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

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Project title: Uranyl peroxide nanoclusters

One of the largest drawbacks of nuclear energy is the generation of large amounts of radioactive waste that is hazardous and very hard to be disposed. Currently, the United States has oriented its policy of nuclear waste disposal towards the usage of geological repositories. This method gets rid of fuel with 95% of UO_2, which has the potential of being recycled into fuel. The Burns' lab has focused its efforts on the nanocontrol of uranium and other actinides in an attempt to find an efficient and effective way to recycle and reprocess spent nuclear fuel. By controlling uranium and plutonium materials at a nano-scale, the separation of poisons and unwanted materials from spent fuel can become more efficient. This would mean not only a greener nuclear energy but a potentially cheaper as almost no fuel would be wasted.

Over the course of the summer, I worked in the incorporation of organic ligands into uranyl peroxide nanoclusters. My work primarily focused on the synthesis of these clusters. The synthesis was done by loading a solution using uranyl nitrate, hydrogen peroxide, a base, a ligand, an acid, and a salt into a 5ml glass vial. The crystals containing nanoclusters form from this mixed solution after several weeks at room temperature. Then crystals were isolated from their mother solutions, placed on cryoloop in oil, and cooled to 100K for data collection using a Bruker single crystal X-ray diffractometer. The structures of the nanoclusters can be resolved from the data. To obtain clusters with different size, structure, and solubility, several variables were controlled: the ligand used, the pH of the solution, the acid used, and the counterion present in solution by the use of different salts. Besides the production of new clusters, I also work on re-synthesizing previous clusters for further characterization of their chemical and physical properties.

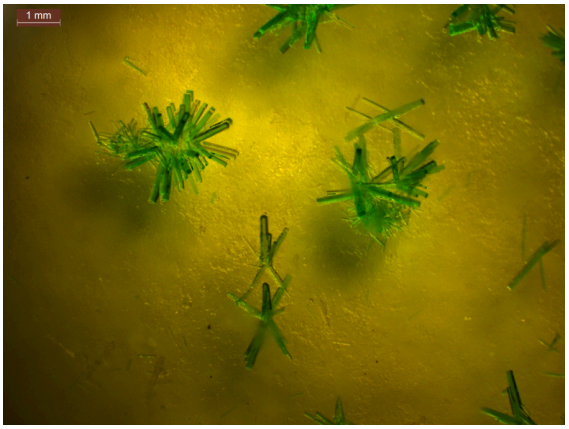

Figure 1. Image of a Crystal containing U_5-Citric, a uranium pentamer.

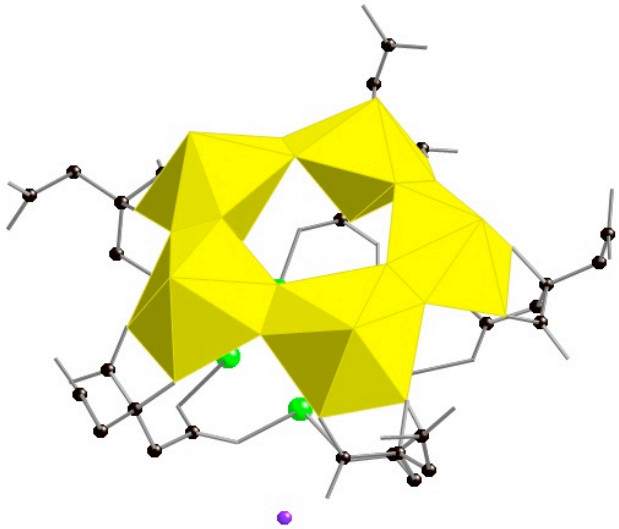

Figure 2. Structure of U_5-Citric. It contains 5 uranyl peroxide hexagonal bipyramids(yellow), silver ions(green), potassium ions(purple), and a citric acid ligand.

Works Cited:

Bruno, Jordi, and Rodney C. Ewing. "Spent Nuclear Fuel." *Elements* 2. (2006): 343-349. Print