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Nanoscale thermal transport measurements: Bridging ultrafast and steady-state[1] BRIAN GREEN, MARK SIEMENS, University of Denver, SARAH MASON COLLABORATION, BARRY ZINK COLLABORATION —
Macroscale thermal transport is explained by classical thermal diffusion, but as nanostructure length scales are reduced towards the order of the phonon mean free path, transport of thermal energy takes on a fundamentally different character. Nanoscale effects emerge such as sensitivity to the presence of surfaces and the onset of ballistic transport. We investigate nanoscale thermal physics by comparing results from two different transport measurement techniques applied to systems of highly confined thermal transport: metallic thin films deposited on a suspended bridge structure. One technique uses the transient thermoreflectance (TTR) method to measure picosecond cooling dynamics following ultrafast laser heating in a micron-sized region of the metallic film deposited on the bridge; the second is a DC technique that measures transport driven by an Ohmically-generated thermal gradient across the bridge through the full volume of the film. We find that these very different methods give similar results of significantly reduced thermal conductivity relative to macroscale values. We compare TTR and DC results between differing film thicknesses, and evaluate conductance uniformity across film surfaces. In combination, the TTR and DC methods are powerful tools for investigating and understanding thermal transport at the nanoscale.

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Brian Green
University of Denver

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