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OPTICAL NONLINEAR ABSORPTION PROPERTIES OF 4H-SIC—EXPERIMENT AND MODEL

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Intensity-dependent nonlinear light absorption in bulk 4H-SiC at the above-bandgap energy of 3.49 eV (λ=355 nm) is studied. Characterization and understanding of such nonlinear optical behavior in 4H-SiC forms the basis of efficiency improvements and design of optoelectronic SiC devices, including photo-conductive semiconductor switches. It is noted that previous research performed elsewhere had focused primarily on nonlinearities at below-bandgap energies, while little had been explored above-bandgap. In this study, absorption of short laser pulses with fluences ranging from 1 mJ/cm2 to 30 mJ/cm2 incident on 160 μm-thick high purity semi-insulating 4H-SiC samples of varying recombination lifetimes is addressed. Sample bulk recombination lifetimes vary from 0.5 ns to 100 ns displaying the range of effects from growth, electron irradiation, and annealing. The effective absorption coefficient varies significantly within this range as an apparent function of bulk recombination lifetime. A four-level time- and space-dependent finite difference time domain (FDTD) model taking into account electron trapping, interband absorption, and free-carrier absorption was constructed that yielded further insight into the absorption dynamics. For instance, the importance of free carrier absorption and deep-level trapping in the nonlinear absorption behavior is elucidated.

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