Effect of Foaming on the Electrical and Thermal Conductivities of GnP Composites

Mahdi Hamidi and Chul B. Park
Department of Mechanical and Industrial Engineering, University of Toronto, Toronto, ON, Canada
park@mie.utoronto.ca

Abstract:

Recently, multifunctional, lightweight, and low-cost polymer-composites incorporating graphene nanoplatelets (GnP) have demonstrated great promise as next-generation materials for energy management and storage, electromagnetic interference (EMI) shielding, heat dissipation components in electronic industries. However, the practical underpinning needed to economically manufacture graphene-based polymer composites is missing. Our research has demonstrated how critical challenges for efficient manufacturing of functional polymer composites, can be overcome by using supercritical fluid (SCF)-treatment and physical foaming technologies.

Our research has developed an in-depth understanding of the effects of cellular structures, GnPs' orientation, arrangement, and exfoliation on the thermal/electrical conductivity, percolation threshold, dielectric performance, and EMI shielding effectiveness of the polymer/GnP composites. We have demonstrated how SCF−foaming can significantly enhance thermal conductivity of polymer/GnP composites (Figure 1a) [1]. This technique can exfoliate the layers of graphene in situ [2] and microscopically tailor the composites' structure [3] to substantially increase the electrical conductivity, EMI shielding effectiveness and can decrease the percolation threshold of the polymer/GnP composites [4] (Figure 1b). We have also presented a facile technique for manufacturing a new class of ultralight polymer/GnP composite foams with excellent dielectric performance by generation of a unique parallel-plate arrangement of GnPs within a microcellular structure [5]. (Figure 1c-d)

Our research presents new routes to microscopically engineer the structures and properties of conductive polymer composites for EMI shielding, energy storage and heat management in microelectronic packaging.

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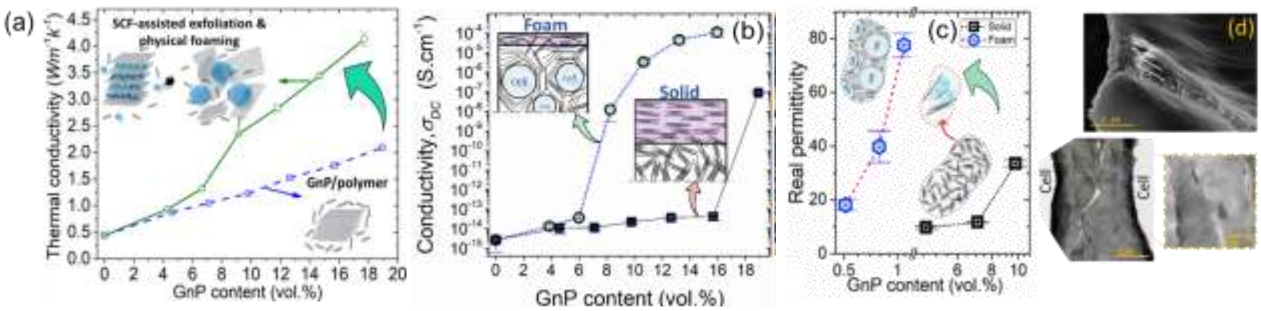

Figure 1: a) Thermal conductivity [1]; b) electrical conductivity [4]; and c) dielectric constant of the polymer/GnP composites [5]. d) SEM and TEM images of polymer/GnP foams [5].