents a significant improvement and lays the foundation for a scale-up framework for future development. Thus, this study paves the way for future research and development to establish a comprehensive laboratory level scale-up approach that endeavors towards the ultimate usage of vein graphite in LIB anode.

**Topic:** New Materials and Advanced Materials

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**Presentation Type:** Oral Presentation

**Keywords:** Li-ion batteries, optimization, scaling-up, vein graphite