STRATEGY TO ENHANCE THERMAL CONDUCTIVITY OF POLYMER NANOCOMPOSITES

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Due to the rapid rise in power and integration in electronic devices, the heat accumulation is becoming serious bottleneck for their normal function [1, 2]. Therefore, new type of thermally conductive composites is needed for which the graphene-based thermal interface materials (TIMs) are exceptional candidate. [3, 4]. In this study, several methods for fabricating polymer nanocomposites composed of graphene (Gr) and BN are proposed. First, the extrusion and injection molding combined method was employed to get graphene filled PA6 composite achieving an unprecedented through-plane TC$^{\perp}$ of 6.13 Wm^{-1}K^{-1} At 28 wt% (Fig.1). Second, the nano-urethane linkage-based modified graphene and carbon fibers (CFs) architecture termed as NUL-Gr/CFs is fabricated through the process (Fig.2). Interestingly, the prepared composite with PVDF matrix shows an unprecedented TC$^{\perp}$ of 7.96Wm^{-1}K^{-1} at a low loading of 13.8 wt%. Since NUL is a chemical bond that takes heat from one Gr to others, the heat transfer ability is much enhanced. This heat transfer mechanism is very much reported already [5, 6]. Third, the alignment of graphene induced by shear and friction force during FDM 3D printing is achieved in TPU composites. Fig.3a illustrates the representative spiral morphology of Gr/TPU micro-filament of 0.37mm in diameter. The cross-section of micro-filament exhibits an obvious spiral morphology with graphene sheets protruded from sectional plane (Figs.3c-e).

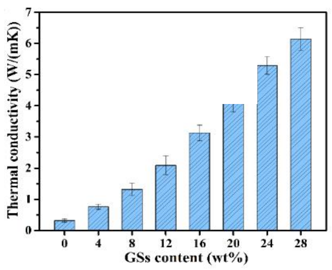

Fig.1 TC$^{\perp}$ of Gr/PA6 composites

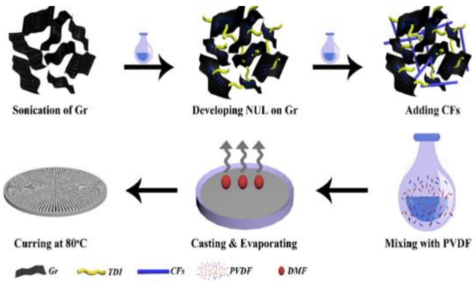

Fig.2 Schematic for the fabrication of NUL-Gr/CFs and NUL-Gr/CFs/PVDF composite

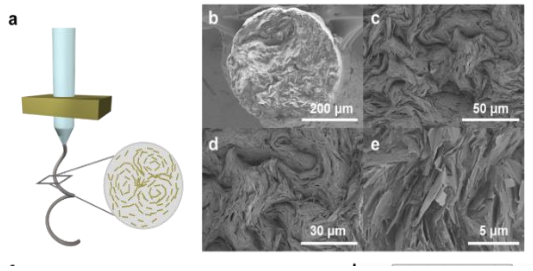

Fig.3 (a) Schematic of extruded micro-filament. (b) Morphology of micro-filament (c-e).

In Fig. 4, TP1 exhibits higher TC$^{\perp}$ than TP2 with maximum of 12.25Wm^{-1} K^{-1} at 45 wt % Gr, while it is only 1.57Wm^{-1}K^{-1} for its counterpart. The cooling performance of printed composite is shown by a battery pack (Fig.6a). Fig.6b gives the IR image during charging and discharging. The battery temperature profile (Fig.6c) reveals that the maximum temperature of Gr/TPU pack is 5.7 °C lower than that of TPU pack, reflecting the distinctive heat dissipation properties of printed Gr/TPU composites.

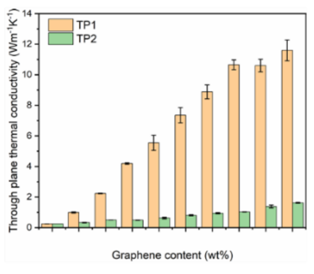

Fig.4 TC$^{\perp}$ of TP1 and TP2

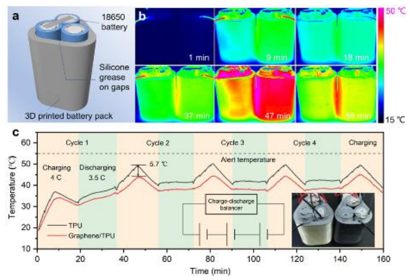

Fig.5 (a) Battery test setup. (b) IR images of pure TPU pack (left) and Gr/TPU pack (right). (c) temperature

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