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Opinion Article

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Efficient Adsorption of Pharmaceutical Contaminants with Cellulose-Wrapped Graphene Oxide

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DESCRIPTION

Pharmaceutical contaminants shows a growing concern in water sources, affecting both environmental and human health. Traditional water treatment methods often struggle to efficiently remove these contaminants. Cellulose-Wrapped Graphene Oxide (CGO) emerges as a prominent adsorbent due to its exceptional adsorption capacity, low cost, and environmental friendliness. To ensure the safe and widespread use of CGO in water treatment, regulatory approval and comprehensive toxicity assessments are essential.

The presence of pharmaceutical contaminants in water bodies is a pressing global issue, primarily driven by the widespread use of pharmaceuticals and their incomplete removal during conventional wastewater treatment processes. These contaminants, which include antibiotics, hormones, and other pharmaceutical compounds, have been detected in various aquatic environments and even in drinking water sources, posing risks to ecosystems and human health.

Efforts to combat this problem have led to the development of advanced water treatment technologies, with adsorption being a pro minent approach. Among various adsorbents, cellulose-wrapped graphene oxide stands out due to its unique combination of properties, such as a high surface area, excellent adsorption capacity, and environmental compatibility. The synthesis of cellulose-wrapped graphene oxide involves the combination of two materials: graphene oxide and cellulose. Graphene oxide is a two-dimensional carbon material with oxygen-containing functional groups.

Graphene Oxide (GO) is typically synthesized from graphite using a modified Hummers' method, resulting in a layered structure with oxygenated functional groups (hydroxyl, epoxy, and carboxyl) on the graphene sheets. These functional groups enhance the surface reactivity of GO. Cellulose is modified to improve its compatibility with GO. This can be achieved through esterification or other chemical modifications that introduce functional groups capable of forming strong interactions with GO. The modified cellulose is then combined with GO *via* simple mixing or covalent bonding, resulting in the formation of Cellulose-Wrapped Graphene Oxide (CGO) nanocomposites. The cellulose provides structural integrity and stability to the GO, preventing agglomeration and improving its dispersibility in water.

CGO nanocomposites exhibit an exceptionally high surface area due to the presence of graphene oxide sheets. This property is crucial for adsorption processes, as it provides a large number of active sites for pharmaceutical contaminants to bind. The oxygenated functional groups on GO sheets and the modified cellulose enhance the adsorption capacity of CGO for various pharmaceutical contaminants. These materials can effectively adsorb organic compounds, including antibiotics, hormones, and pharmaceutical intermediates. Cellulose, as a renewable and biodegradable material, ensures that CGO is environmentally friendly. Additionally, the low toxicity of graphene oxide further contributes to the eco-friendliness of these nanocomposites.

CGO exhibits good chemical stability in water, which is essential for sustained adsorption performance over time. The strong interactions between cellulose and GO prevent the detachment of GO sheets during the adsorption process. CGO nanocomposites have shown promise in the removal of pharmaceutical contaminants from water sources. Their high adsorption capacity and efficiency make them suitable for use in water treatment plants and decentralized water purification systems. The presence of pharmaceutical contaminants in industrial wastewater streams is a significant concern. CGO can be employed as an effective adsorbent in industrial wastewater treatment processes, reducing the discharge of pharmaceuticals into the environment.

Cellulose-wrapped graphene oxide nanocomposites offer a specific solution for the removal of pharmaceutical contaminants from water sources. Their unique combination of high surface area, strong adsorption capacity, and environmental compatibility makes them a valuable tool in addressing the growing concerns associated with pharmaceutical pollution. As research in this field continues to evolve, CGO-based materials have the potential to play a significant role in safeguarding both aquatic ecosystems and human health.