

Mechanochemical Fabrication of Magnetic Graphene Oxide: A Sustainable Sorbent for Environmental Remediation

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Abstract

Graphene oxide (GO) is a nanomaterial with outstanding physicochemical properties and is widely employed across a broad range of technological applications. Traditionally, GO is synthesized via wet chemical methods, which typically involve harsh reaction conditions and the use of strong oxidizing agents, raising environmental and safety concerns. In recent years, mechanochemical synthesis has emerged as a rapid, solvent-free, and environmentally sustainable alternative for the preparation of advanced materials.

In this study, an optimized protocol for the mechanochemical synthesis of GO directly from graphite was developed. The resulting materials were thoroughly characterized using transmission electron microscopy (TEM), scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS), elemental analysis, and nitrogen adsorption–desorption isotherms. Graphene oxide synthesized by dry mechanochemical methods (d-GO) and by conventional wet synthesis (w-GO) were both functionalized with magnetic nanoparticles (MNPs) to obtain magnetic graphene oxide-based sorbents (d-M@GO and w-M@GO, respectively).

The adsorption performance of the materials was evaluated using selected inorganic and organic pollutants. The results demonstrated superior adsorption efficiency for d-M@GO compared to its wet-synthesized counterpart, highlighting the potential of mechanochemical methods for the fabrication of efficient sorbents.

To the best of our knowledge, this is the first reported study in which graphene oxide is synthesized by mechanochemistry using only atmospheric oxygen, and subsequently applied to produce magnetic graphene oxide (M@GO) for use in magnetic solid-phase extraction (MSPE). This work contributes to the advancement of greener synthetic strategies and underscores the applicability of dry synthesis in environmental remediation technologies.

Keywords

Include sustainability, graphene oxide, magnetic nanoparticles, MNPs, GO.