Thermal Transport in Amorphous Nanostructures

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Thermal transport in amorphous materials has been relatively less explored compared to that in crystalline materials. Amorphous materials are considered to possess the lower limit to the thermal conductivity (k), which is ~1 W/m-K for a-Si. However, recent work suggested that k of micron-thick a-Si films can be greater than 3 W/m-K, which is contributed by propagating vibrational modes, referred to as "propagons". However, precise determination of k in a-Si has been elusive. Here, we used a-Si nanotubes and suspended a-Si films for precise in-plane thermal conductivity ($k_{//}$) measurement within a wide thickness range of ~5 nm to 1.7 um. We showed unexpectedly high $k_{//}$ in a-Si nanostructures, reaching ~3.0 and 5.3 W/m-K at ~100 nm and 1.7 um, respectively. Furthermore, the measured $k_{//}$ is significantly higher than the cross-plane k on the same films. This unusually high and anisotropic thermal conductivity in the amorphous Si nanostructure manifests the surprisingly broad propagon mean free path distribution, which is found to range from 10 nm to 10 um, in the disordered and atomically isotropic structure. Time permitting, we will discuss non-diffusive thermal transport in a-Si as well as radiative heat transfer in amorphous polar dielectrics (e.g., SiO_2).

[1] S. Kown, J. Zheng, M. C. Wingert, S. Cui, and R. Chen, *ACS Nano* **11**, 2470-2476 (2017)