MATERIALS ENGINEERING
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"MECHANOCHEMICAL EXFOLIATION OF GRAPHENE IN VOLATILE ORGANIC SOLVENTS"

By Ramazan Oduncu
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Advisor: Professor Alexander Wei
Advisor: Professor Lia A. Stanciu

ABSTRACT

Graphene is a two-dimensional allotrope of sp^2-hybridized carbon with extraordinary thermal, electrical, and mechanical properties. Liquid-phase exfoliation (LPE) of high-quality graphite is one of the most widely used techniques for preparing graphene since its first report in 2008. LPE is cost-effective and capable of converting graphite directly into mono- or few-layered graphene in a scalable fashion. Stable dispersions of few-layered graphene are desirable for thin-film deposition over large areas but are limited by the use of polar organic solvents with high boiling points and unfavorable toxicity profiles. This limitation can be overcome by milling and exfoliation of graphene nanoplatelets (GrNPs) in ethyl acetate (EtOAc) and acetone, volatile solvents with low toxicity profiles and modest environmental impact. Solvent-assisted grinding of pristine GrNPs on a horizontal ball mill followed by sonication produces concentrated suspensions up to 356 µg/mL that remain stable at room temperature for a minimum of 6 weeks without the need of surfactants. Spray deposition of exfoliated graphene on Si/SiO2 substrates can produce coatings with an average thickness of 4 nm. EtOAc and acetone-based dispersions of exfoliated graphene can be deposited uniformly using conventional airbrush equipment, to produce coatings that are dry to the touch immediately after deposition. Spray coating is versatile with respect to target substrates; practical demonstrations of spray-coated graphene films include conductive surfaces with sheet resistances as low as 1 kΩ/sq. and solid contacts for disposable, low-cost ion-selective electrodes, enabling significant improvements in the reproducibility of signal readouts across multiple sensors.

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Place: via WebEx:
https://purdue.webex.com/meet/alexwei

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School of Materials Engineering