ESRP: Study of Perovskites as a Possible Solar Cell Material, Focusing on Advantages and Disadvantages

Oluwabusola Alabi[1], Claire An[1], Lillian Borbas[1], Patrick Flores[1], Annalise Pitt[1], Austin Rivera[1], Kaylnn Rivera[1], Ghada Ali[1], and Dr. Luca Rebuffi[2]

[1]Romeoville High School, Romeoville 60446
[2]Advanced Photon Source, Argonne National Lab, Lemont 60439

ABSTRACT

Perovskites are one of the most promising photovoltaic cells. Even though Perovskites are 23.7% efficient, which is very close to a silicon solar cell's efficiency of 25%, they are much cheaper to produce, lighter, greatly flexible, and may be spray painted on surfaces. It has been predicted that perovskites play a critical role in next-generation lasers, sensors, and electric vehicle batteries. However, they are only effective for a short amount of time as they are sensitive to heat, oxygen, UV, and moisture. Scientists today are still studying ways to slow the degradation and strengthen the stability of perovskite cells to produce longer lasting, more durable solar cells. In this research, we explored DSSC's and perovskites.

MOTIVATION & FUTURE OUTLOOK

- More efficient, sustainable, cheaper source of energy is needed.
- Silicon solar cells can last up to 25 years, costly to manufacture, & produce greenhouse gasses.
- Perovskites can last up to a month, much cheaper to manufacture, and highly flexible (figure 1).

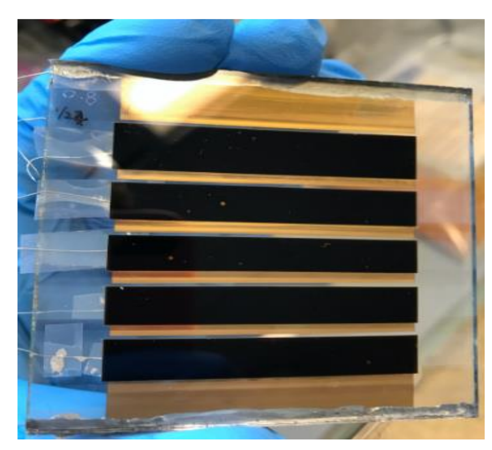

Figure 1: Perovskite Cell

EXPERIMENT OVERVIEW

DSSC

- TiO_2 mixed with citric acid, sonicated and coated on the photoanode of ITO glass & silicon substrate, annealed on a 450℃. Paste thickness was varied.
- Photoanodes were soaked in hibiscus tea or blueberry juice for various times.
- Iodine, potassium iodide, & ethylene glycol were mixed to form an electrolyte.
- Counter electrode was coated with graphite using a candle flame.

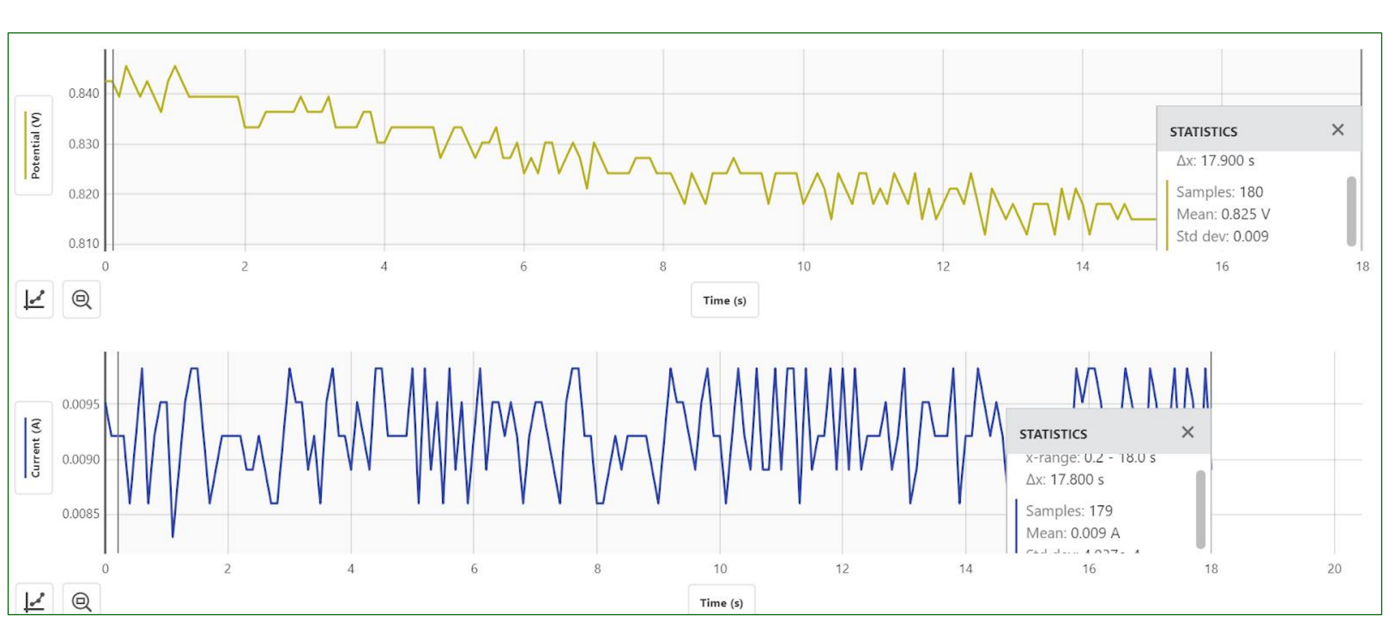

Figure 2a: Voltage and current reading of an ITO cell in hibiscus tea

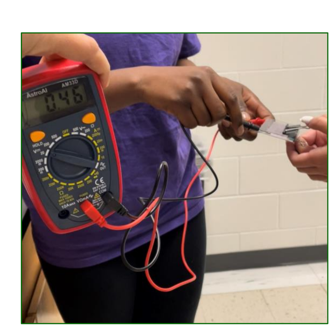

Figure 2b: ITO cell voltage

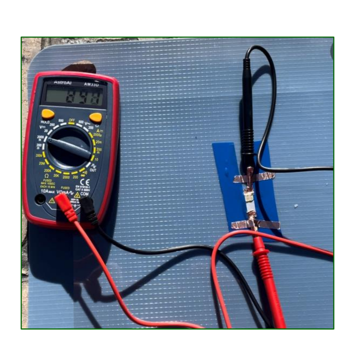

Figure 2C: Si cell voltage

Perovskite Solar Cell

- A voltage bias was introduced to a perovskite cell in a scanning tunneling microscope. We examined the emission of electrons and collected the voltage-current data as seen in figure 5.

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DATA

Sample #	Voltage (V)	Current (Amp)	Area (m^2)	Efficiency (%)
1	0.102	0.025	0.0036	1.18
2	0.092	0.018	0.0035	0.81
3	0.250	0.045	0.0048	3.9

Figure 3: Blueberry DSSC's Efficiency

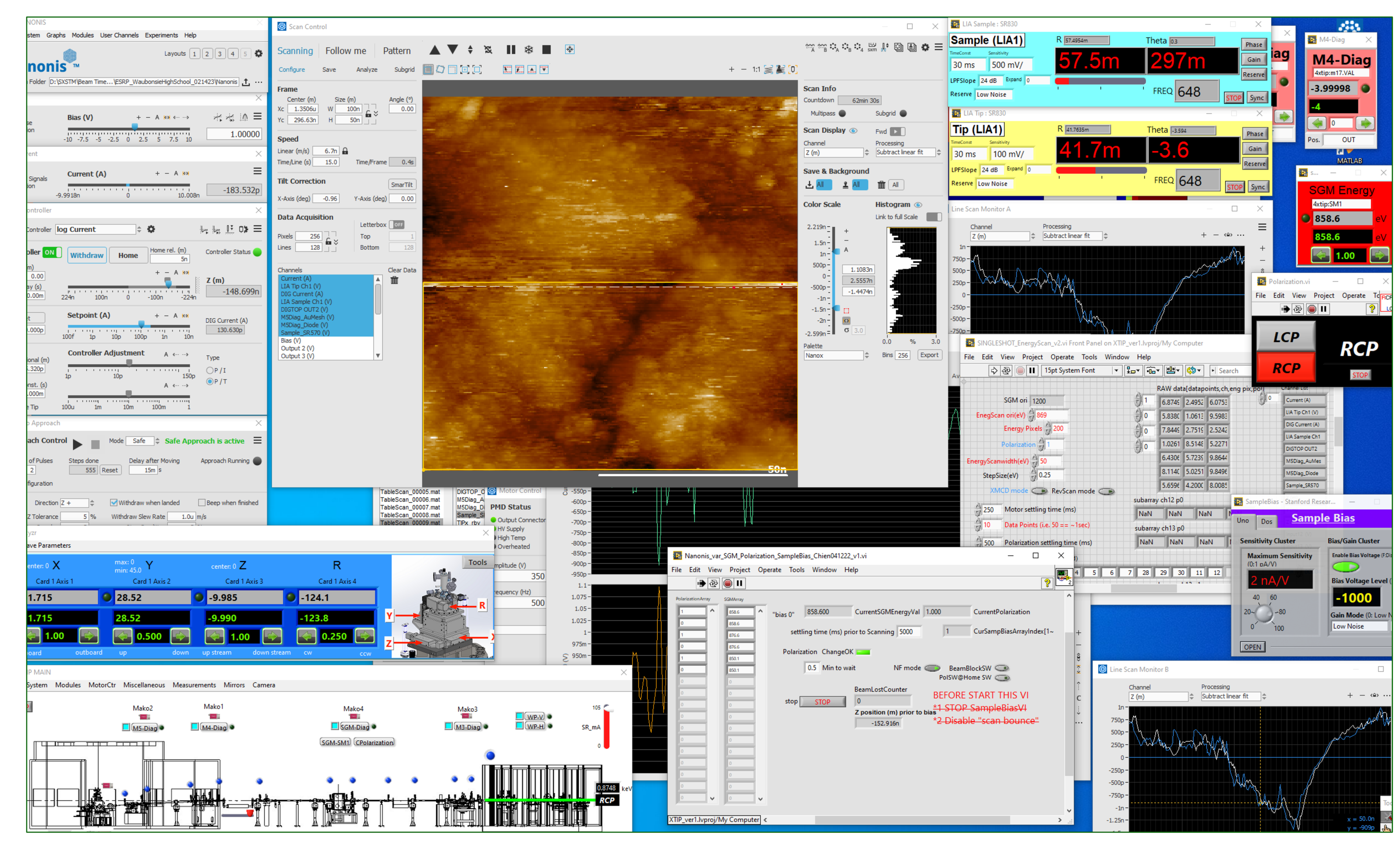

Figure 4: Scanning tunneling microscopy for a perovskite cell analysis

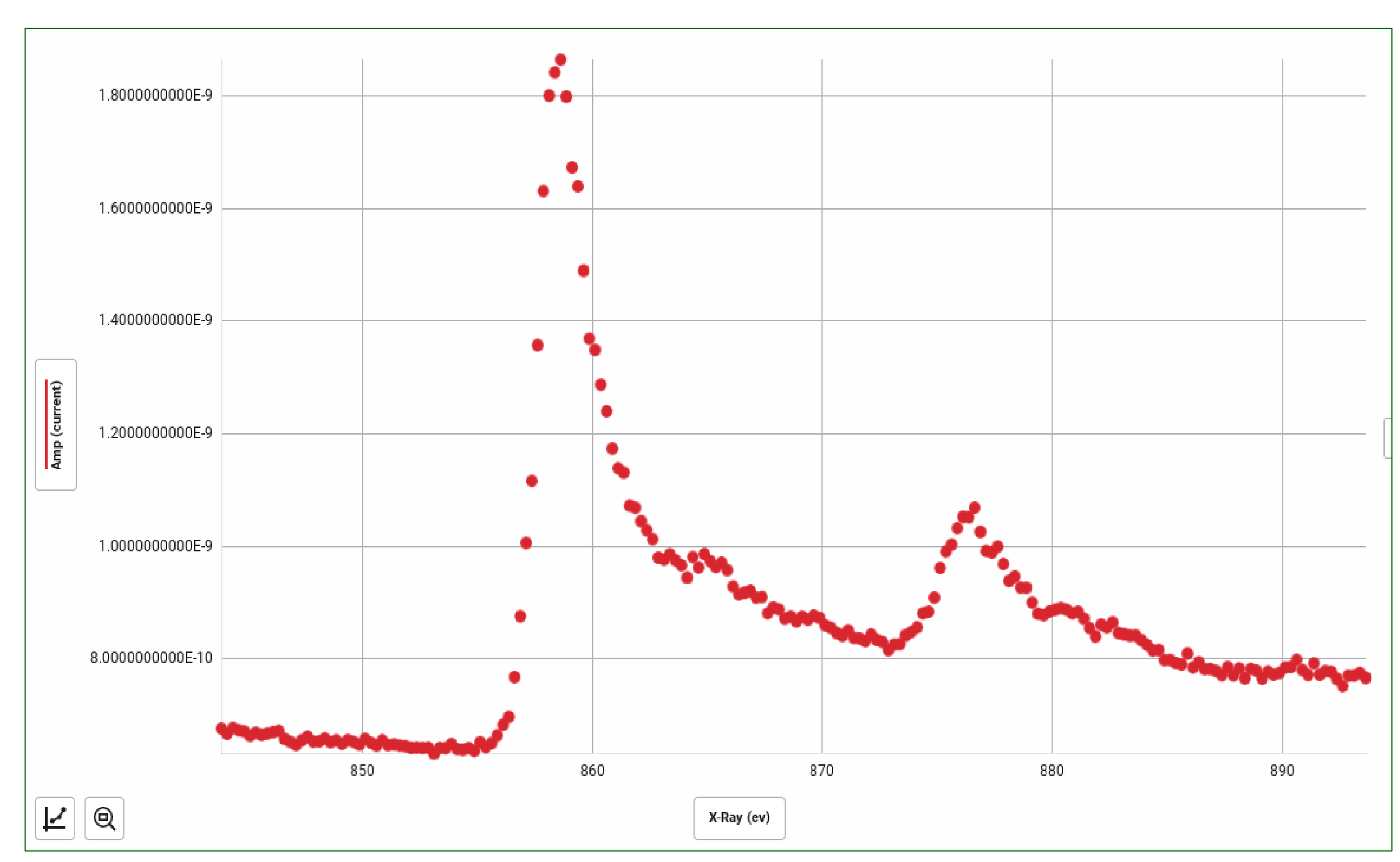

Figure 5: Voltage bias vs. current produced by a Ni electron

TAKEAWAYS

- DSSC's were easy to manufacture, unstable, with efficiency dependent on surface area as shown in (figure 3), soaking time, and dye. Voltage produced varied inversely with the thickness of TiO_2 paste. A longer soaking time was needed. Blueberry worked best.
- A voltage bias of 855 eV was introduced to release a Ni core electron to produce maximum current.
- Perovskites have a narrow energy band gap making them much more promising than silicon cells at about the same efficiency. Further research is needed to manufacture a more stable cell.

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