ND*nano* Undergraduate Research Fellowship (NURF)
2011 Project Summary

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Project title: Graphene-based electrodes in Li-ion storage battery

This project broadly deals with the problem area of solar energy. Thus, we attempted to convert the energy of the sun into electrical energy in a way that is both more energy efficient as well as cost efficient than current energy sources. More specifically, I attempted to realize the potential of quantum dots in the making of solar cells. Quantum dots are theoretically great for making solar cells because of their high extinction coefficient as well as their easy size control. With this size control, it is also easy to control the range of wavelengths of light that the dots can absorb.

To achieve this goal, I attempted to make a rainbow quantum dot solar cell. A rainbow quantum dot solar cell contains layers of each size and color of quantum dot. By layering the quantum dots within the cell, we can take advantage of the quicker charge injection time of the smaller dots while also increase the range of wavelengths absorbed with the larger dots. The light will first hit the smaller, yellow dot layer, absorbing the highest energy wavelengths of light. Next the light will go through the orange layer, absorbing the lower wavelengths that passed through the yellow layer. Finally, the light will pass through the red layer, absorbing even lower energy wavelengths of light. I first attempted to layer the dots into the TiO2 though the use of Electrophoretic Deposition. Through this, I made some progress in learning which voltages and TiO2 thicknesses worked best for absorbing the most dots. However, I changed approaches to the making of a CdSe/TiO2 paste. For this paste, I synthesized CdSe/TiO2 quantum dots of three different sizes/colors: yellow, orange, and red. I suspended each color of dots in tertiary butanol and made each into a paste by adding both water and P25 TiO2. I then doctor bladed and annealed each paste onto an FTO, layering the pastes in the order of yellow, orange, and red. For comparison, I made a cell using three layers of red paste. The results were not as I was expectin. I would expect the rainbow cell to have a greater photocurrent than the triple red cell. However, as displayed below, the red cell performed better. I believe that this may be because the triple red cell absorbed more light in each layer than did the rainbow cell. Thus, I plan to continue with this project by increasing the number of dots in each color paste. Additionally, I would like to replace the ligands on the CdSe dots from TOPO to MPA, which should attach better to the TiO2 particles.

Figure 1:

Figure 2:

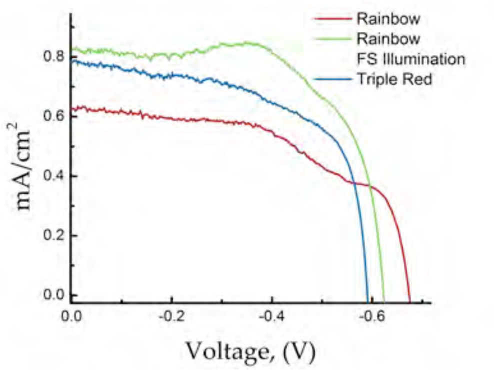

Figure 1 shows the IV curves for the rainbow quantum dot solar cell, the cell containing three layers of red CdSe paste, and a front side illumination of the rainbow cell.

Figure 2 is an image of the three pastes used to make the rainbow solar cell.