Nanoelectronics Undergraduate Research Fellowship (NURF)
2010 Project Summary

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Project title: Developing an organic/inorganic "rainbow" solar cell

Presently, solar cells use inorganic materials which are expensive, inefficient, and too heavy for practical uses. This project strives to create an organic/inorganic hybrid solar cell that uses a hole-conducting polymer nanoparticles along with an array of sizes of CdSe-sensitized quantum dots. The main focus of the project is to be able to measure charge transport as a function of the domain sizes of both the polymer and the quantum dots. The goal is to create an ordered bulk heterojunction "rainbow" cell (see Figure 1) that will 1) absorb and convert a large fraction of light to electrical energy and 2) use environmentally benign solvents. Being able to control the nanoscale morphology of the polymer and quantum dots will allow us to be able to fabricate an ordered bulk heterojunction device that will hopefully be efficient and practical for large-scale uses.

This summer, I focused on synthesizing CdSe quantum dots in an aqueous environment. Normally, these dots are prepared using the modified Peng method which requires the use of harsh solvents and brutal conditions (must be brought to 300°C and kept under nitrogen). Also, the smallest size of dots this preparation can make is about 2.2 nm.[1] I was able to locate a paper by Park, et. al that claimed to synthesize extremely small (~1.7 nm) CdSe quantum dots in water at ambient conditions.[2] Not only was I able to successfully duplicate the results of the paper, but I was also successful at linking these aqueous quantum dots to titanium dioxide (TiO_2) in solution for use in a device, a step that to my knowledge has not yet been taken with these aqueous dots. The absorbance spectrum of these aqueous quantum dots shows the small size, as evident by the very sharp first excitonic peak at ~420nm (Figure 2).

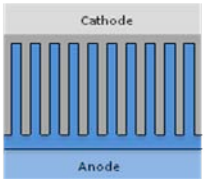

Figure 1: An ordered bulk heterojunction

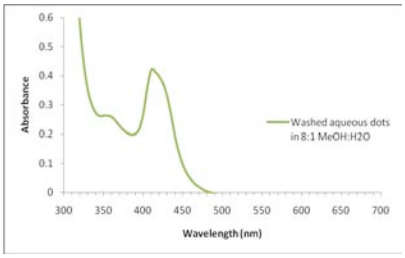

Figure 2: Absorbance spectrum of aqueous quantum dots

[1] Pen, Z.A., Peng, X. "Mechanisms of the Shape Evolution of CdSe Nanocrystals." *J. Am. Chem. Soc.* **2001,** 123, 1389-1395.
[2] Park, Y.-S., et. al. "Aqueous-Phase Synthesis of Ultra-Stable Small CdSe Nanoparticles." *J. Nanosci. Nanotechnol.* **2007**, *7*, 3750–3753.

No papers or posters were published within the 10 weeks since results were obtained towards the end of the fellowship, but several papers will be in the works this fall and will hopefully be published in the fall and winter of 2010.