Cadmium telluride charged-particle detector

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Introduction

Cadmium telluride, a room temperature detector material [1] was tested for detecting charged-particles. Its performance is mostly affected by the small $\mu\tau$ figure ($<10^{-4} cm^2/s$) for holes. However, 0.5 to 1mm thick detectors are found suitable for detection of low-energy (<150 keV) γ-rays. Hence, the material is also expected to be useful for detecting charged-particles such as alpha having energy up to ~70 MeV. High-resistivity ($>10^8 \Omega$-cm) samples showing maximum counting efficiency for 60 keV γ were selected for making alpha counter. Electron to hole mobility ratio is about 10 in CdTe. Hence, signal was generated by collecting the electrons at the positively biased back contact. Detectors with chemically plated gold window were found resolving Am- and Pu-α peaks with energy resolution of ~3%.

Experimental

CdTe crystals grown from melt by Bridgman technique [2] were evaluated for resistivity. 1 to 1.5 mm thick samples were provided with Ag-paste contacts on their lapped surface to measure resistivity. The high-resistivity ($>10^8 \Omega$-cm) samples were then tested for their counting efficiencies for 60 keV γ-rays coming from the negatively biased contact side (Fig.1). Samples were graded by keeping bias field, threshold signal and all other measurement conditions the same. Providing lower resistive $AuCl_4$-plated gold contacts helped in collecting charges better. The samples which showed gamma-rays response with photo peak, as shown in Fig.2, were selected for making alpha detector.

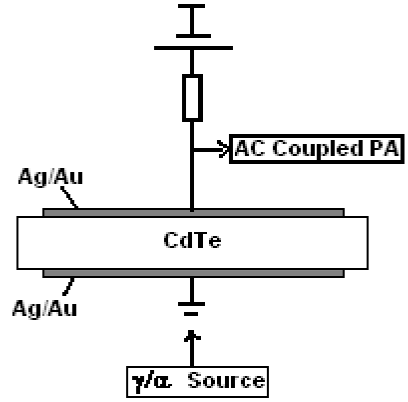

Fig. 1. Detection set-up (schematic).

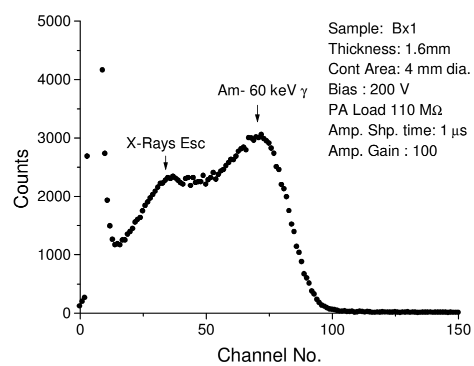

Fig. 2. CdTe Response to 60 keV γ-rays.

CdTe Samples for detecting charged particle were lapped, etched in 10% Br - methanol solution, and then provided with 6 mm dia. chemically plated Au contacts. One or two drops of $AuCl_4$ solution (in water) were just placed on the polished surface for a few seconds to make the contacts. The samples were then washed thoroughly in water, dried and then mounted with pressure contacts in vacuum to carry out the testing. Detectors were tested with standard electronic set-up. Fig.3 shows the 5.48 MeV Am-α spectra recorded at different bias voltages for a 1.5 mm thick sample. It also shows the spectrum obtained with a Si surface barrier detector having 35 keV energy resolution. The charge collection looks to be nearly complete for CdTe at 300V.The higher pulse

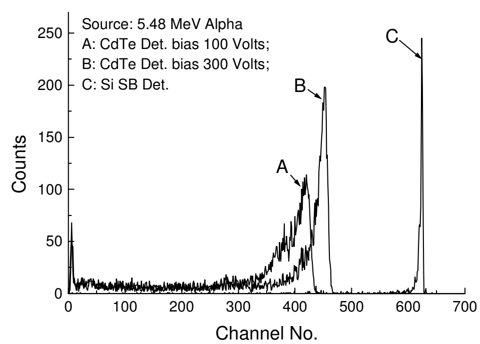

Fig.3. Am-α (5.48 MeV) spectra of CdTe and Si detectors.

height for same energy in the case of Si detector is ascribed to the lower e-h pair formation energy in Si. Energy resolution, as shown in Fig.4, is about 175 keV (3%) for 5.48 MeV α. Better performances could not be achieved due to breakdown, either at the contact or in the bulk, at higher bias voltage.

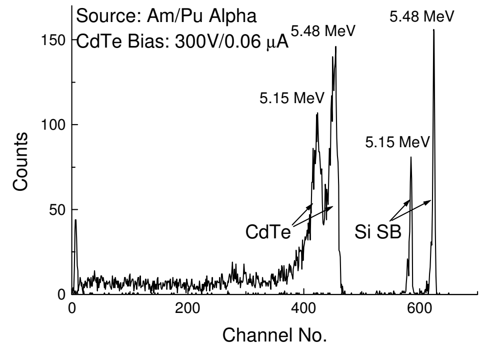

Fig. 4. Am-Pu α spectra recorded with CdTe and Si detectors

Conclusion

Small area (~25 mm^2) CdTe charged-particle detector showing 3% energy resolution for 5.4 MeV was made from high-resistivity melt-grown crystal. Improving the material property and contact making process are likely to help in achieving better performance.

Acknowledgement

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References

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