Growth of $AgSbS_2$ Single Crystals for Radiation Detector Applications

Venika Ekanayake[1], Matthew Webster[1], Manipaul Dhillon[2], and Peng Wang[1]

[1]Department of Chemistry, Queen's University, Kingston, Ontario, Canada

[2]Department of Chemistry, University of British Columbia , Vancouver, British Colombia, Canada

INTRODUCTION

In medical imaging, nuclear safety, intelligence, and security applications, there is a high demand for room-temperature radiation detectors. A desirable radiation detection material must exhibit high sensitivity to radiation, high density, and a suitable band gap. Silver antimony sulfide ($AgSbS_2$) is an emerging ternary semiconductor material used in photovoltaics, optoelectronics, and radiation detector applications. As a non-toxic and environmentally friendly semiconductor, $AgSbS_2$ adheres to principles of sustainable and safer chemical practices. With a bandgap (E_g) of 1.7 eV, it offers higher chemical stability, sufficient hardness to stop radiation, and ease of synthesis, making it a promising sustainable alternative.

METHODOLOGY

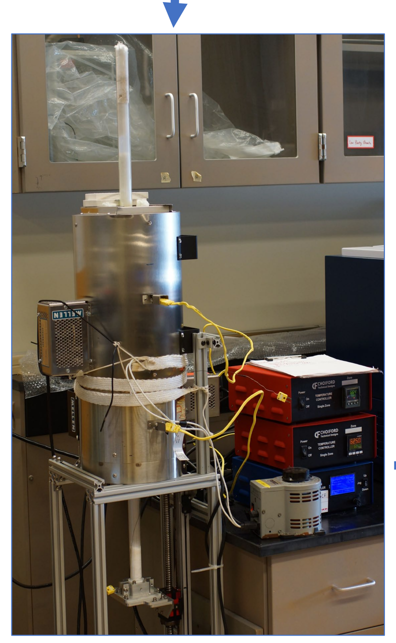
H_2 Reduction

650 °C

Purification of Ag and Sb by reduction

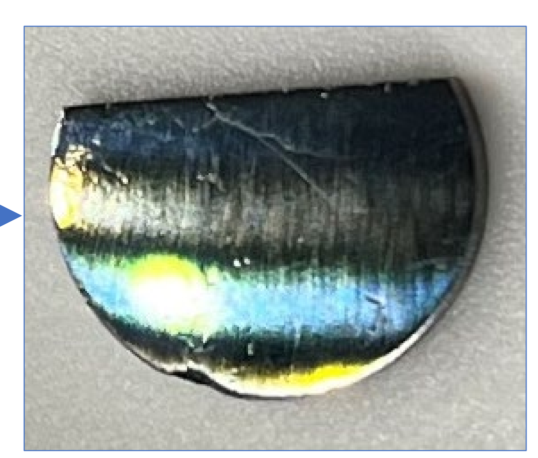
Purification of S by sublimation

Purified Ag, Sb & S sealed in a quartz ampoule



Growth of single crystal in vertical Bridgman furnace

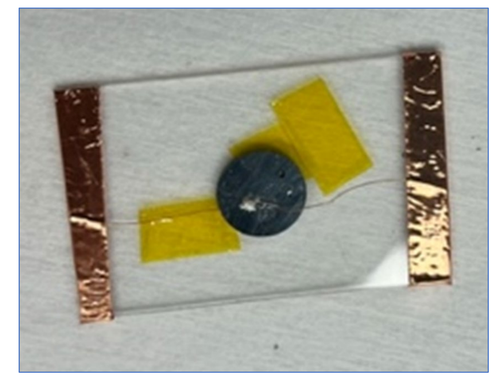
$AgSbS_2$ Ingot

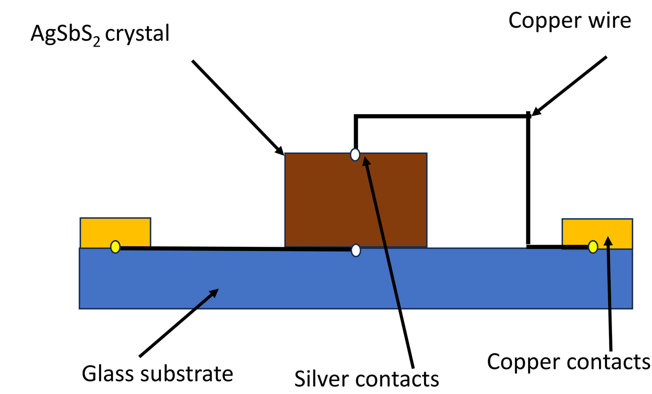


Polished single crystal wafer

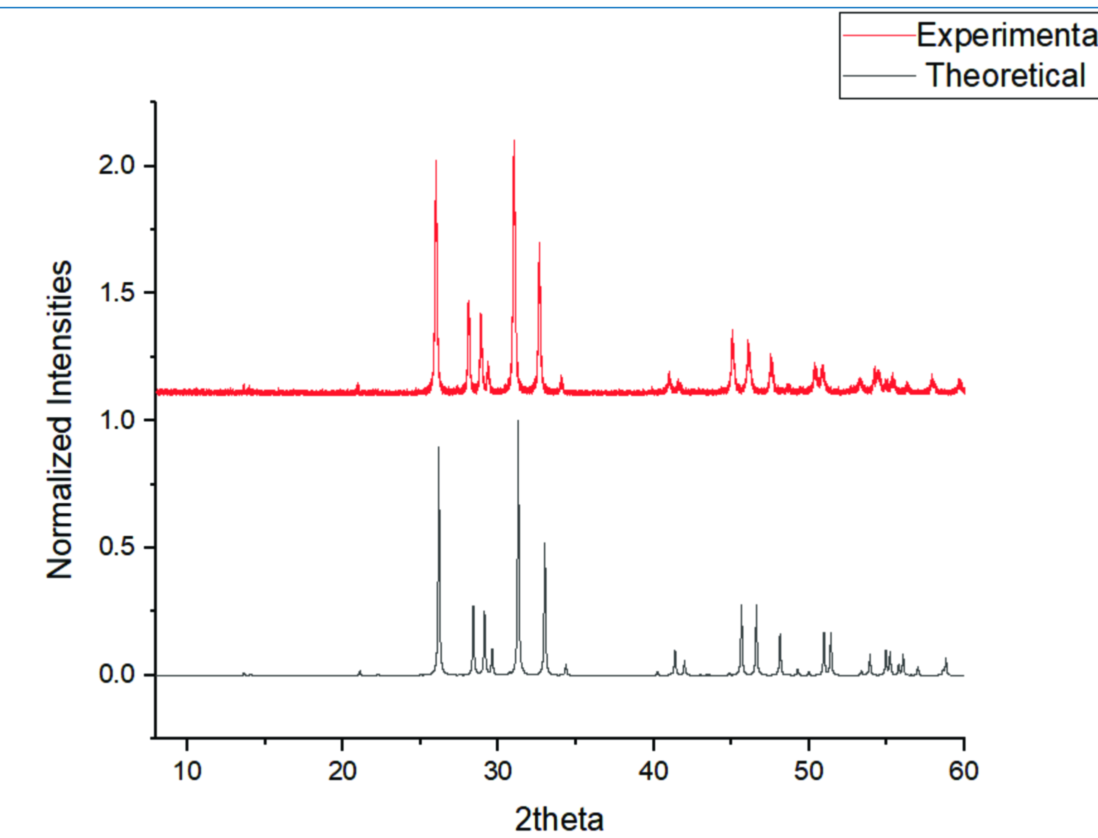
RESULTS AND DISCUSSION

Device Fabrication

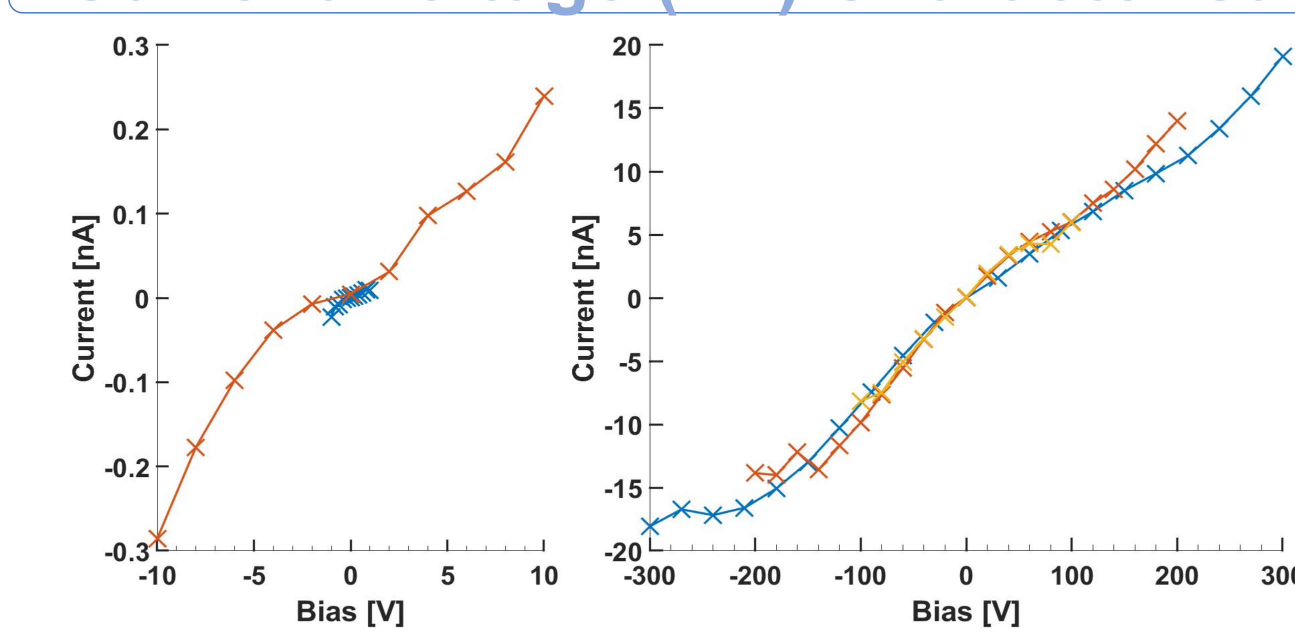




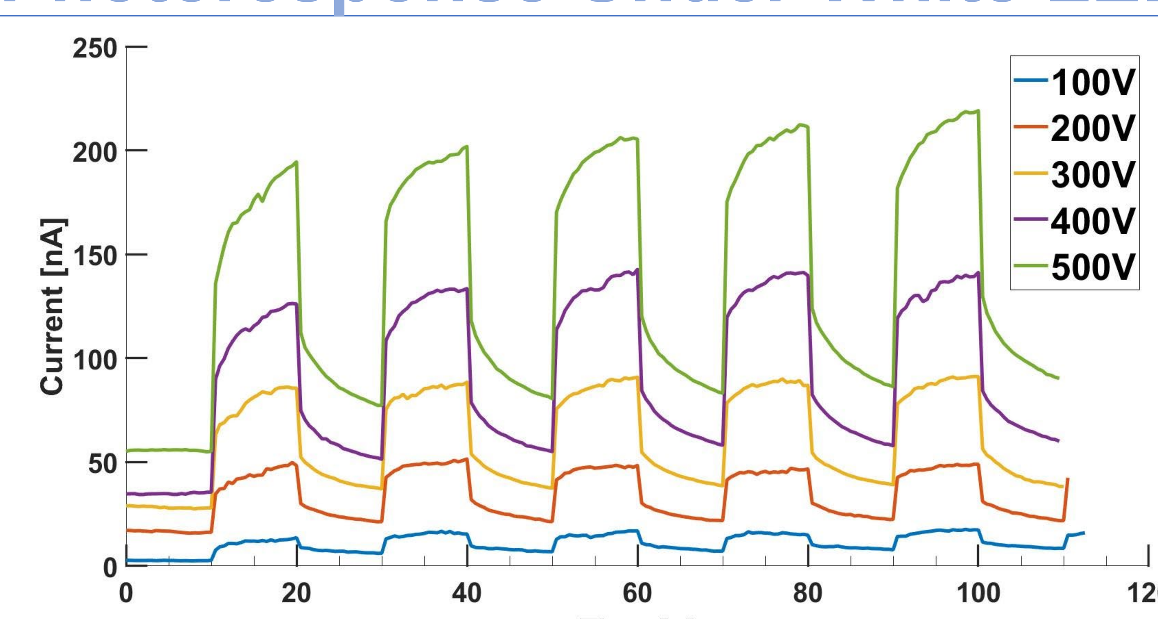
PXRD Pattern



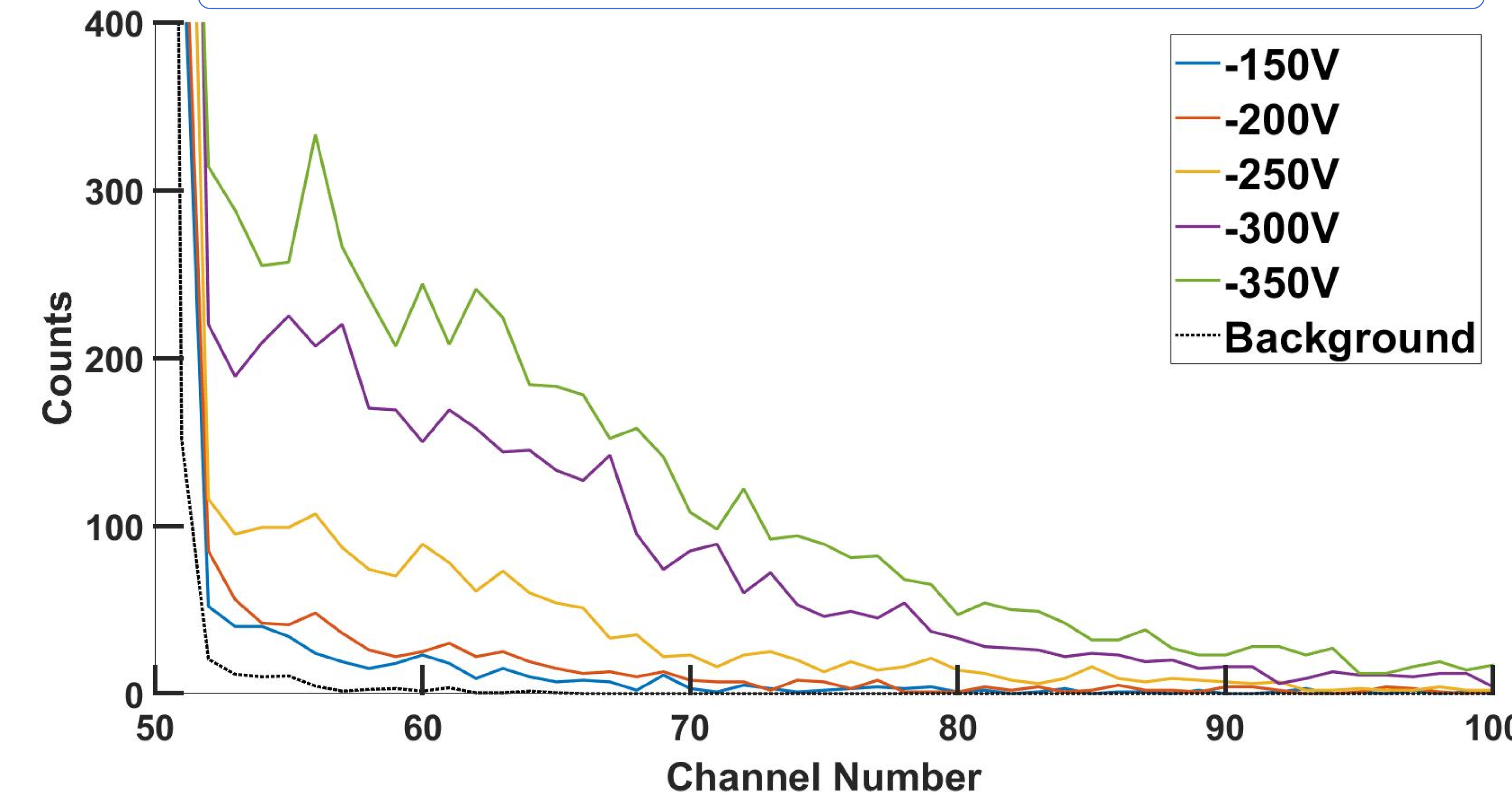
Current-Voltage (I-V) Characteristics



Photoresponse Under White LED



Radiation Measurement



Hardness Measurement

Load/ g	Indent length/ µm	Knoop hardness/ HK
50	77	120
50	76.8	121
50	76.5	122

Median Knoop hardness : 121 Kg mm^{-2}

CONCLUSION

- PXRD shows that phase pure material with a monoclinic structure was obtained.
- This compound exhibits higher mechanical robustness and chemical stability.
- Material has higher resistance and high photosensitivity.
- Pulse height data collected for 5 minutes from 0.9µCi ^{241}Am source indicated that this material is responsive for α radiation.

FUTURE WORK

- Many bubbles and cracks were formed during the crystal growth. This should be avoided by controlled crystal growth in the future steps.
- Optimize the electrical contacts to get a clear signal.
- Radiation measurement for X/ γ- rays.

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