Abstract Submitted
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Understanding nanoscale mechanical properties of materials using ultrafast EUV photoacoustics[1] K. HOOGEBOOM-POT, E. TURGUT, JILA, CU-Boulder, J. SHAW, NIST Boulder, J. HERNANDEZ-CHARPAK, M. MURNANE, H. KAPTEYN, D. NARDI, JILA, CU-Boulder — How do the elastic properties of materials evolve as a nanostructure builds up layer by layer? A host of questions in nanoscience, nanotechnology, quantum dot systems and more rely on an answer to this issue; but our ability to probe mechanical properties is severely constrained at dimensions below 100 nm. With tabletop high harmonic generation (HHG), we overcome these limitations by extending non-destructive visible photoacoustics to extreme ultraviolet (EUV) wavelengths. The short wavelength of EUV light, combined with the coherence and ultrashort pulses of HHG creates a unique and powerful probe of nanostructured materials on their intrinsic length and time scales. We study a series of ultrathin bilayer (10-nm Ni/0-6-nm Ta) nanostructures on SiO_2 substrates. A femtosecond infrared pulse excites longitudinal acoustic waves (LAWs) within the nanostructures and surface acoustic waves (SAWs) in the substrate. Diffraction of a time-delayed EUV probe pulse monitors the dynamics. LAW resonances are directly related to the bilayer thickness and effective speed of sound; their dependence on Ta-layer thickness reveals that the LAW velocities of both Ni and Ta differ from bulk values. The changing mass of Ta also affects the SAW frequency, allowing us to extract nanoscale densities.

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