Investigating the synthesis, properties, and new uses of three-component nanocomposites built with graphene oxide

Dr. Sujata Kumari[1], Pooja Sharma[1], Dr. Pratibha Sharma[1]

1 Assistant Professor, Chemistry, School of Basic and Applied Sciences, K R Mangalam University

Abstract

Graphene-based nanocomposites have seen significant growth in recent years due to their exceptional thermal, mechanical, electrical, and barrier properties, making them highly sought after for diverse research applications. Graphene oxide (GO) and reduced graphene oxide (rGO) have garnered particular attention because of their easy preparation methods and wide range of applications. Among the various synthesis methods available, adsorption has emerged as a preferred technique for wastewater treatment. Compared to other methods such as coagulation, flocculation, and reverse osmosis, adsorption stands out due to its effectiveness, high efficiency, low cost, minimal chemical usage, eco-friendliness, and simple operational process. Additionally, it produces no sludge, making it an attractive option for sustainable water purification. This review paper explores the synthesis methods for both graphene oxide and graphene-based ternary nanocomposites, focusing on the key advantages of each. Several characterization techniques, including FTIR, UV-Vis, SEM, TEM, XRD, Mass Spectrometry, and BET theory, have been employed to analyze these nanocomposites. Finally, the paper discusses the various applications of graphene oxide-based ternary nanocomposites in fields such as biomedical, environmental, and optical industries, highlighting their potential to revolutionize current technologies and offer solutions to global challenges.

Introduction

Adsorption is a cost-effective, eco-friendly wastewater treatment method. Graphene oxide (GO) is highly effective due to its large surface area, reactivity, and ease of modification. It enhances material strength for aerospace, electronics, and biomedical applications. Binary nanocomposites (GO + one material) improve conductivity and strength, while ternary nanocomposites (GO + two materials) enhance multifunctionality. These composites are used in energy storage, catalysis, and wastewater treatment, offering sustainable, renewable, and regenerative solutions.

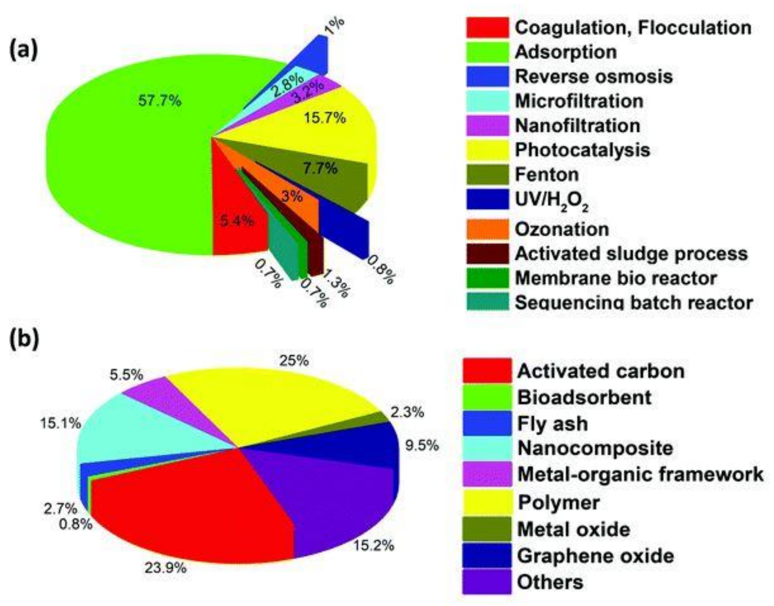


Fig.1 Pie chart showing the percentage of various physiological and biological techniques

Synthesis Methods

Ternary nanocomposites of graphene oxide (GO) are synthesized using methods like solvothermal/hydrothermal, sol-gel, solution mixing, microwave-assisted, ultrasonication, co-precipitation, and green synthesis.

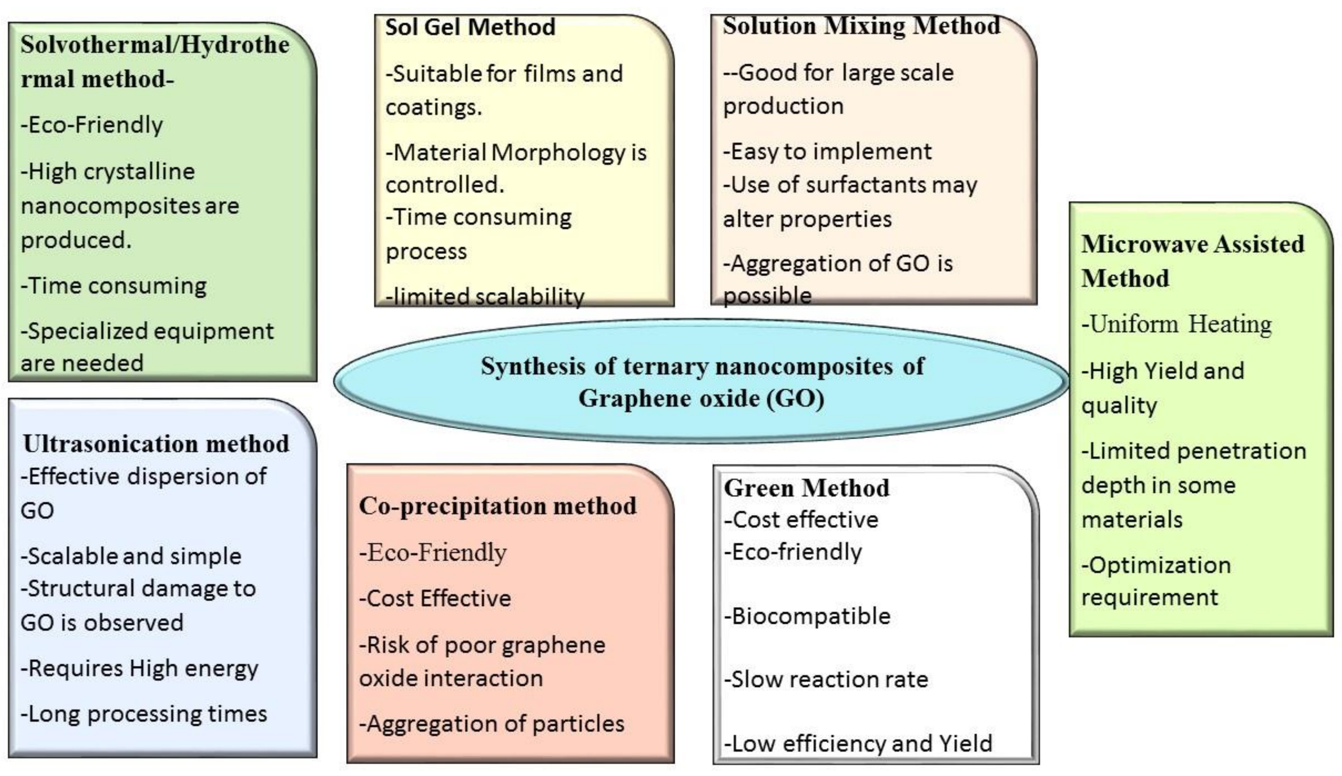


Fig.2. The block diagram of synthesis methods of graphene based ternary nanocomposites of graphene oxide.

Properties of Ternary Nanocomposites of Graphene Oxide

❑ **Mechanical Properties**
- High strength and durability
- Good flexibility and lightweight
- Large surface area for better interactions

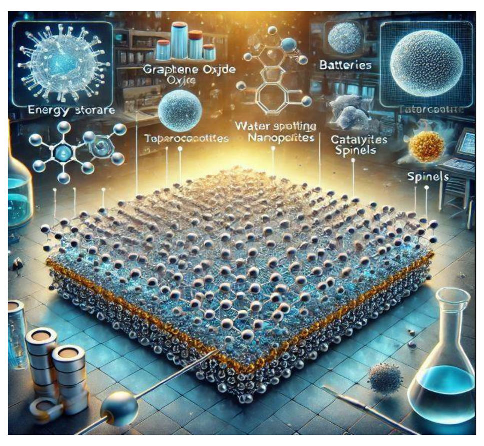
❑ **Electrical & Optical Properties**
- High conductivity for energy storage and sensors
- Tunable bandgap for photocatalysis
- Good optical absorption for electronic applications

❑ **Thermal Properties**
- High thermal stability for extreme conditions
- Efficient heat dissipation in electronics

Applications

Ternary nanocomposites based on Graphene Oxide (GO) have drawn the attention due to their high mechanical strength, high surface area, good chemical tunability and good electrical conductivity.

❑ Biomedical Applications
❑ Environmental Applications
❑ Photocatalytic Applications
❑ Energy Conversion and Storage
❑ Optical Properties



Future Prospects and Challenges

Scalability: Developing cost-effective synthesis routes for large-scale production.

Stability: Enhancing long-term stability for real-world applications.

Interfacial Engineering: Optimizing oxide-GO interactions for improved functionality.

Biocompatibility: Exploring biomedical applications with minimal cytotoxicity

Conclusions

Graphene oxide-based ternary oxide nanocomposites offer a promising pathway for next-generation materials with superior performance in multiple domains. Future research should focus on optimizing synthesis techniques, understanding interfacial mechanisms, and developing industrial applications for these composites.

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