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Mechanical, Electrical and Thermal Properties of *In-situ* Exfoliated Graphene/Epoxy Nanocomposites

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ABSTRACT

Depending on processing conditions, *in-situ* exfoliated graphite nanoplatelets (GNP) with low defect content and average aspect ratios up to 300-1000 and thicknesses of 5-17 nm could be produced by three roll milling (TRM). This paper focuses on the mechanical, electrical and thermal properties of *in-situ* GNP/epoxy nanocomposites, evaluated in terms of simple analytical models. Good mechanical reinforcement (160% increase in flexural modulus @ 4 wt.% GNP), electrical conductivity ($\sim 10^{-2}$ S/m @ 3 wt.% GNP with a percolation threshold of 0.52 vol.%) and thermal conductivity ($0.70 \text{ W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$ @ 5 wt.% GNP) were obtained. The production of GNP-filled resins using TRM technology can potentially remove important cost barriers for GNP modified plastics, composites and coatings as compared to traditional multi-step solvent based exfoliation methods.

1 INTRODUCTION

Interest in graphene and its potential applications has grown rapidly since 2004, when the material was first isolated [1, 2]. Graphene is a one-atom thick planar sheet and an emerging class of nanomaterials with remarkable properties, such as, high thermal conductivity ($\sim 5000 \text{ W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$) [3], electrical conductivity ($10^8 \text{ S}\cdot\text{m}^{-1}$) [4], high intrinsic mobility ($2\times 10^5 \text{ cm}^2\cdot\text{s}^{-1}\cdot\text{V}^{-1}$) [5], extremely high tensile strength ($\sim 130 \text{ GPa}$), Young's modulus ($\sim 1.0 \text{ TPa}$) [6], and large specific surface area

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