Biosynthesis of Graphene Oxide as an Alternative, Eco-Friendly Method for Producing Carbon Nanomaterials

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Abstract

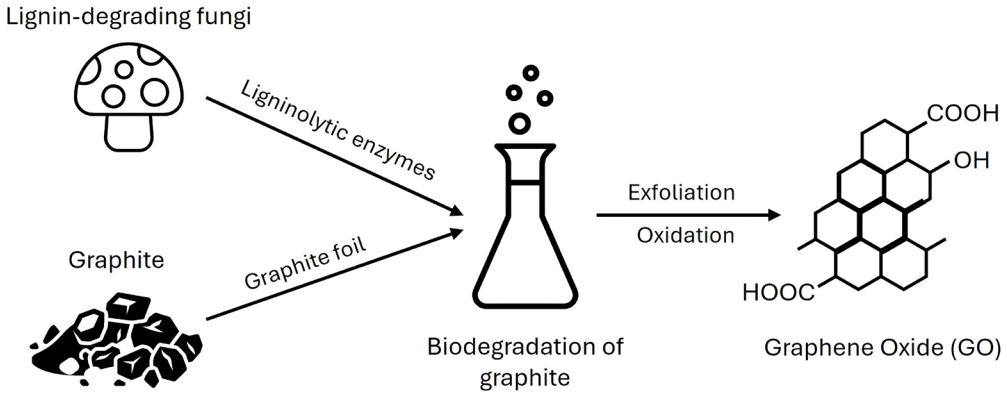
Graphene oxide (GO) is used in numerous fields (e.g., structural materials, electronics, catalysis) due to its unique properties, such as high hydrophilicity, ease of chemical modification, large specific surface area, and high mechanical strength.

Commercial chemical methods for GO synthesis typically involve the oxidation and exfoliation of graphite using concentrated acids combined with potassium permanganate. This process generates significant amounts of hazardous waste, making the synthesis environmentally unfriendly and the product relatively expensive. Additionally, GO purification is time-consuming and labor-intensive. In the era of green technology, it is particularly important to search for alternative, environmentally friendly solutions that minimize harm to the environment.

According to the literature, certain basidiomycete fungi such as *Sparassis latifolia, Phanerochaete chrysosporium,* and *Trametes versicolor* are capable of biodegrading carbon structures with sp^2 bonding. The biodegradation process by aerobic microorganisms involves gradual enzymatic oxidation. Following natural principles, this degradation occurs with minimal energy expenditure from the microorganism. In the case of graphite biodegradation, it is assumed that the oxidation process begins with the breakdown of the weakest bonds - van der Waals forces between the graphene layers in graphite.

This study shows the changes in the oxidation state of graphite following after interaction with the fungus *Phanerochaete chrysosporium*. Graphite was added to the fungal culture in an aqueous solution, where it served as the only available carbon source. After one month, the effects of this interaction were evaluated. Subsequently, wood pellets to serving as a natural nutrient source for the fungus were introduced to stimulate enzyme production, and the samples were reassessed after another month. The final stage of the study involved the addition of hydrogen peroxide, which, according to the literature, activates specific degradative enzymes.

The degree of graphite oxidation was assessed using measurements of surface hygroscopicity, contact angle, and Raman spectroscopy. This work represents the first stage of research into the potential for biosynthesis of valuable carbon-based nanoparticles.



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