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OPTIMIZATION AND SCALE-UP OF PREPARING BATTERY-GRADE GRAPHITE FROM SRI LANKAN VEIN GRAPHITE FOR RECHARGEABLE LITHIUM-ION BATTERIES

H.M.H.D.K. Naranpanawa[1*], T.H.N.G. Amaraweera [1,2], N.W.B. Balasooriya [1,3], K.W.S.N. Kumari [4], H.W.M.A.C. Wijayasinghe [1]

[1]National Center for Advanced Battery Research, National Institute of Fundamental Studies, Kandy,Sri Lanka.
[2]Department of Applied Earth Sciences, Uva Wellassa University, Badulla, Sri Lanka.
[3]Department of Geology, University of Peradeniya, Peradeniya, Sri Lanka.
[4]Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.
**Correspondence E-mail: himashee.na@nifs.ac.lk, TP: +94717900148*

Abstract: The portable energy storage market has witnessed significant growth in the past decade, with Lithium-Ion Batteries (LIBs) emerging as a leading solution. High-quality battery-grade graphite is vital for the anode component of LIBs. Sri Lankan Vein Graphite (SLVG) exhibits exceptional purity and crystallinity, making it a promising candidate. However, to effectively utilize SLVG as an anode material in LIBs, further enhancements to its purity and structure are necessary. This study focuses on practical utilization of SLVG as the anode material in LIBs, through process optimization and scaling up at the laboratory level. Though several methods have been explored for the purification and surface modification of vein graphite, the most effective techniques identified are HCl acid leaching and chemical mild oxidation using HNO_3 acid, respectively. By inventing novel purification and surface modification processes for vein graphite, the National Center for Advanced Battery Research (NCABR) at NIFS has successfully developed battery-grade graphite by showcasing promising performances. It was followed by a comprehensive optimization process in order to determine the optimal conditions for the invented processes, including parameters such as temperature, concentration, weight, volume, and duration, prior to scaling up. The laboratory-level scale-up of these processes was achieved, accompanied by the development of a framework employing linear regression models and the design of experiments. This study reveals that the performance of the graphite samples subjected to the scale-up is comparable to the initial laboratory sample in terms of capacity, rate capability, and cycling life for LIBs anode applications. The successful optimization together with scale-up of the purification and surface modification processes for SLVG pave the way for further advancements in scaling up for industrial-level applications. Additionally, a cost estimation study is necessary to facilitate industrial-level scaling-up with economic viability. The findings of this study will contribute to the progress of battery grade graphite production from Sri Lankan graphite, supporting the development of more efficient and sustainable LIBs for energy storage.

Keywords: Sri Lankan vein graphite; Purification; Surface modification; Li-ion Battery; Scale-up