X. INFRARED NONLINEAR OPTICS

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1. INFRARED NONLINEAR PROCESSES IN SEMICONDUCTORS

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As a preliminary to high-field, four-wave mixing experiments in (Hg,Cd)Te, extensive studies of below-gap, IR absorption have been performed in this material. Crystals studied included samples from Honeywell, Cominco, and CNRS (provided by C.J. Vérié). At helium temperatures, the absorption coefficient is nearly independent of frequency (below the gap) and ranges from 3-50 cm^{-1}. As temperature is raised, increased absorption due to intervalence-band transitions and free-carrier absorption is observed. Values of $\alpha \gtrsim 10\ cm^{-1}$ preclude the use of (Hg,Cd)Te as a nonlinear material. Thus, the origin of the 4°K absorption is now being sought. Its variation from sample to sample, and near constancy in frequency, argue for a defect absorption mechanism.

A careful study of the power dependence of CO_2 laser absorption in n-Ge has recently been completed. This work, in contrast to previous experiments along these lines, employed a single-mode TEA laser which provides smooth pulses. The absorption coefficient of cold n-Ge crystals was observed to decrease markedly (from 1 cm^{-1} to below 0.1 cm^{-1}) with laser power. The results have been interpreted with a two-level kinetic model which balances the photoionization rate (from donors) against the capture rate (of free electrons). The fit determines the photoionization, free-carrier, and capture cross sections.

Calculations of plasmon gain and pumping threshold for narrow-gap semiconductors with $E_G = \hbar\omega_p$ are continuing. The ultimate aim of this work is the development of a plasmon laser. The theory indicates that magnetic fields enhance the gain, via Landau-level quantization, and reduce the minority carrier recombination rate through modification of the plasmon dispersion relation. The optimal situation occurs in semimetallic (Hg,Cd)Te with field-induced gap; thresholds below 100 kW/cm^2 are predicted under these circumstances.

References

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