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Time Evolution of Charge Carriers Phonons after Photo-Excitation by an Ultra-Short Light Pulse in Bulk Germanium[1] STEPHEN FAHY, University College Cork, FELIPE MURPHY-ARMANDO, Tyndall National Institute, Cork, Ireland, MARIANO TRIGO, Stanford Institute for Materials and Energy Science, SLAC National Accelerator Laboratory, IVANA SAVIC, EAMONN MURRAY, Tyndall National Institute, Cork, Ireland, DAVID REIS, Stanford Institute for Materials and Energy Science, SLAC National Accelerator Laboratory — We have calculated the time-evolution of carriers and generated phonons in Ge after ultrafast photo-excitation above the direct band-gap. The relevant electron-phonon and anharmonic phonon scattering rates are obtained from first-principles electronic structure calculations. Measurements of the x-ray diffuse scattering after excitation near the L point in the Brillouin zone find a relatively slow (5 ps, compared to the typical electron-phonon energy relaxation of the Gamma-L phonon) increase of the phonon population. We find this is due to emission caused by the scattering of electrons between the Delta and L valleys, after the initial depopulation of the Gamma valley. The relative slowness of this process is due to a combination of causes: (i) the finite time for the initial depopulation of the conduction Gamma valley; (ii) the associated electron-phonon coupling is relatively weaker (compared to Gamma-L, Gamma-Delta and Delta-Delta couplings) ; (iii) the TA associated phonon has a long lifetime and (iv) the depopulation of the Delta valley suppresses the phonon emission.

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