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Analyzing Data of Thin-Film Photovoltaic Cells

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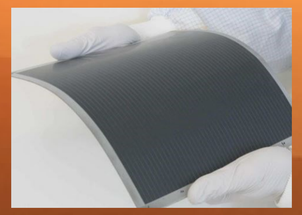
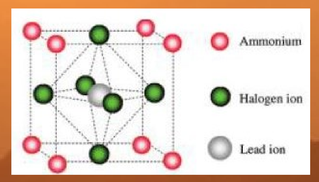
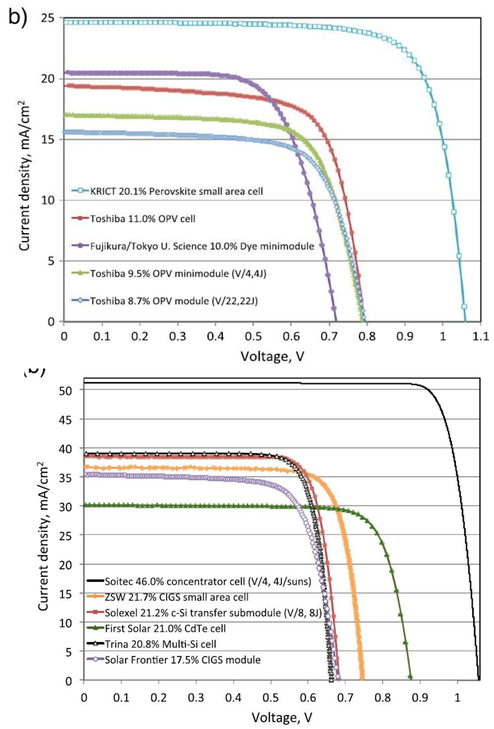
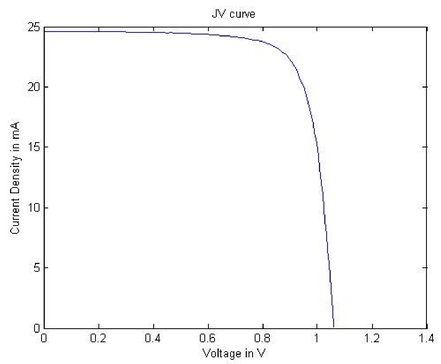
Introduction

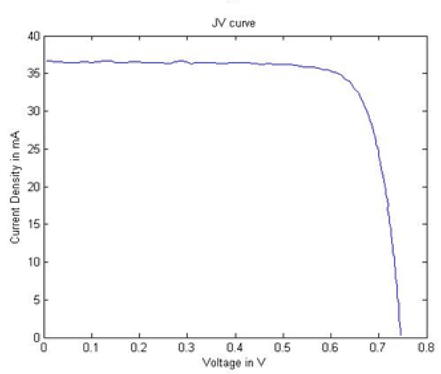
The purpose of this study is to determine the basic device characteristics from the Current-Voltage curve of perovskite photovoltaic cells. Martin Green's "Solar cell efficiency tables (Version 45)" highlighted the accomplishments in photovoltaic cell research for the year 2015. One notable achievement was done by KRICT using perovskites to achieve a 20.1% efficiency. According to Wall Street Journal article "Perovskite Offers Shot at Cheaper Solar Energy", Ulicia Wang (2014) reports that perovskites have "achieved a jump in efficiency to 20% from around 10% just two years ago."











Parameter	KRICT	Test 1	ZSW	Test 2
MP (Max Power)		20.04 mW		21.66 mW
V_{mp} (Voltage at Max Power)		0.88 V		0.64 V
J_{mp} (Current Density at Max Power)		22.65 mA		33.94 mA
V_{oc} (Open-Circuit Voltage)	1.059 V	1.059 V	0.7963 V	0.745 V
J_{sc} (Short-Circuit Current Density)	24.65 mA	24.65 mA	36.59 mA	36.63 mA
FF (Fill Factor)	77.0%	77.0%	79.3%	79.3%
Efficiency (%)	20.1%	20.04%	21.7%	21.7%

Conclusions

Understanding and finding the parameters from the raw data will enhance the understanding of future efficiency testing. Photovoltaic cells have a few distinct parameters that characterize how well it will function once the material and processing has been accomplished: light shunt resistance (LR_{sh}), series resistance (R_s), maximum power (MP), voltage at maximum power (V_{mp}), current density at maximum power (J_{sc}), open-circuit voltage (V_{oc}), short-circuit voltage (J_{sc}), fill factor (FF), and efficiency.

With promising results from the MATLAB program, further studies can be done using this program to analyze data for future experiments. These experiments involve a long-term study of measuring the change in the J-V curve at a set temperature, humidity, and solar irradiance Future work will include implementation of the code developed in MATLAB for data analysis and testing both perovskite and CIGS solar cells for long-term power conversion efficiency.

Method and Materials

Looking at the data resulting can be a daunting task, but with the use of the software *MATLAB*, analyzing is made much simpler. For PV cells, many parameters must be calculated for to understand it's properties: Max Power (MP), Voltage at max power (V_{mp}), Current at max power (J_{mp}), Open-Circuit Voltage (V_{oc}), Short-Circuit Current (J_{sc}), Fill Factor (FF), Light Series Resistance (LR_{series}), Shunt Resistance (R_{shunt}), and Efficiency.

Results

The *MATLAB* program had an efficiency of 20.04% for KRICT while Green's chart showcased 20.1%. Using the formula, with the theoretical being 20.1 and the experimental being 20.04, the percent error was 0.30% away from the nominal reading that Green has. ZSW experimental result was 21.7% which is right on nominal.

Similarly, the values of V_{oc} when compared to Green's table for KRICT was 1.059 V compared to 1.059 V, respectively. ZSW had 0.745 V compared to 0.7963 V which resulted in 6.44% error, but the nominal value itself does not match with its graphical representation in Figure 7.

The J_{sc} for KRICT had an experimental value 24.65 mA compared to Green's 24.65 mA; the percent error was nominal. ZSW had 36.63 mA compared to 36.59 mA; the percent error was 0.11%.

The final comparison, FF, KRICT had an experimental value 77.0% with Green's 77.0%. ZSW had 79.3% compared to 79.3%. Both results were nominal.