Sn based Perovskite Solar Cell

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Introduction

The demand of renewable energy resources due to the degradation of fossil fuel has led researchers to focus on solar energy. A solar cell is a device which converts light energy into electrical energy. Perovskite solar cells are just one of many types of solar cells currently being tested for application. However, most of these perovskite contain lead, which is a toxic material, and this can lead to various health hazards. Therefore, there is a need for research in non-toxic lead free perovskite solar cells. This leaves researchers with two primary forms of perovskite material: Tin-based perovskite or Bismuth (III) based perovskite.

Variable	Chemical Type	Examples
A	Organic cation	Methylammonium, Formamidinium
B	Divalent metal ion	Lead, Tin, Bismuth (III)
X	Halide ion	Iodine, Bromine, Chlorine

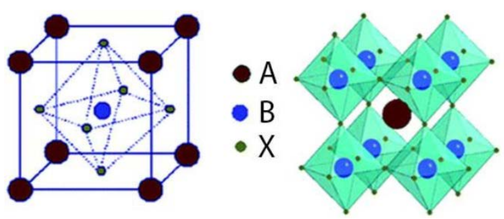

Figure 1: Perovskite concept development and selection.

For this research, the fabrication and testing will be done with a Sn based perovskite solar cell. Sn based HPSC have excellent optical and electrical properties. Furthermore, Sn based perovskites have a broader temp range of up to 200 °C.

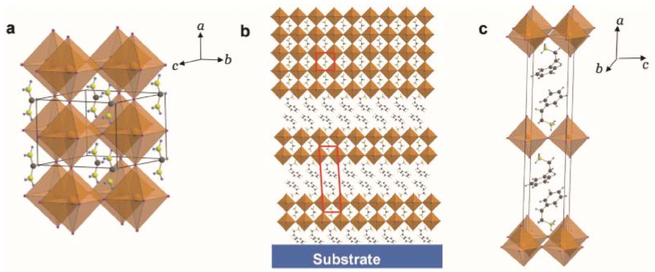

Figure 2: a) 3D reference FASnI3, b) 3D/3D mixture with a unit cell outlined in red, c) 2D PEA2SnI4.

Acknowledgements

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Abstract

The purpose of this project is to focus on the understanding and implementation of a lead-free hybrid perovskite solar cell. A solar cell is a photovoltaic cell, which converts light energy into usable electrical energy. The solar cell presents a valuable source of future energies. Lead based perovskite solar cell have exhibited prominent results. But due to their unstable nature and toxicity, there has been a development of lead-free organic-inorganic halide perovskite solar cell. Therefore, they are the center of research in the market of renewable energies. Ideally, a renewable energy source must be atmospherically stable and non-toxic. This concept of atmospherically stable and non-toxic has led us to incorporate the materials which are both non-toxic in nature and present a more atmospherically design. This design efficiently integrates the perovskite crystalline structure which constructed by using the properties of Phenylethyl ammonium Formamidinium Tin Iodide $PEA_2FA_{24}Sn_{25}I_{76}$. Among the various alternatives to lead, Tin (Sn) Posses great potential in the form of HPSCs perovskite material as it displays excellent optical and electrical properties. Recently, tin based HPSCs have displayed a commendable PCE (Power Conservation Efficiency) of 9%. The device will be fabricated defining the layers from Front to back as FTO coated glass/ TiO_2 Blocking layer/ TiO_2 Compact Layer/ $PEA_2FA_{24}Sn_{25}I_{76}$ Perovskite layer/ CuO2 Hole Transfer layer/ Cu Backing layer. The fabricate layers will be analyzed via SEM, Profilometer, UV Spectrometer, IV characteristic machine and Impedance analyzer for the surface topography, microstructure, thickness, efficiency, conductivity and stability. The fabricated device will also be tested for degradation of the different layers as well as the perovskite layer.

Procedure

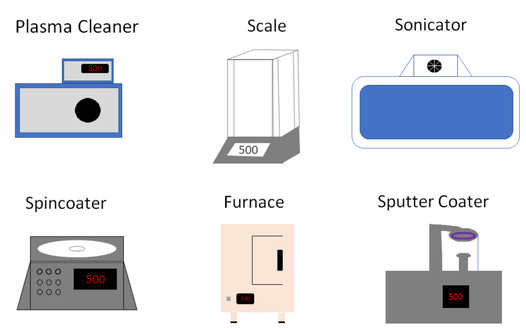

Figure 3: : Procedure flow chart legend

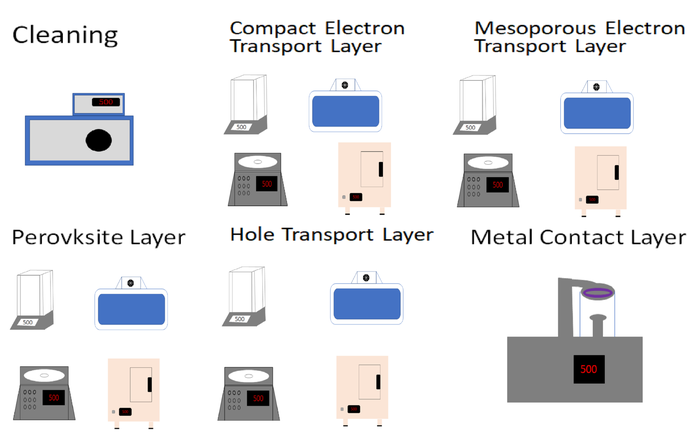

Figure 4: Procedure flow chart. Procedure for the Hole Transport Layer subject to change

Testing Procedure

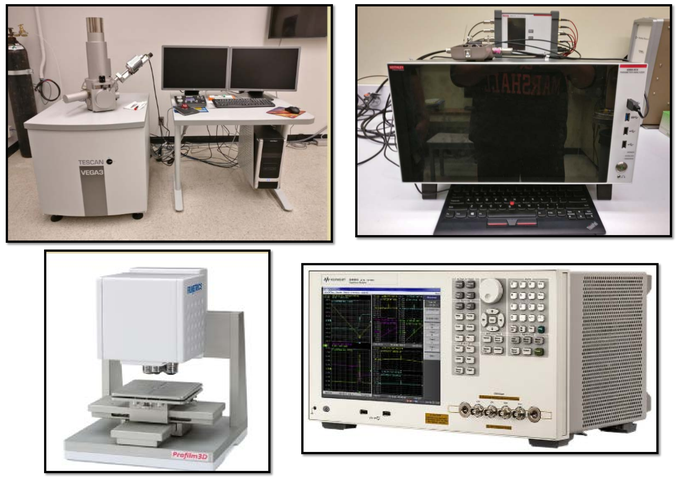

Figure 5: (1) Scanning Electron Microscope (SEM), (2) IV Testing, (3) Profilometry, and (4) Impedance analysis.

Solar Cell Design

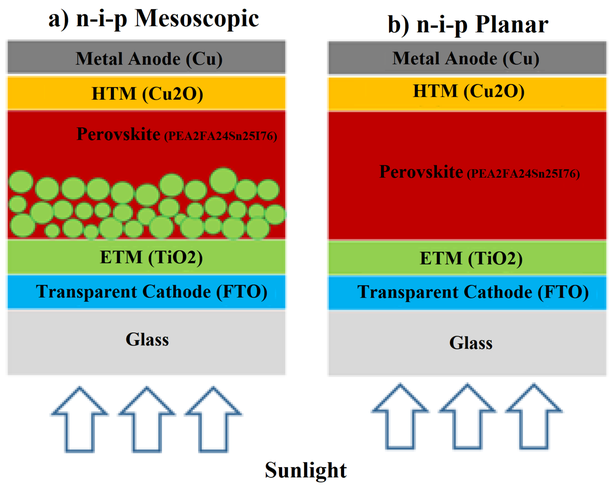

Figure 6: Lead Free Hybrid Formamidinium Tin Iodide Perovskite Solar Cell

Conclusion

Over the following months, the solar cell design will be finalized, and pre-alpha prototyping will begin. Plans have also been made to allow time to optimize the design before extensive testing begins. Consistency, accuracy, and precision will be crucial to the success of this project in order to allow for further research and replication.

2018