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Mapping wavevector dependent electron-phonon coupling and nonequilibrium phonon dynamics in thin graphite with ultrafast electron diffuse scattering JEAN-PHILIPPE BOISVERT, ROBERT P. CHATELAIN, MARK J. STERN, MARK SUTTON, Department of Physics, Center for the Physics of Materials, McGill University, BRADLEY J. SIWICK, Departments of Physics and Chemistry, Center for the Physics of Materials, McGill University — Radio-frequency compressed ultrafast electron diffraction has been used to probe the coherent and incoherent coupling of impulsive electronic excitation at 1.55 eV (800 nm) to optical and acoustic phonon modes directly from the perspective of the lattice degrees of freedom. Recent improvements in source brightness for ultrafast diffraction experiments are now allowing for the study of diffuse scattering signals. Here, we show that ultrafast electron diffuse scattering (UEDS) can yield time and momentum-resolved phonon population data. Beyond the possibility of directly probing the dynamics of thermalization, this can also be used to determine the wavevector dependent electron-phonon coupling strength in materials. This new information provides significant insights into the electron relaxation pathways of graphitic materials. In particular, we present the first direct measurement of the K-point phonon population dynamics after impulsive electronic excitation and maps of the phonon population in momentum-space. Finally, we propose a simple mechanism for the thermalization of graphitic materials after impulsive electronic excitation which unifies all ultrafast measurements of this process to date.

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