Static Phonon Scattering in Graphene Foam: Uncovered by Residual Thermal Diffusivity at 0 K Limit

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Due to its intriguing thermal and electrical properties, graphene has been widely studied for potential applications in electrodes, conductors, sensor, and energy devices. However, the reported value for its thermal conductivity varies from dozens to thousands of W/mK due to the different levels of alternations and defects in graphene samples. In this work, the thermal transport in suspended four-layer graphene foam (GF) was experimentally studied and reported from room temperature to temperature as low as 10 K. By measuring GF at different lengths, the real thermal diffusivity (α) without radiation effect was obtained. The thermal diffusivity of GF shows a linearly increasing behavior with decreasing temperature in the temperature range of 295 to 95 K. At low temperatures it tends to be stable with a slight decrease. By using classical model for thermal conductivity and fitting $1/\alpha$- T curve to the point of $T=0$, we are able to identify the effect of defects scattering and evaluate the static phonon scattering of GF. The ideal thermal diffusivity of GF without effect of defects was subsequently reported. Without measuring the porosity of GF, the intrinsic thermal diffusivity of free-standing four-layer graphene (α_G) at different temperatures was obtained based on Schuetz's model. The ideal thermal conductivity of graphene (k_G) against temperature (T) profile was calculated. A peak value of 2220 W/mK at 75 K is observed for the thermal conductivity. These results provide an important insight to the thermal transport physics in graphene.