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Efficient "Photon Drag" Detector Using p-Type Tellurium

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An electromotive force generated in p-Ge by an intense Q switched CO_2 laser has been described in terms of momentum transfer from photons to holes during the intervalence band transition or so called "photon drag" effect[1,2]. In p-Ge the intervalence band transition occurs far from the centre of the Brillouin zone because the heavy and light valence bands are degenerate at k=0. For this reason a cancellation between heavy and light holecurrent yields a poor sensitivity as a "photon drag" detector. On the other hand, in Te these valence bands are splitted at k=0 because of a lack of centre of symmetry, the separation between which corresponds to an energy at 11μ, so that a strong intervalence band absorption occurs at k=0 by 10.6μ radiation from a CO_2 laser. A improved sensitivity is expected in p-type Te.

The optical absorption in Te shows a strong anisotropy reflecting the uniaxial property of the crystallographic symmetry. A strong intervalence band absorption is observed at 11μ when the polarization of the incident light is parallel to the c-axis[3]. This anisotropy of the optical absorption will be useful to reveal the true mechanism of so called "photon drag" effect.

The photo-electromotive force in p-Te was measured when the sample of about 5mm long was irradiated by an intense Q switched CO_2 laser with peak power of 1kw at 10.6μ. The induced voltage across the sample was large as high as several mV at 77K, comparing with that of the order of 0.1mV in p-Ge. The quick response similar to p-Ge was also observed in p-Te, precisely reproducing the waveform of the laser pulse. As shown in the figure, the induced voltage decreased with increasing temperature. But no polarity change with temperature was found. Temperature dependence of photoconductivity in p-Te was also measured and the obtained density of excess carriers was used to make a quantitative estimation of the induced voltage.

References

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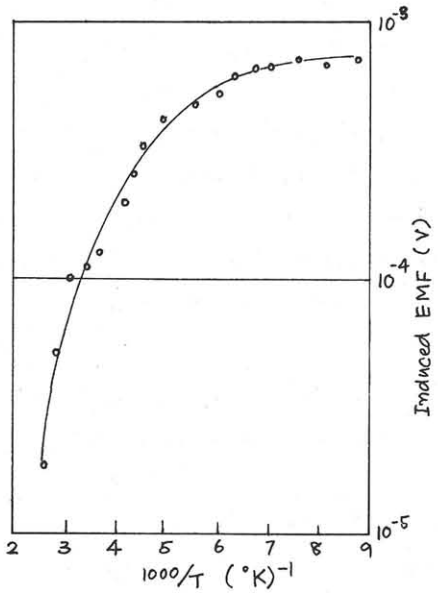

Fig.1 Temperature dependence of the induced EMF in p-Te.