XI. INFRARED NONLINEAR OPTICS

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1. INFRARED NONLINEAR PROCESSES IN SEMICONDUCTORS

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During the past year, a first series of experiments concerning the dispersion of the nonlinear optical susceptibility of n-type germanium was completed.[1] When pumped with two CO_2 lasers (ω_1 and ω_2), such a crystal generates radiation at frequency $\omega_3 = 2\omega_1 - \omega_2$. The power $P(\omega_3)$ is strongly enhanced (200-fold) when $\omega_1 - \omega_2$ coincides with valley-orbit splitting of the donor states. The results are in good agreement with our calculations of impurity Raman scattering and the third-order nonlinear coefficient. We plan next to use the resonant, four-photon mixing effect as a probe of other impurity levels. Experiments to detect the 1S-2S transition in n-Ge are in progress. We are also performing calculations of 2S (and higher) energy levels.

The measured cross sections imply that stimulated impurity Raman scattering should be achievable in n-Ge with CO_2 or far-infrared pumping. Preliminary experiments to test this idea were not successful, probably because the intense optical fields stripped the impurities. Measurements to confirm this hypothesis, and possibly obviate the problem, are planned.

We have recently observed resonant, spin-induced four-photon mixing in a ($Cd_xHg_{1-x}Te$) crystal loaned to us by Dr. Paul Kruse of the Honeywell Research Center. These experiments were performed with two CO_2 laser beams. The results clearly indicate that the sample contains a number of distinct regions, with slightly different g-values. Individual resonances are sharp, suggesting that there is an abrupt variation of properties from one region to the next. We plan to correlate our results with similar data obtained by the Bell Laboratories group on (Cd_xHg_{1-x})Te samples grown by Cominco.

References

1. R. A. Wood, M. A. Khan, P. A. Wolff, and R. L. Aggarwal, "Dispersion of the Nonlinear Optical Susceptibility of n-Type Germanium," Opt. Commun. 21, 154 (1977).