



# Growth of CZTS Thin Films for Environmentally Benign Solar Cells

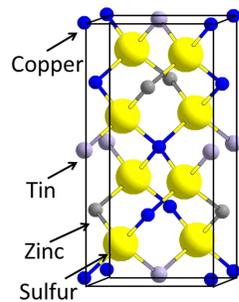


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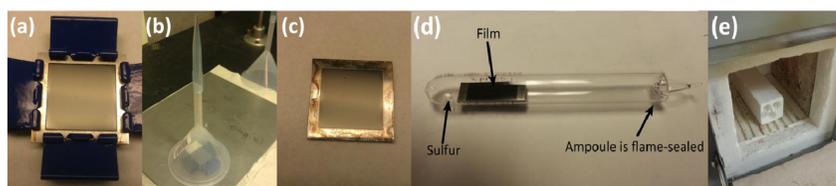
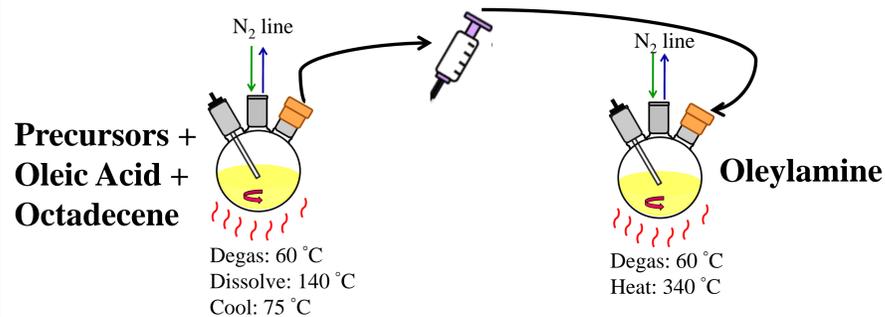
## Background

Copper-zinc-tin-sulfide (CZTS) is a new semiconducting material that is promising in the development of solar cells. Its component materials are nontoxic, abundant, and inexpensive to process. This project examines processing conditions such as temperature, time, pressure, and substrates, and their effects on the properties of the CZTS films.



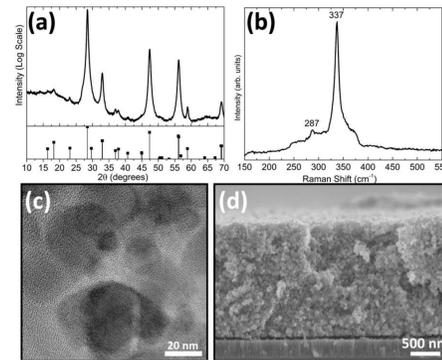
## Procedure

### Precursors



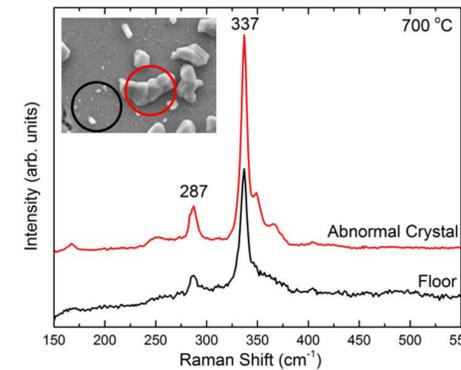
(a) Drop cast films (b) Drying (c) Remove frames after dry (d) Seal in vacuum tube with sulfur (e) Anneal

## Results



### Elemental Composition (%)

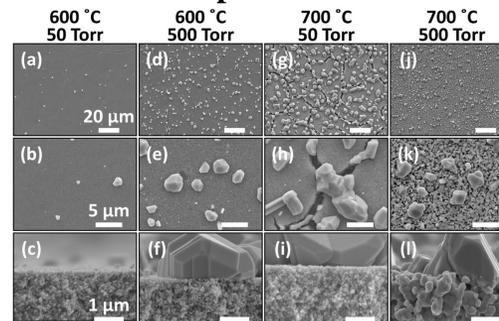
Cu	Zn	Sn	S
25	12	13	50



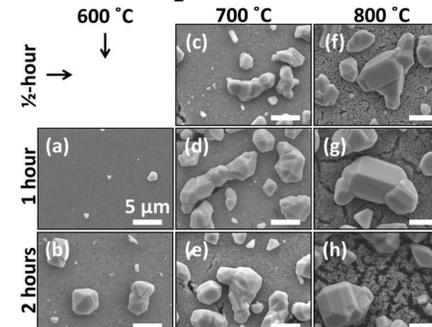
Raman spectroscopy measurements on different-sized grains shows that both are CZTS.

X-Ray Diffraction, Raman Spectroscopy, and Scanning Electron Microscope techniques confirm that the material is CZTS.

### Sulfur Pressure and Temperature Dependence

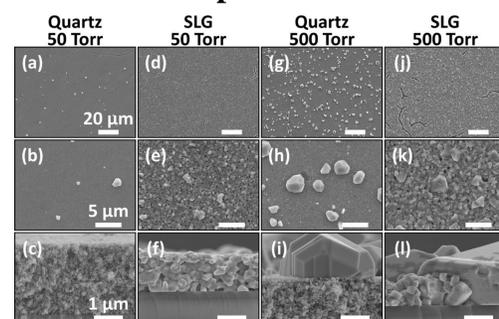


### Temperature and Time Dependence



Larger grains are composed of a single crystal and better conduct electric current to increase solar cell efficiency. Processing conditions that produce larger grains include longer annealing time, higher temperature, higher sulfur pressure when annealing, and the use of soda lime glass substrate.

### Sulfur Pressure and Substrate Dependence



## Future Goals

Among the ongoing experiments in this project, annealing with selenium vapor has been giving better results (i.e. more uniform microstructure). Thus, we plan to further investigate the effects selenium on the films. We would also like to begin taking the next step of this project by constructing a complete solar cell from the base films we have created, as we had done once in the picture below. Thus, we will apply the results from our examination of the CZTS itself to optimizing a viable source of energy.



## Acknowledgements

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## References

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- B. B.D. Chernomordik, A.E. Beland, N. D. Trejo, D.D. Dong, A.A. Gunawan, K. A. Mkhoyan, and E.S. Aydil, *J. Mater. Chem. A*, Submitted (2013).