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Ambipolar diffusion and recombination of photoexcited carriers in bismuth films YU-MIIN SHEU, YI-JIUNN CHIEN, CTIRAD UHER, STEPHEN FAHY, DAVID REIS, FOCUS Center and Department of Physics, University of Michigan, Ann Arbor, Michigan 48109-1040, USA — Recent experimental and theoretical studies on bismuth show that intense ultrafast photoexcitation leads to a large- amplitude, softened coherent A1g phonon. Thus, the subsequent dynamics of the photoexcited carriers will strongly influence the dynamics of the phonon. However, little is known about the nonequilibrium carrier dynamics due to difficulty in separating carrier relaxation and other processes. Here we report ultrafast counter propagating optical pump-probe experiments, measuring photoexcited carrier transport across optically thick single crystal bismuth films at room temperature. The films are grown on transparent sapphire substrates with thicknesses varying between 185 and 385 nm, sufficient to separate the carrier dynamics from the effects of lattice heating and strain, when pumped and probed on opposite faces. The measured recombination time is about 14-30 ps and ambipolar diffusivity between 22 and 28 cm^2/s for the different films. The carrier recombination time is much longer than the A1g phonon period, supporting a two chemical potential model for the photoexcited electronic system and phonon dynamics, in which carrier diffusion (rather than electron-hole plasma cooling or recombination substantially reduces the carrier density over the lifetime of the phonon, leading to a chirped mode.

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