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Thermally conductive composites

Oren Regev
Ben-Gurion University of the Negev, oregev@bgu.ac.il

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Oren Regev, Ben-Gurion University of the Negev, 84105 Beer-Sheva, Israel
T: +972 86472145, oregev@bgu.ac.il

The rapidly increasing device densities in electronics calls for efficient thermal management. If successfully exploited, graphene, which possesses extraordinary thermal properties, can be commercially utilized in polymer composites with ultrahigh thermal conductivity (TC). The total potential of graphene to enhance TC, however, is restricted by the large interfacial thermal resistance between the polymer-mediated graphene boundaries. We report a facile and scalable dispersion of commercially available graphene nano platelets (GnPs) in a polymer matrix, which forms composite with ultra-high TC of 12.4 W/mK (vs. 0.2 W/mK for neat polymer). This ultra-high TC is achieved by applying high compression forces during the dispersion that results in the closure of gaps between adjacent GnPs with large lateral dimensions and low defect densities. We also found strong evidence for a thermal percolation threshold. Finally, the addition of electrically insulating nano-boron nitride to the thermally conductive GnP-polymer composite significantly reduces its electrical conductivity (to avoid short circuit) and synergistically increases the TC. The efficient dispersion of commercially available GnPs in polymer matrix provides the ideal framework for substantial progress toward the large-scale production and commercialization of GnP-based thermally conductive composites.

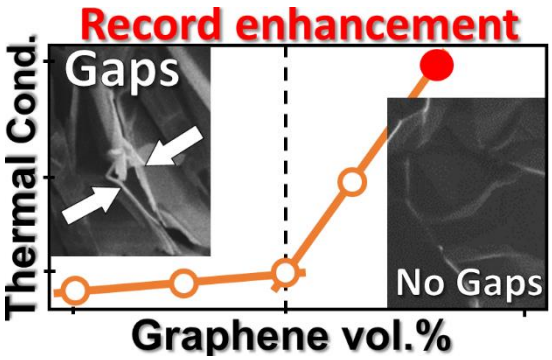

Figure 1 – Thermal conductivity enhancement via gap closure between adjacent fillers