Cadmium Telluride Photovoltaic Cells

Elaine Smith

Supervised By: Kevan Cameron, Amit Munshi, Sampath Walajabad

Department of Mechanical Engineering

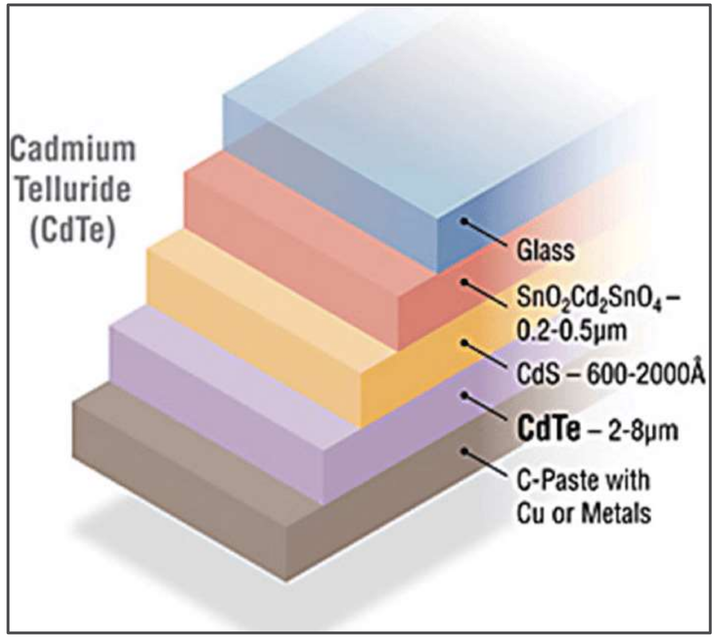
Colorado State University, Fort Collins, CO, USA

Background, Introduction, & Motivation

We live in a world run by fossil fuels, a state which cannot be maintained. While there are many renewable energy options, solar power is one of our safest and most promising– and in the world of solar energy, efficiency is key.

Renewability is an aspect of science that is important to me personally. In the past I have worked with freelance designers working on energy efficient and affordable housing, which runs on solar. That is why I chose to work with Sampath in the Cadmium Telluride Photovoltaic lab. Based on current research CdTe cells are the most efficient at converting solar energy into electrical energy, with a record of 22.1% conversion efficiency, and normal rates around 20%[1]. This efficiency allows for a quicker energy payback time – and if used in bulk carbon emissions can be lowered very quickly with less energy deficit issues related to switching energy sources[2].

Additionally, these cells have a smaller carbon footprint than more commonplace silicone-based cells[2], which adds to their appeal.



https://www.nrel.gov/pv/cadmium-telluride-solar-cells.html

Methods & Experimental Setup

Figure 1. ARDS deposition chamber

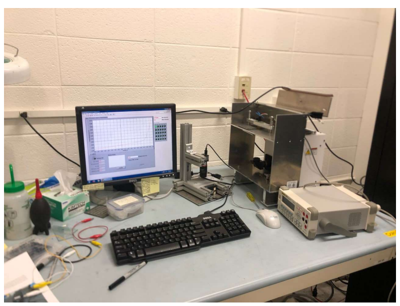


Figure 2. JV testing station

To make a substrate to test:

1. Clean and dry glass.
2. Place glass in the MZO sputtering chamber and sputter MgZnO onto glass.
3. Move glass to ARDS deposition chamber and deposit materials such as CdTe, CdS, CdCl and others
4. Transfer the glass to the copper tool and deposit Cu onto glass, to act as the electrical contact.
5. Transfer the glass to the painting booth and paint a layer of specialized carbon paint followed by a layer of specialized nickel paint—forming the back of the electrode.
6. Transfer glass to the mechanical etching room and use 100-micron silicon pieces to etch squares into the substrate.
7. Using a soldering iron, solder indium into the newly etched grooves.
8. Transfer substrate to JV testing station & test efficiency.
9. Repeat.

Figure 3. Mechanical etching station

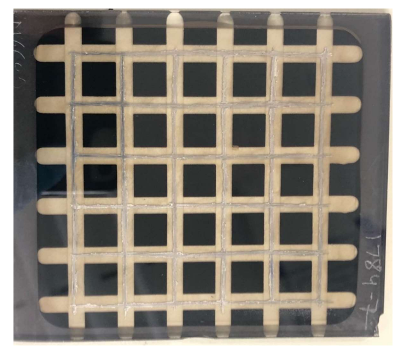


Figure 4. A completed substrate

Results

Current density vs. voltage (JV) curve for a CdTe cell:

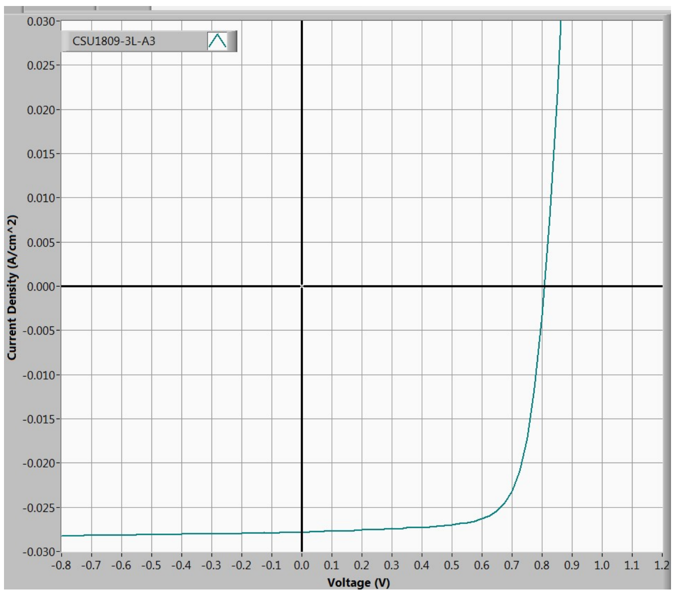


Figure 5. JV Graph for a typical CdTe cell.

Voltage at Open Circuit – Output of the Cell With No Connection.

Current Density at Short Circuit – Max. current Produced by the cell.

Fill Factor – Theoretical Maximum Power

Cell Efficiency

Cell Surface Area.

Cell Identifying Information

Run Numb	Plate I	Devi	Timestamp	Voc	Fill Fact	Jsc	Efficien	Cell Area
				[mV]	[%]	[mA/cm	[%]	[cm^2]
CSU1809	3L	A3	4/6/2021 3	808	73.9	27.8	16.61	0.640

Figure 6. Typical JV numbers for a CdTe cell.

Discussion & Next Steps

The research I have been privileged to be able to work on will continue long after I am gone. The point of this research is to continue increasing the efficiency and decreasing the production cost of CdTe thin film solar panels.

The next steps for this research are to continue to try new combinations of thin film materials, and continue to refine the deposition process.

Conclusions

CdTe thin film technology is a relatively new solar technology. It is viable on the current market, and new advances in the lab will only make it more competitive.

The path to healing the planet is through solar technology, and the path to better solar technology is through labs like this one. I am very privileged to have seen this research process up close and personal, and I am excited to see where this technology goes.

SURE Experience & Benefits

This experience has been my first time working at a lab and I have found it to be a very educational 4 months. I am extremely grateful to the SURE program for their help, for without their support funding I would not have been able to secure this internship.

My time at the lab has greatly developed my drive to succeed, I believe because I was the only undergrad working at the CdTe solar lab for most of this semester. While a lot of pressure on myself, it has been greatly beneficial to me.

Additionally, working here has strengthened concepts that I learn in my lectures, as I then get to apply them in a laboratory setting. For example, after my introduction to JV curves, I learned that we use them in-house to test the efficiency of our cells.

Also, the people working here are absolutely phenomenal coworkers! Thank you so much to them!

References & Acknowledgements

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[1] *"First Solar Builds the Highest Efficiency Thin Film PV Cell on Record" firstsolar.com. Archived from the original on 2014-09-09. Retrieved 2014-08-25.*
[2] de Wild-Scholten, Mariska (2013). "Energy payback time and carbon footprint of commercial photovoltaic systems". *Solar Energy Materials & Solar Cells*. 119: 296–305. doi:10.1016/j.solmat.2013.08.037
[3] https://www.nrel.gov/pv/cadmium-telluride-solar-cells.html

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Thank you

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