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Developing Heat Conduction Pathways through Short Polymer Chains in a Hydrogen Bonded Polymer System

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ABSTRACT: In the past couple of decades, high thermally conductive fillers are extensively used to develop thermally conductive polymer based composites. Such conventional methods suffer from wide variety of problems especially related to fabrication, high-cost, poor mechanical properties *etc*. Though covalent bonds in single polymer chain can lead to very high thermal conduction, it is irony that bulk polymers are thermal insulators due to significant phonon scattering. In this work, we have shown how by engineering intermolecular interaction within the polymer chain, one can create continuous thermal network which in turn drives thermal conduction in polymer without using any traditional fillers. Thermal conduction pathways were introduced in a blend film of long chain polymer Poly (vinyl alcohol) (PVA) and short chain Poly (ethylene glycol) (PEG). Thermal conductivity enhancement of around 1.6 times of neat polymer was achieved. The critical factor responsible for thermal conduction in these films was found to be homogeneous distribution of "thermal bridges" formed by hydrogen bonding between PVA and short PEG chain. Reduction in thermal conductivity was observed when PVA blend film with longer PEG chain, which is mainly due to poor thermal bridges distribution and chain agglomeration. This work presents a fascinating yet promising non-conventional method to make thermally conductive polymer based material without using traditional fillers for thermal management applications.

Keywords: PVA, PEG, polymer blends, thermal conductivity, phonon