Low-Cost Process for the Preparation of Highly Oxygenated Graphene Oxide from Indian Graphite Ore

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Abstract

This study highlights the potential of Indian natural graphite as a sustainable raw material for advanced graphene production, underscoring its strategic role in supporting green technologies and reducing dependency on synthetic graphite and its associated environmental costs. A mechano-chemical milling technique employing a dual-drive horizontal planetary ball mill with oxalic acid enabled the scalable production of few-layer graphene (FLG) with <4 layers. Characterisation using Raman spectroscopy, XRD, SEM, and TEM confirmed the structural integrity and morphology of the FLG, which also showed promising electrochemical properties and potential for polymer composite applications. Building upon this, the few-layer graphene was transformed into cabbage leaf-like graphene oxide (CLGO) through an innovative green mechano-chemical oxidation process. This method drastically reduced chemical consumption and reaction time. Morphological analysis via SEM and TEM revealed wrinkled, folded structures with high surface area and abundant defect sites. Elemental mapping and XPS showed an oxidation level of ~48% for CLGO derived from natural graphite, surpassing that of synthetic (~44%) and commercial (~31%) GO. IR and Raman spectroscopy confirmed the incorporation of oxygen functional groups, while the absence of a 2D peak verified complete oxidation. The structural uniformity, high yield, and accessibility of functional groups in CLGO offer significant advantages for catalysis, energy storage, and polymer reinforcement. This streamlined, eco-conscious workflow presents a scalable solution for next-generation graphene oxide production from indigenous resources.

References

[1] Nair, A. S.; Nallusamy, V.; Jayasankar, K.; SS, S. Scalable Preparation of Graphene from Graphite Ore via Mechano-Chemical Ball Milling. Mater. Manuf. Process. 37 (1), (2022) 113–122.
[2] Costa, M. C. F.; Marangoni, V. S.; Ng, P. R.; Nguyen, H. T. L.; Carvalho, A.; Castro Neto, A. H. Accelerated Synthesis of Graphene Oxide from Graphene. Nanomaterials, 11 (2), (2021) 551.