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Carrier Decay and Diffusion Dynamics in Single-Crystalline CdTe as seen via Microphotoluminescence[1] ANGELO MASCARENHAS, BRIAN FLUEGEL, KIRSTIN ALBERI, NREL, YONG-HANG ZHANG, Arizona State Univ. — The ability to spatially resolve the degree to which extended defects impact carrier diffusion lengths and lifetimes is important for determining upper limits for defect densities in semiconductor devices. We show that a new spatially and temporally resolved photoluminescence (PL) imaging technique can be used to accurately extract carrier lifetimes in the immediate vicinity of dark-line defects in CdTe/MgCdTe double heterostructures. A series of PL images captured during the decay process show that extended defects with a density of $1.4x10^{-5}$ cm^{-2} deplete photogenerated charge carriers from the surrounding semiconductor material on a nanosecond time scale. The technique makes it possible to elucidate the interplay between nonradiative carrier recombination and carrier diffusion and reveals that they both combine to degrade the PL intensity over a fractional area that is much larger than the physical size of the defects. Carrier lifetimes are correctly determined from numerical simulations of the decay behavior by taking these two effects into account. Our study demonstrates that it is crucial to measure and account for the influence of local defects in the measurement of carrier lifetime and diffusion, which are key transport parameters for the design and modeling of advanced solar-cell and light-emitting devices.

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