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Thermal transport in graphene-based nanostructures[1]

ZLATAN AKSAMIJA, IRENA KNEZEVIC, University of Wisconsin-Madison — Thermal conductivity of graphene and graphene-based nanostructures, such as graphene nanoribbons (GNRs), CVD-grown polycrystalline graphene (PCG), and nano-patterned single-layer graphene (SLG), is of great interest due to their potential applications as logic devices, high-frequency amplifiers, and heat spreaders in future nanoelectronic circuits. Both line edge roughness (LER) and substrate scattering have been shown to impact thermal transport and reduce graphene's record thermal conductivity; however, the combination of these two mechanisms, which will both be present simultaneously in supported nanostructures, has not been explored previously, and their combined impact on thermal transport has not be assessed. We solve the phonon Boltzmann transport equation and calculate the thermal conductivity tensor in a variety of suspended and supported graphene nanostructures. We show that there is a competition between LER and substrate scattering processes, leading to a high degree of directional anisotropy of thermal conductivity. We demonstrate that transport in narrow ribbons (W<100 nm) and PCG or nano-SLG with small feature sizes is dominated by roughness scattering and highly anisotropic. We discuss different avenues of controlling thermal transport in graphene-based devices.

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