A COMPARATIVE STUDY ON THE PERFORMANCE OF RADIATION DETECTORS FROM THE HgI2 CRYSTALS GROWN BY DIFFERENT TECHNIQUES

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There have been attempts to develop room-temperature X- and gamma ray semiconductor detectors for various applications. The main physical semiconductor properties required for fabrication of room temperature semiconductor detectors are: (1) high atomic number; (2) high density; (3) high absorption coefficient; (4) a band gap large enough to keep leakage currents low, at room temperature and (5) large electron and hole mobility-lifetime products, for an efficient charge collection [1, 2]. Among these types of detectors, HgI_2 has emerged as a particularly interesting material in view of its wide band gap (2.13 eV) and its large density (7.5 g/cm^3). HgI_2 crystals are composed of high atomic number elements (Z_{Hg}=80 and Z_I=53) and with high resistivity (>10^{14} Ωcm). These are important factors in applications where compact and small thickness detectors are necessary for X- and gamma rays measurements. However, the applications of HgI_2 are limited by the difficulty in obtaining high-quality single crystals and the long-term reliability problems in devices made from crystals [1].

In this work, the HgI_2 crystals were grown using four different techniques: (a) physical vapor transport, (b) solution from dimethylsulfoxide complexes, (c) vapor growth of HgI_2 precipitated from acetone and (d) Bridgman method. The obtained crystals for four methods were characterized considering the following physical chemistry properties: crystal stoichiometry, crystal structure, plan of the crystal orientation, surface morphology of the crystal and crystal impurity. The influence of these physical chemistry properties on the crystals developed by four techniques was studied, evaluating their performance as a radiation detector. The best result of radiation response was found for the crystal grown by physical vapor transport. Also, the dependence of the radiation response on the HgI_2 crystal purity was also studied. For this, the HgI_2 raw material was purified by the many pass zone refining technique. A significant improvement in the characteristics of the detector-crystal was achieved, when the starting materials became purer.

1. *McGregor DS, Hermon H (1997) Room-temperature compound semiconductor radiation detectors. Nucl. Instr and Meth. Phys. Res. A 395: 101-124*
2. *Oliveira IB, Costa FE, Chubaci JFD, Hamada MM (2004) Purification and preparation of TlBr crystals for room temperature radiation detector applications. IEEE. Trans. Nucl. Sci 51: 1224-1228*