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Enhanced Thermal Conductivity In 2D Boron Nitride Infused Plastic

The increasing interest in the hexagonal boron nitride (h-BN) is validated due to its exceptional properties such as high thermal conductivity, better chemical stability, higher mechanical strength and structural stability [1]. As expected, the two-dimensional (2D) nanosheets of h-BN show enhanced physical and chemical properties than their bulk counterparts. With decreasing thickness of bulk h-BN, the phonon-phonon scattering is reduced, leading to a thermal conductivity as high as 400 W/mK for a single layer of boron nitride nanosheet (BNNs). Using such 2D nanosheets as nano fillers in polymers or any host material that require better thermal management is an obvious application for many industries, particularly the polymer industry [2]. To realize such an application at industrial level, the obvious task is to synthesize 2D nanosheets in large scale. We have been able to synthesize BNNs in large quantities by a novel opto-mechanical method [3]. The exfoliated BNNs with an average nanosheet thickness of about 10 nm and lateral area of about 1 μm^2 were dispersed into polyethylene terephthalate (PET) polymer. The nanocomposite of PET with BNNs (PET:BN) showed uniform dispersion of BNNs in PET matrix without major effect on the transparency of PET. Thermal conductivity of PET:BN nanocomposite was studied as a function of filler percentage (wt.%) in the PET matrix. Before studying the thermal conductivity, the structural properties of the nanocomposite films were studied employing SEM, DSC and Raman spectroscopy. The cross-sectional SEM images of nanocomposite films show presence of BNNs in the volume matrix of the polymer. The DSC studies show increasing melting and crystallization temperature for the composites, hinting the increased stress in the polymer matrix. The increased stress in the lattice due to increased presence of 2D nanosheets was confirmed by Raman spectroscopy. The thermal conductivity measured by the non-destructive optical method (Raman spectroscopy) [4], shows that the thermal conductivity of PET:BN nanocomposite film increases by almost a factor of two over a filler infusion of 0.5 wt.%. Figure 1 shows cross-sectional SEM image of PET:BN composite and the plot of thermal conductivity as a function of BNNs infusion concentration. Over all we find that BNNs is an excellent filler material for enhancing thermal conductivity in PET polymer.

References

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Figures

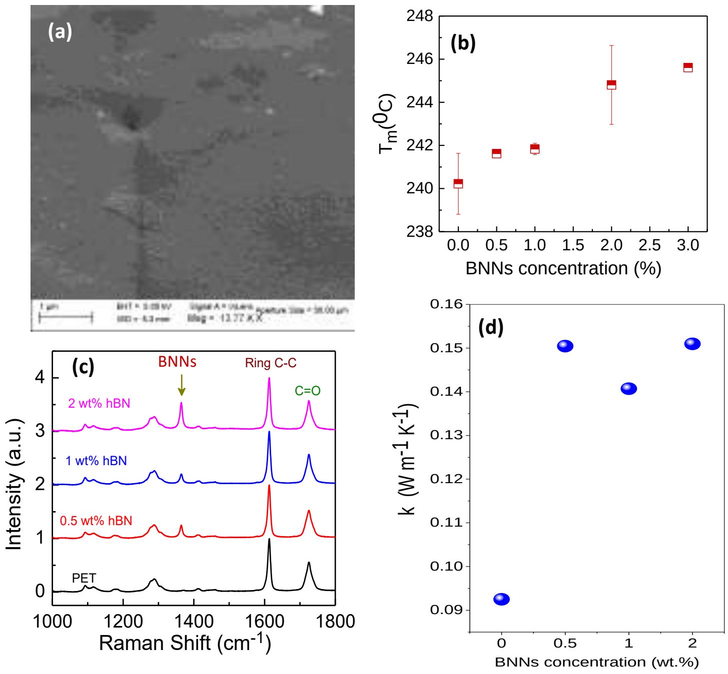

Figure 1: (a) Cross-sectional SEM image of a typical PET:BN composite film. (b) Increasing melting temperature of PET:BN composite as a function of BNNs filler concertation (wt.%). (c) Raman signatures for various PET:BN nanocomposite films. (d) Thermal conductivity as a function of BNNs filler concentration.