CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

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Project Number

36751

Project Title

The Effect of Chloride Ion Concentration in Organolead Halide Perovskite Crystal Based Solar Cells

Abstract

Objectives/Goals

The purpose of this research project is to investigate the formation of perovskite crystals from a variety of precursor solutions and their respective semiconductor properties. Although many of the highest efficiencies have been achieved in technical labs with solar cell areas much too small to be practical, the goal of this project was to create low grade cells with greater surface area to experiment with different crystal combinations and test relative efficiencies. In addition, tandem (stacked) cells were constructed by combining perovskite cells with commercial silicon-based solar cells to improve total efficiency.

Methods/Materials

Formamidinium lead halide perovskite crystals with a 2-to-1 molar ratio iodide to chloride ions were used as a control. The cells were then modified with different chemical compositions in an attempt to achieve higher output voltages. For this research the molar ratio of chloride and iodide ions in the perovskite precursor solution was altered to achieve crystal structures with different band gaps. The more chloride, the higher the band gap. To test the cells in a controlled environment, the cells would be exposed to equal amounts of light and their voltage could be measured.

Results

During this project, a perovskite crystal based solar cell was constructed with an output voltage of up to 520 millivolts, comparable to traditional silicon solar cells. However the internal resistance of the cells was much too high to produce any sort of usable current or measure any reliable total efficiency. Interestingly, the experiments where molar concentrations of solutions was altered suggested that a two to one ratio of formamidinium chloride (FACl) to lead (II) iodide produced the semiconductor crystals with the highest output voltage. Additionally, the perovskite crystal solar cell was used successfully in improving the overall voltage of a silicon and perovskite tandem cell.

Conclusions/Discussion

The studies showed that rudimentary perovskite crystals could be fabricated at low cost with basic laboratory equipment that give an indication as to which precursor chemicals and concentrations serve as best recipes for final semiconductor crystals. Additionally, the studies show that perovskite semiconductor layers with band gaps of increasing value could be applied to today#s silicon cells to improve overall efficiencies.

Summary Statement

I altered the light absorption properties of perovskite based solar cells through the use of varying precursor solutions.

Help Received

I built the cells in my high school fume hood. My teacher, Mrs. Messenger gave me advice on basic lab skills and techniques. I also had a couple of questions about perovskites answered from researchers Sameer Patwardhan of NorthWestern and Giles Eperon of Oxford.