UNIVERSITY OF LIVERPOOL

Josiah O'Brien
200957544

Studying the use of Thallium Bromide as a Gamma-ray Sensor

Thallium Bromide

Thallium Bromide is a dense, wide band gap (2.68eV) semiconductor, which allows for room temperature operation, and gives it a greater attenuation coefficient than currently popular CZT crystals. It also has a large resistivity at room temperature, minimising electronic noise, and a low melting point, allowing for simplistic production methods. These properties have made TlBr extremely promising for use in gamma-ray and X-ray detection, and resolutions comparable to CZT are expected.

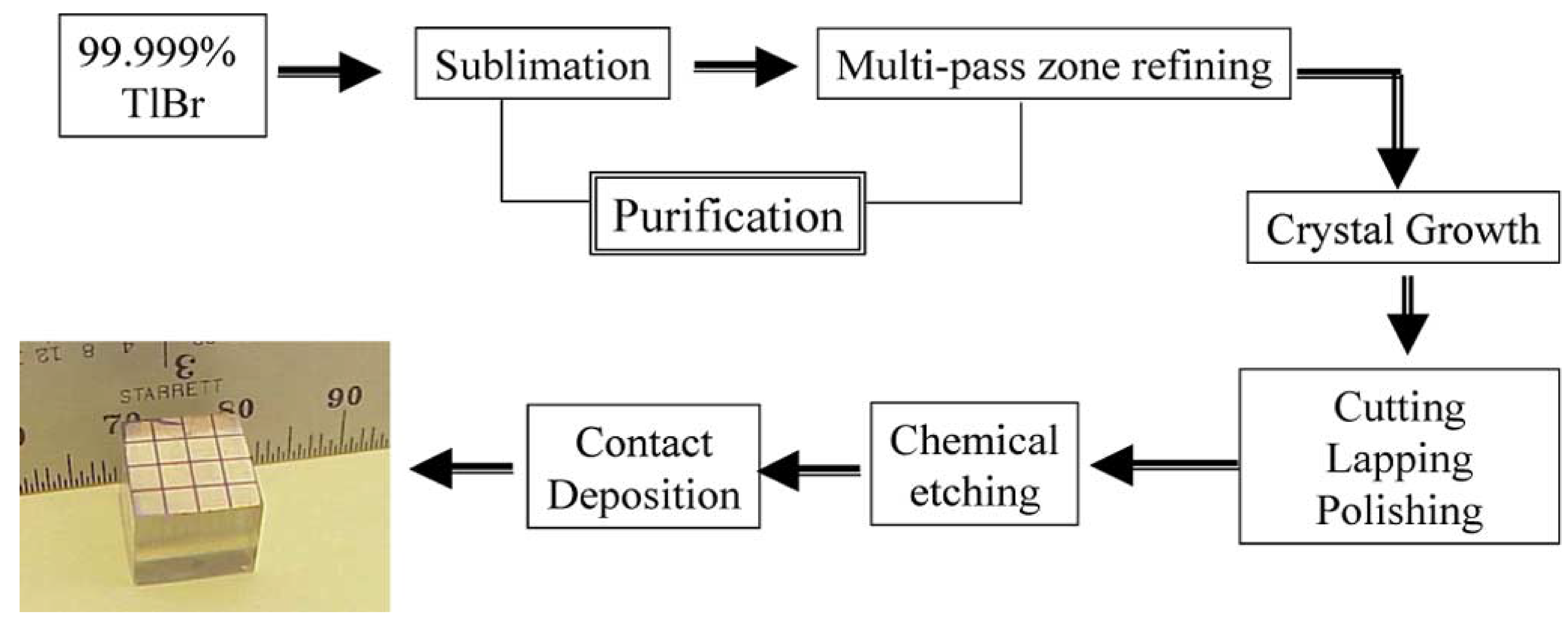

Figure 1. Diagram of steps taken to fabricate a TlBr Crystal

Current Detectors

Four gamma-ray detectors were characterised, revealing the germanium detector had superior energy resolution, whilst the sodium iodide was the most efficient. Fano factors of 0.11 and 1.4 were found for the Ge and LaCl detectors respectively, which agree with those in the literature.

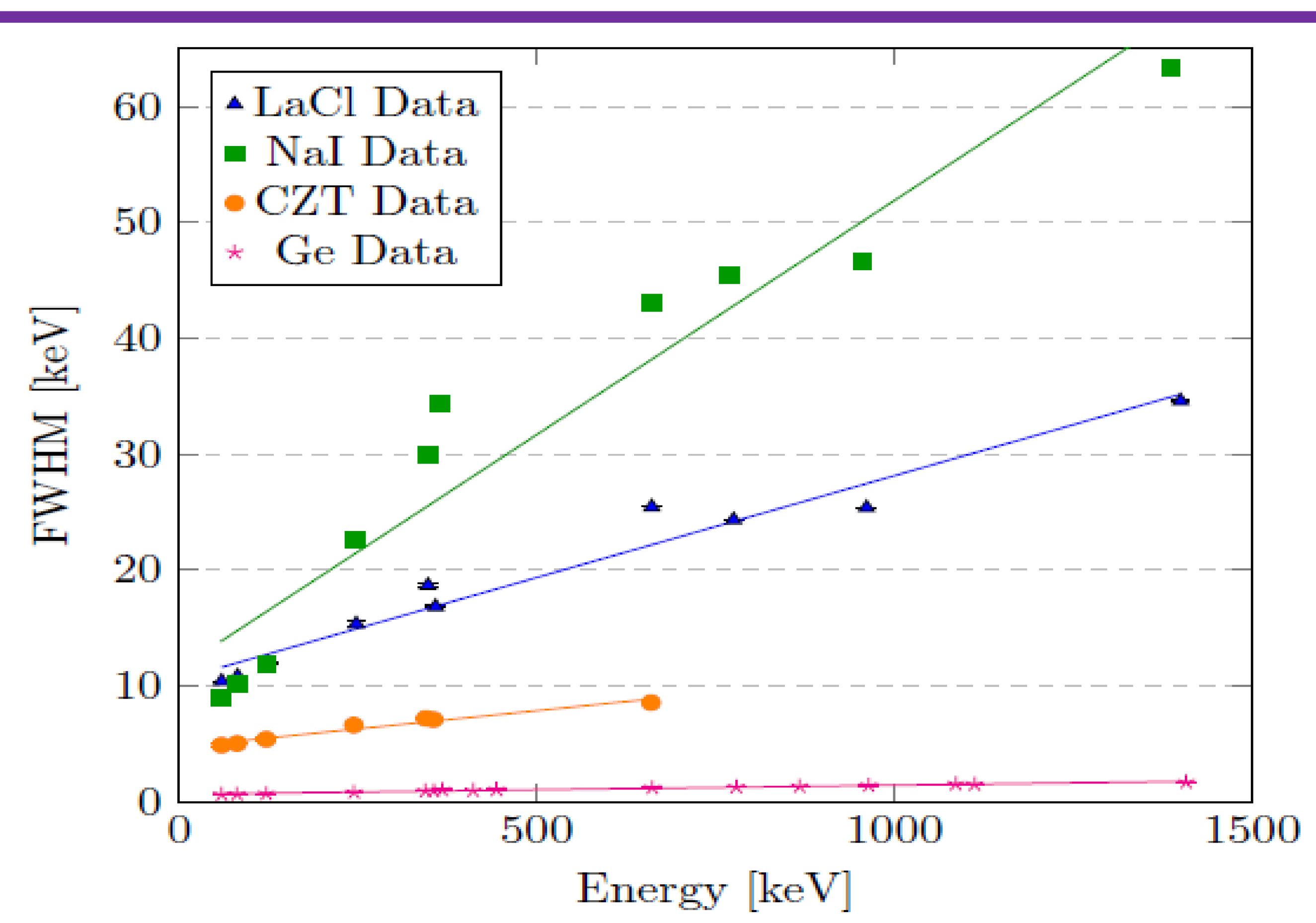

Figure 2. Plot of measured FWHM against corresponding gamma-ray energy, for each of the four detectors

	Detector			
	Ge	CZT	LaCl	NaI
FWHM (keV)	0.67	5.37	11.98	11.89
Efficiency (%)	32.6	2.1	23.1	37.9

Table 1. Comparisons of FWHM and Efficiency, at an energy of 121.8 keV

Detector Fabrication

A 5x5x2mm^3 TlBr crystal was deposited with palladium via thermal evaporation. Fine gold wires were attached to these electrodes, which were then connected to analogue electronics. The electronics consisted of a preamp, specamp, MCA and computer to read the spectra.

A 5x5x30mm^3 crystal was also tested in this setup, which at the time of writing is the largest TlBr crystal tested in the literature. Optimum operating parameters had to be tested, and it was found the 30mm crystal produced results when operated under bias of -3000V respectively. Ideal conditioning time for a 30mm crystal is thirty days, however results had to be taken after only two.

Figure 3. Images of the 30mm and 2mm crystals, after 130h and 30h under bias, respectively. Note the bubbles in the 30mm crystal, and discoloration in the 2mm crystal.

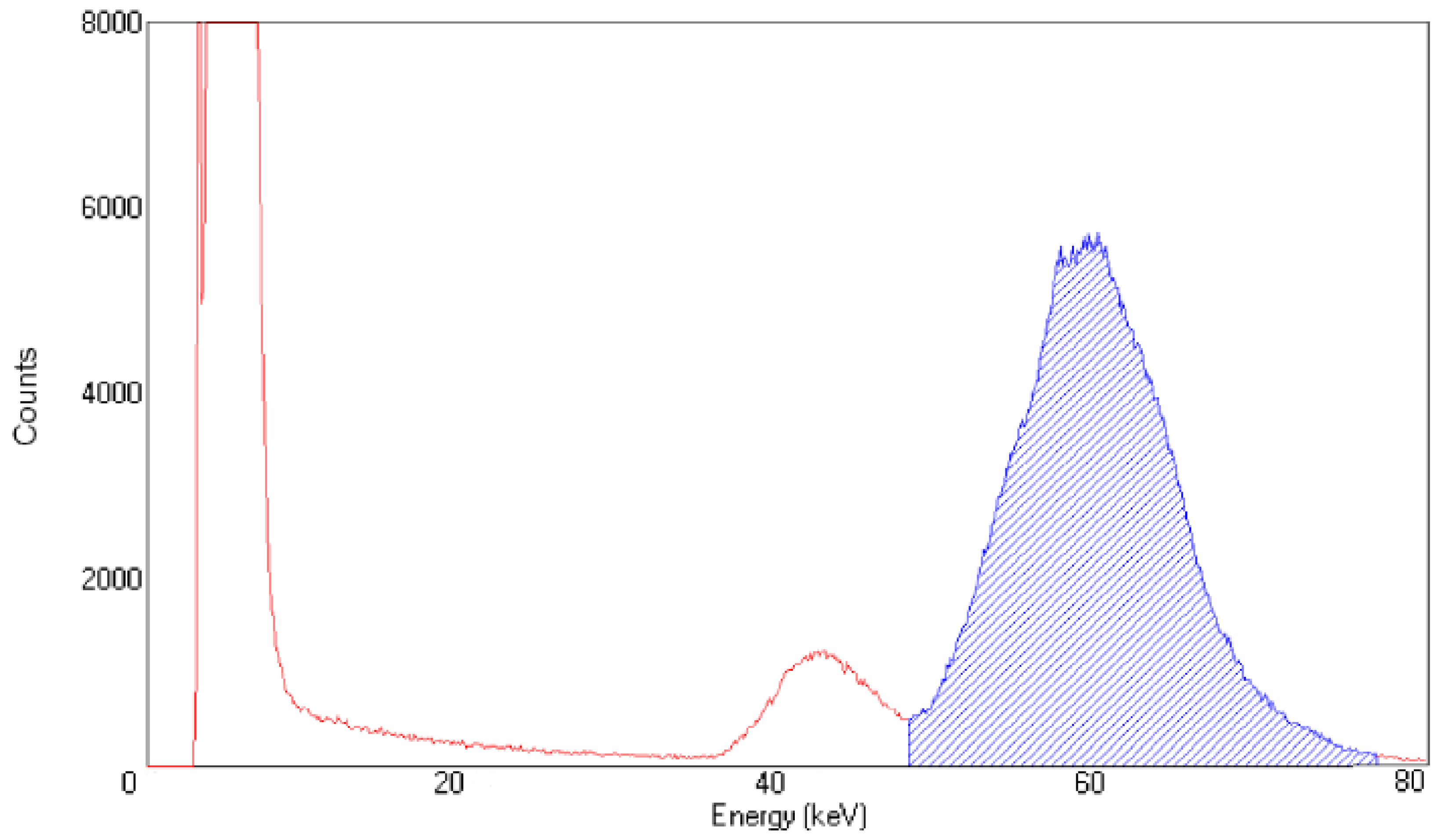

Figure 4. Spectrum of Am^{241} taken with a 5x5x30mm^3TlBr crystal, operating at -3000V bias.

TlBr Results

Due to a combination of factors, no results were obtained for the 2mm crystal. The 30mm crystal resolved a 59.6 keV peak with a FWHM of 10.9 keV, which is comparable to the LaCl detector. Due to the system being so far from optimum, it is unfair to compare it efficiency to current detectors. Were more time available for conditioning, and finding optimal parameters, it is believed this detector could have produced results comparable to those achieved with the CZT detector.

Value at 59.6 keV	Detector				
	TlBr	Ge	CZT	LaCl	NaI
FWHM (keV)	10.9±0.5	0.60±0.01	4.9±0.1	10.37±0.01	8.98±0.01

Table 2. Comparison of FWHM at an energy of 59.6 keV