

# Application of Graphene in Water Purification

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**Abstract** - Graphene and its derivatives have emerged as promising materials for water purification due to their unique properties, including high surface area, excellent conductivity, and tenable chemical reactivity. This paper explores the application of graphene-based materials, such as graphene oxide (GO), reduced graphene oxide (rGO), and graphene composites, in various water treatment processes. The high porosity and surface chemistry of graphene make it ideal for adsorption, filtration, and removal of contaminants like heavy metals, organic pollutants, and microorganisms from water. In addition, graphene's ability to enable advanced filtration technologies such as membrane-based systems, electrochemical processes, and photo catalytic degradation offers significant improvements in water purification efficiency and selectivity. Challenges related to scalability, material functionalization, and long-term stability is also discussed. The paper highlights recent advancements in the use of graphene materials for sustainable and efficient water treatment, and provides an overview of future research directions in this field to optimize performance and commercialization.

**Key Words:** Graphene, membrane-based, contaminants

## 1. INTRODUCTION

Access to clean and safe drinking water remains one of the most pressing global challenges of the 21st century. With increasing population growth, rapid industrialization, and environmental degradation, the demand for efficient, sustainable, and cost-effective water purification technologies has never been more critical. Traditional water treatment methods—such as chlorination, reverse osmosis, activated carbon filtration, and UV treatment—have played significant roles in improving water quality. However, these conventional techniques often come with limitations, including high energy consumption, membrane fouling, limited contaminant removal capacity, and the

generation of harmful by-products. As a result, researchers have been actively exploring advanced materials and innovative technologies to address the shortcomings of existing water purification systems.

Among the new generation of nanomaterials, graphene and its derivatives have emerged as highly promising candidates for revolutionizing water purification. Graphene is a two-dimensional, atomically thin sheet of carbon atoms arranged in a hexagonal lattice. It exhibits extraordinary physical, chemical, and mechanical properties, including exceptional tensile strength, high thermal and electrical conductivity, chemical stability, and an enormous specific surface area. These attributes make graphene particularly attractive for environmental and water-related applications. Furthermore, the ability to functionalize graphene's surface with various chemical groups opens up new possibilities for targeted interactions with a wide range of waterborne contaminants.

One of the most notable derivatives of graphene is graphene oxide (GO), which contains abundant oxygen-containing functional groups such as hydroxyl, epoxy, and carboxyl groups. These functionalities not only make GO highly dispersible in water but also enhance its affinity for binding with metal ions, organic pollutants, and microbial contaminants. Another derivative, reduced graphene oxide (rGO), retains many of the desirable features of pristine graphene while offering improved conductivity and structural integrity, making it suitable for membrane development and sensor applications.

## 2. Body of Paper

Graphene used in water purification is typically engineered as graphene oxide (GO) or nano porous graphene sheets. The design process involves:

**Synthesis:** GO is usually synthesized using the Hummers' method from graphite powder, introducing oxygen-containing groups.

**Structure:** GO sheets are stacked or layered to form membranes with nanochannels, allowing water to pass while blocking contaminants.

**Functionalization:** Surface modifications improve selectivity, adsorption, or antimicrobial properties.

These materials can be embedded in filters or composite systems for various purification applications.

### 3. METHODOLOGY

To conduct various tests on collected sample.

To suggest remedial measure for water purification

To suggest advanced water purification technology and innovation.

### 4. RESULT

#### High Contaminant Rejection Rates:

GO membranes have achieved up to 94.2% rejection of humic acid under pressurized filtration conditions, indicating their effectiveness in removing natural organic matter from water.

Mica-incorporated GO membranes (MGO) demonstrated 100% rejection of biomolecules like tannic acid and bovine serum albumin, and over 99% rejection of various dyes, including methylene blue and rhodamine.

#### Enhanced Water Permeability:

These membranes exhibit high water flux rates, with some GO-based membranes achieving water permeance of approximately 493.9 liters per square meter per bar per hour, significantly higher than traditional polymeric membranes.

#### Advanced Fabrication Techniques:

Innovative methods like inkjet printing have been employed to create ultrathin GO nanofiltration membranes, allowing for scalable production with high rejection rates for small organic molecules.

#### Catalytic and Self-Cleaning Properties:

Some GO-based membranes are engineered with photocatalytic materials, such as bismuth oxobromide, enabling self-cleaning capabilities upon exposure to

visible light, which helps maintain membrane performance over time.

#### Durability and Stability:

MGO membranes have shown remarkable stability, maintaining high performance for up to 60 days in neutral environments, which is crucial for long-term water treatment applications.

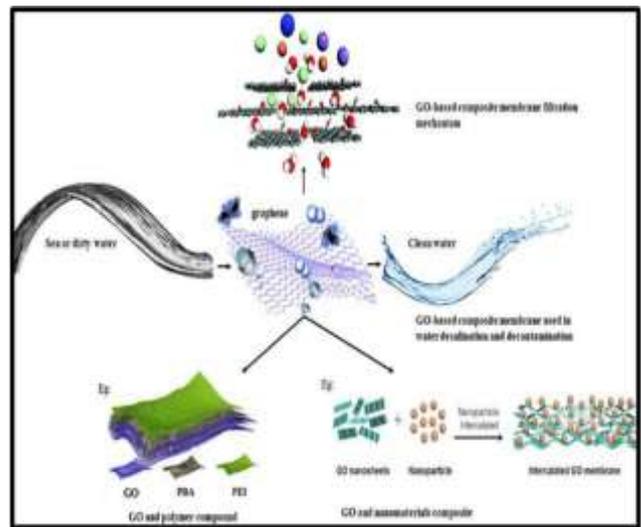


Fig -1: Figure

### 5. CONCLUSIONS

Graphene-based materials offer a highly promising solution for water purification due to their exceptional surface area, mechanical strength, and ability to remove contaminants such as heavy metals, organic pollutants, and microbes. Their efficiency in filtration and adsorption makes them ideal for advanced, energy-efficient water treatment technologies. As research progresses, graphene has the potential to revolutionize clean water access, especially in areas lacking traditional purification infrastructure.



## 6. PHOTOGRAPHS



## 5. REFFERANCE

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