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Discovering new thermal and mechanical properties of nanostructured systems JORGE N. HERNANDEZ-CHARPAK, KATHLEEN HOOGEBOOM-POT, TRAVIS FRAZER, DAMIANO NARDI, EMRAH TURGUT, JILA and University of Colorado, Boulder, ERIK ANDERSON, Lawrence Berkeley National Laboratory, XIAOKUN GU, RONGGUI YANG, University of Colorado, Boulder, JUSTIN SHAW, National Institute of Standards and Technology, Boulder, HENRY KAPTEYN, MARGARET MURNANE, JILA and University of Colorado, Boulder — How is thermal transport affected by spatial confinement in nanoscale systems? How do elastic properties of materials evolve as nanostructures build up layer by layer? A host of applications in nanoscience and nanotechnology rely on an answer to these questions but our ability to probe the dynamics of nano-systems is still limited. With tabletop high harmonic generation (HHG), we overcome these limitations by extending non-destructive photoacoustic and photothermal techniques to extreme ultraviolet (EUV) wavelengths. The short wavelength and pulse duration of coherent EUV beams from HHG sources offer revolutionary capabilities for observing nano-systems on their intrinsic length and time scales. By generating and directly monitoring hypersonic acoustic waves in nanosystems, we characterize the mechanical properties of sub-10nm layers. Here we find that the density of ultrathin layers remains close to their bulk material value, while their elastic properties are significantly modified. Moreover, with the same technique, we follow the heat dissipation dynamics from 30-750nm heat sources uncovering a new thermal transport regime that dominates for closely-spaced nanoscale sources. Surprisingly, in this regime heat sources can cool more efficiently than widely-spaced sources of the same size.

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