NDnano Summer Undergraduate Research
2016 Project Summary

1. Student name: Charles Marchant

2. Faculty mentor name: Prof. Prashant V. Kamat

3. Project title: The Role of Methylammonium Cations in Perovskite Solar Cells

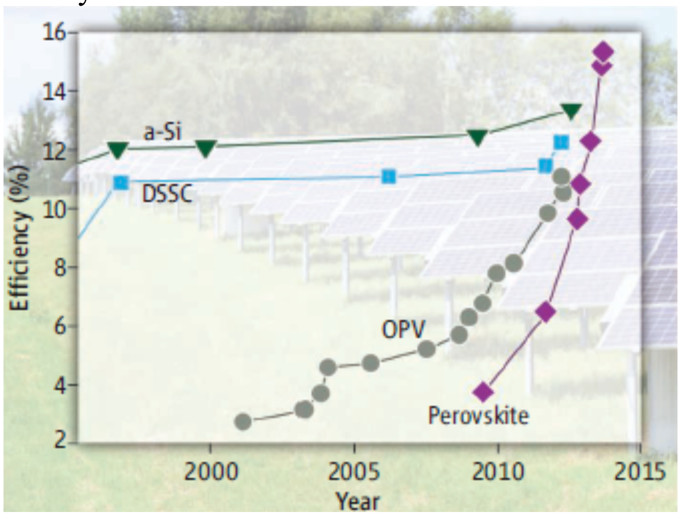
4. Briefly describe any new skills you acquired during your summer research:
Working in a research lab for the first time, I acquired many new skills and techniques. These include how to work in a glove box and how to manufacture solar cells by spin coating solutions onto glass. I also learned about how solar cells work and how to test their performances a lamp and filter to simulate solar light and a potentiostat to measure current and voltage. The experience was a fantastic chance to get to know life in a research environment and helped prepare me for the future.

5. Briefly share a practical application/end use of your research:
Perovskite solar cells are a promising type of solar cell which has a high rate of light to energy conversion, with a power conversion efficiency only 3% below standard silicon based solar cells in use today. As such it is expected that perovskite solar cells will be available commercially within the next decade. The research I have conducted here at Notre Dame is being continued after my departure.

Begin two-paragraph project summary here (~ one type-written page) to describe problem and project goal and your activities / results:

Over the past seven years, perovskite solar cells have emerged as one of the most exciting developments in solar cell technology. Since the first publication on the subject being published in 2009, with a power conversion efficiency of 3.8%, the technology has made a huge advancement, with a record of 22.1% power conversion efficiency being reported earlier in 2016. To put this in perspective, current commercial silicon based solar cells have a record of 25.2% power conversion efficiency, however that technology has been in development since the 1950s. such a large leap in efficiency in such a short time is truly superb.

Despite this, perovskite solar cells face significant challenges to commercial use. Firstly, the exhibit low stability under atmospheric conditions and degrade rapidly in the presence of water. Secondly, there is a lack of understanding of the fundamental processes taking place during the photoconversion process. The project I undertook sought to investigate the role that methylammonium cations play in $CH_3NH_3PbI_3$ perovskite. This was achieved by varying the amount of methylammonium iodide used in the synthesis of perovskite precursor solutions, and replacing lost iodide using LiI. The two most important findings were that the solar cell performance is affected dramatically by a change in methylammonium concentration, varying by as much as 10% power conversion efficiency, while a sharp increase in emission intensity is observed when the Pb:methylammonium ratio drops below 1:1. One possible reason for this is that the Li cation from the LiI used to replace iodide is being incorporated into the structure somehow, as a colleague of mine has repeated the experiment without using LiI, removing the increase in emission intensity.



Graph of advancement of different types of solar cells.

Publications (papers/posters/presentations):