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Characterisation of CdMnTe for use as a room temperature gamma ray detector

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Cadmium Manganese Telluride is a semiconductor material that has previously been used as IR detectors, visible and near-IR lasers and solar cells. However, despite its promising properties for radiation detection, it has so far seen little investigation in this area.
Samples have been grown that show high resistivity (> 1010 Ωcm) and high $\mu\tau$ (>10-6 cm2/V) [1]. It has also been shown that it is possible to grow material with better crystal quality than CdTe with a grown crystal 30 to 40mm in diameter and 50 to 60 mm in length [2]. Some of the properties of single crystal CdMnTe samples are investigated, including mapping of precipitates and defects, band-gap measurements to determine composition, I-V measurements, and alpha spectroscopy.

The distribution of precipitates and defects was mapped using sub band-gap IR microscopy. This technique can give micrometer resolution and provides a good insight into the quality of the crystal, indicating the spread of Te precipitates as well as any twins or grain boundaries that may exist within the crystal from precipitates that lie on the boundaries. Few large precipitates were found in the sample, but there were some lines of precipitates suggesting grain boundaries.

Band gap measurements were carried out using two different methods; room temperature photoluminescence at 632,8nm excitation, and room temperature transmission spectroscopy. The band gap energy calculated from the PL and transmission methods was found to be 1.70 and 1.71 eV respectively. These results were then used to find the composition of the sample using the equation detailed in [3]. The composition of the Cd1-xMnxTe was found to be x = 0.13 from PL and x = 0.14 from transmission data.

I-V curves were measured at room temperature in the range of -100V to +100V bias and at low temperature (150K) in the range of -300V to +350V. The shape of the curves gives information about the properties of the sample and its contacts. The leakage current at room temperature also provides information on how the material is likely to perform as a detector.

The alpha spectra were taken at 150K and over a range of bias voltages from 0 to 200V. The spectra obtained from the CdMnTe sample show the predicted response to varying bias voltage, with CCE increasing with bias voltage. The CCE values obtained are relatively low, and degraded by a relatively high level of leakage current.

[1] Arnold Burger et al., Journal of Crystal Growth 198/199 (1999) 872-876

[2] Kotani et al. Sumitomo, Electrotechnical Review V27 (1998) 166-173
[3] Y.R. Lee and A.K. Ramdas, Solid State Commun. Vol. 51, No. 11 (1984) 861-863

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