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Material Safety Data Sheet - Graphene

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Introduction

Graphene is a two-dimensional allotrope of carbon with a single layer of atoms arranged in a hexagonal lattice. Its unique structure gives rise to exceptional properties, making it a promising material for a wide range of applications. This data sheet provides a comprehensive overview of graphene's key properties, safety information, and potential applications.

Chemical Properties

- **Chemical Formula:** C
- **Molar Mass:** 12.01 g/mol
- **Reactivity:** Graphene is relatively inert but can be functionalized with various chemical groups to modify its properties.
- **Solubility:** Graphene is generally insoluble in common solvents but can be dispersed in certain solutions with the aid of surfactants or by chemical modification.

Physical Properties

- **Appearance:** Transparent, single-atom-thick sheet
- **Thickness:** 0.345 nm
- **Specific Surface Area:** ~2630 m²/g
- **Optical Properties:** High optical transparency (~97.7% for a single layer)
- **Thermal Conductivity:** ~5000 W/m·K

Mechanical Properties

- **Young's Modulus:** ~1.0 TPa
- **Tensile Strength:** ~130 GPa
- **Hardness:** Exceptional hardness due to strong carbon-carbon bonds
- **Elasticity:** High elasticity, capable of withstanding significant strain

Electrical Properties

- **Electrical Conductivity:** High electrical conductivity, with electron mobility exceeding 200,000 $\text{cm}^2/(\text{V}\cdot\text{s})$
- **Charge Carrier Mobility:** Exceptional charge carrier mobility
- **Dirac Fermions:** Charge carriers behave as massless Dirac fermions, leading to unique electronic properties.

Applications

- **Electronics:** Transistors, sensors, transparent conductive films
- **Composites:** Enhanced mechanical strength and thermal conductivity
- **Energy Storage:** Batteries, supercapacitors
- **Biomedicine:** Drug delivery, biosensors, tissue engineering
- **Coatings:** Protective coatings, anti-corrosion layers
- **Water Filtration:** Membranes for water purification

Safety Information

While graphene is generally considered safe, some studies suggest potential toxicity depending on the form, size, and concentration of exposure.

- **Inhalation:** Avoid inhalation of graphene nanopowders or aerosols. Use appropriate respiratory protection.
- **Skin Contact:** Avoid prolonged skin contact. Wear gloves to prevent irritation.
- **Eye Contact:** Avoid eye contact. Wear safety glasses or goggles.
- **Disposal:** Dispose of graphene waste in accordance with local regulations. Consult the SDS (Safety Data Sheet) for more detailed information.

References

- Novoselov, K. S., et al. "Electric field effect in atomically thin carbon films." *Science* 306.5696 (2004): 666-669.
- Geim, A. K., and K. S. Novoselov. "The rise of graphene." *Nature materials* 6.3 (2007): 183-191.
- Allen, M. J., et al. "Graphene-based materials for energy storage." *Advanced Materials* 22.35 (2010): E103-E119.

Summary

This material data sheet provides essential information regarding the chemical, physical, mechanical, and electrical properties of graphene. It also outlines potential applications and important safety considerations for handling this material. Graphene's unique characteristics make it a versatile material for various scientific and industrial purposes. Always consult the full Safety Data Sheet (SDS) for comprehensive safety guidelines before handling graphene.