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Mechanically Strong and Highly Thermal Conductive Polymer Composites Enabled by Three-Dimensional Interconnected Graphite Network

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Abstract : Three-dimensional (3D) network structure has been recognized as an effective approach to enhance the mechanical and thermal conductive properties of polymeric composites. However, it has not been applied in energetic materials. In this work, a fluoropolymer based composite with vertically oriented and interconnected 3D graphite network was fabricated for polymer bonded explosives (PBXs). Here, the graphite and graphene oxide platelets were mixed, and self-assembled via rapid freezing and using crystallized ice as the template. The 3D structure was finally obtained by freezing-dry and infiltrating with the polymer. With the increasing of filler fraction and cooling rate, the thermal conductivity of the polymer composite was significantly improved to 2.15 W m^{-1} K^{-1} by 1094% than that of pure polymer. Moreover, the mechanical properties, such as tensile strength and elastic modulus, were enhanced by 82% and 310%, respectively, when the highly ordered structure was embedded in the polymer. We attribute the increased thermal and mechanical properties to this 3D network, which is beneficial to the effective heat conduction and force transfer. This study supports a desirable way to fabricate the strong and thermal conductive fluoropolymer composites used for the high-performance polymer bonded explosives (PBXs).

Keywords : mechanical properties, oriented network, graphite polymer composite, thermal conductivity
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