Graphene/Polymer Nanolaminates for High-Performance Electrothermal Systems

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Abstract
Graphene's exceptional electrical, thermal, and mechanical properties continue to drive innovation in the design of high-performance composite systems. In this talk, we present recent developments in the fabrication and characterization of graphene/polymer nanolaminates—engineered architectures that leverage the synergistic integration of continuous graphene monolayers or reduced graphene oxide (rGO) films with ultrathin polyetherimide (PEI) layers. Two scalable fabrication routes are highlighted: a modified iterative lift-off/float-on process for incorporating CVD graphene, and a Marangoni-driven self-assembly method enabling precise layer-by-layer deposition of rGO. Despite low filler volume fractions (as low as 0.165 vol% for Gr and up to 5.2 vol% for rGO), the resulting freestanding nanolaminates exhibit substantial enhancements in tensile strength, electrical conductivity, and electrothermal response. We focus on the electrothermal behavior of these materials, which demonstrate rapid Joule heating with peak rates exceeding 400 °C/s and surface temperatures surpassing 325 °C. Areal power densities up to 30 kW/m² are achieved with minimal energy input, maintaining uniform thermal profiles even under mechanical deformation. These characteristics position graphene/PEI nanolaminates as prime candidates for next-generation thermal management systems, with potential applications spanning flexible electronics, aerospace components, and wearable thermoelectric devices.

References
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Figures

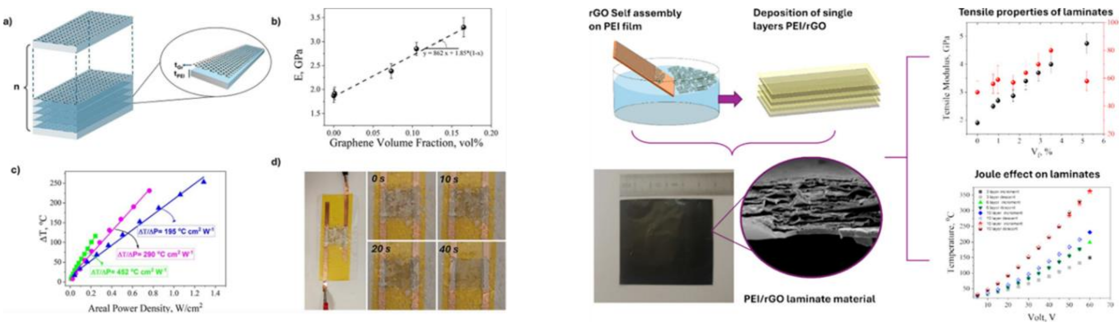

Figure 1: Fabrication process and characterization of graphene/polymer nanolaminates-engineered architectures; continuous CVD graphene monolayers (left) reduced graphene oxide (rGO) films (right) with ultrathin polyetherimide (PEI) layers.