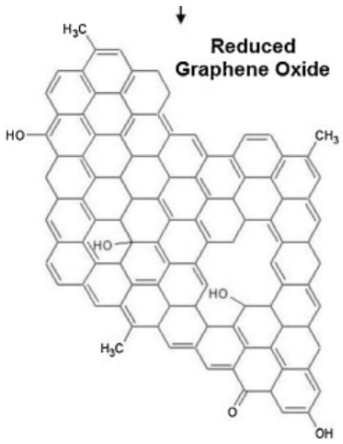
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Technical Data Sheet

Reduced Graphene Oxide (rGO)

Properties

Form	Reduced graphene oxide sheets
Particle size	D90 50 µm
	D50 20 µm
	D10 < 20 µm
Color	Black
Odor	Odorless
Dispersibility	Non-polar solvents
Solvents	DMSO, NMP, DMF
Concentration	0.25 - 4 mg/ml
pH	-
Monolayer content (measured in 0.5mg/mL)	>35-55%*

(*) The reduced graphene oxide dispersion requires proper sonication before use.

Elemental Analysis*

Carbon	98%
Hydrogen	0%
Nitrogen	0.5%
Sulfur	0.5%
Oxygen	1%

* Sample preparation: 20 mg of rGO in DMF were dried under vacuum at 60°C overnight.

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Innovation
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Application

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Reduced Graphene Oxide (rGO):

Introduction:

Reduced graphene oxide (rGO) is a chemically or thermally reduced form of graphene oxide (GO), where oxygen-containing groups are partially removed to restore electrical conductivity and improve structural integrity. It bridges the gap between pristine graphene and GO in terms of properties and cost-effectiveness.

Structure:

Reduced graphene oxide is derived from graphene oxide (GO) through chemical, thermal, or electrochemical reduction. This process partially restores the sp^2 carbon network by removing oxygen-containing groups such as hydroxyl, epoxy, and carboxyl. However, rGO retains some structural defects and residual oxygen, resulting in a partially restored graphene lattice with non-uniform conductivity and inhomogeneous morphology.

Properties:

- **Electrical Conductivity:** Significantly higher than GO, though lower than pristine graphene
- **Surface Area**: High, depending on the reduction method
- **Mechanical Strength:** Improved over GO
- **Chemical Reactivity:** Retains some functional groups for further modification
- **Thermal Stability:** Enhanced compared to GO

Characterization Techniques:

To characterize reduced graphene oxide (rGO), several analytical techniques are employed to assess its structural and morphological changes after reduction. X-ray Diffraction (XRD) is used to confirm the reduction process by observing shifts in diffraction peaks. In GO, a prominent peak appears around 10-12°, indicating increased interlayer spacing due to oxygen functional groups. Upon reduction, this peak diminishes or shifts toward ~25°, reflecting the partial restoration of the graphitic structure and decreased interlayer distance.

Raman Spectroscopy provides insight into the degree of disorder and graphitization in rGO. It highlights two key bands: the D band, associated with structural defects, and the G band, related to the in-plane vibration of sp^2 carbon atoms. The intensity ratio of these bands (I_D/I_G) increases after reduction, indicating a higher defect density introduced during the removal of oxygen groups.

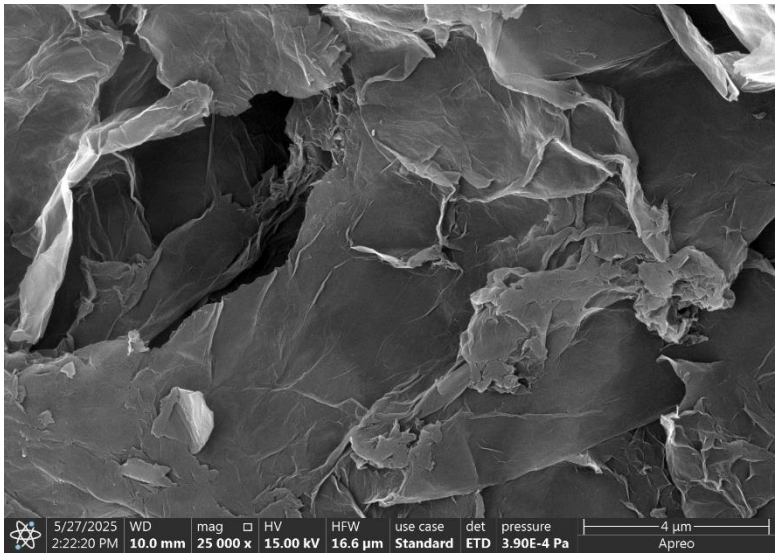


Figure: Scanning Electron Microscopy (SEM) of NM-RGO

Scanning Electron Microscopy (SEM) is employed to visualize the surface morphology and layer structure of rGO. SEM images typically reveal thin, wrinkled, and flake-like sheets, offering clues about exfoliation quality, stacking behavior, and surface roughness. In EDX, there is a significant increase in carbon content and a decrease in oxygen, with C/O ratios often exceeding 6:1. This confirms successful reduction and partial restoration of the sp^2 carbon network. Together, these techniques provide a comprehensive understanding of rGO's transformation from GO and its suitability for various applications.

Applications:

- **Energy Storage:** Electrodes in super capacitors and lithium-ion batteries
- **Sensors:** Gas and biosensors due to high surface reactivity
- **Catalysis:** Support material for metal catalysts
- **Biomedical:** Drug delivery, bio imaging (with biocompatible modifications)
- **Composites:** Enhances mechanical and thermal properties of polymers
- **Environmental:** Adsorbent for pollutants and heavy metals

Conclusion:

rGO offers a cost-effective, scalable alternative to pristine graphene with tunable properties suitable for diverse applications. Its performance depends heavily on the reduction method and thorough characterization, making it a key material in next-generation nanotechnology.