

Betty A. and Donald J Baumann Family Scholarship Fund Application Form

1. Name and NetID

Eric Marsh – elm82217

2. Chemistry Faculty Research Director

Dr. Joel Destino

3. Title: Extraction and Analysis of Fluorescent Species in Glucose-Derived Carbon Nanodot Solutions

4. The proposal should be limited to about 500 words and may include a few figures as appropriate. Your proposal should briefly outline the overall project and its goal(s). If you have previous results related to your proposed project, concisely summarize these results and describe what you expect to accomplish during the time frame of this scholarship.

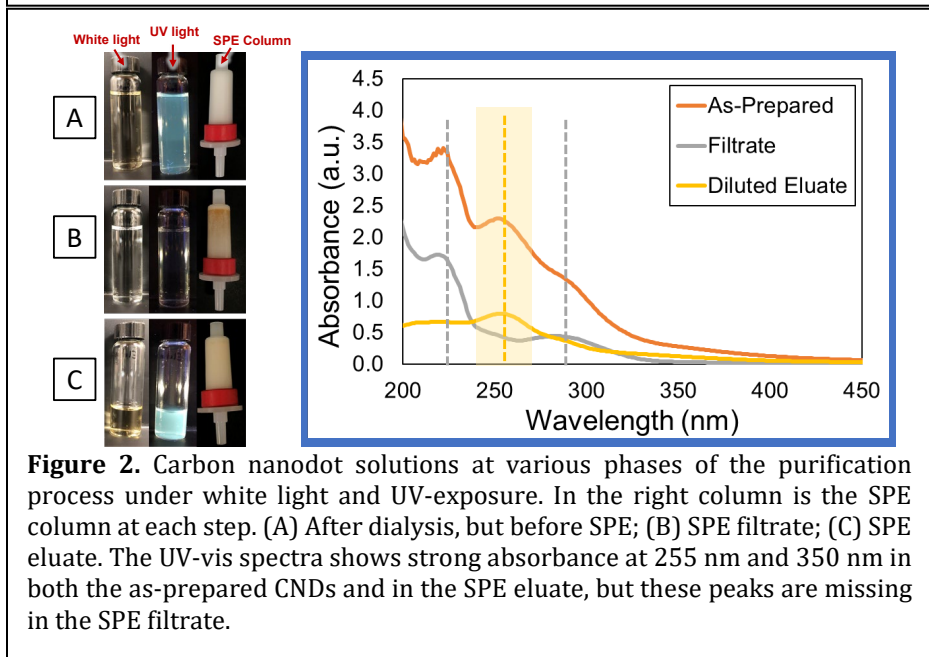
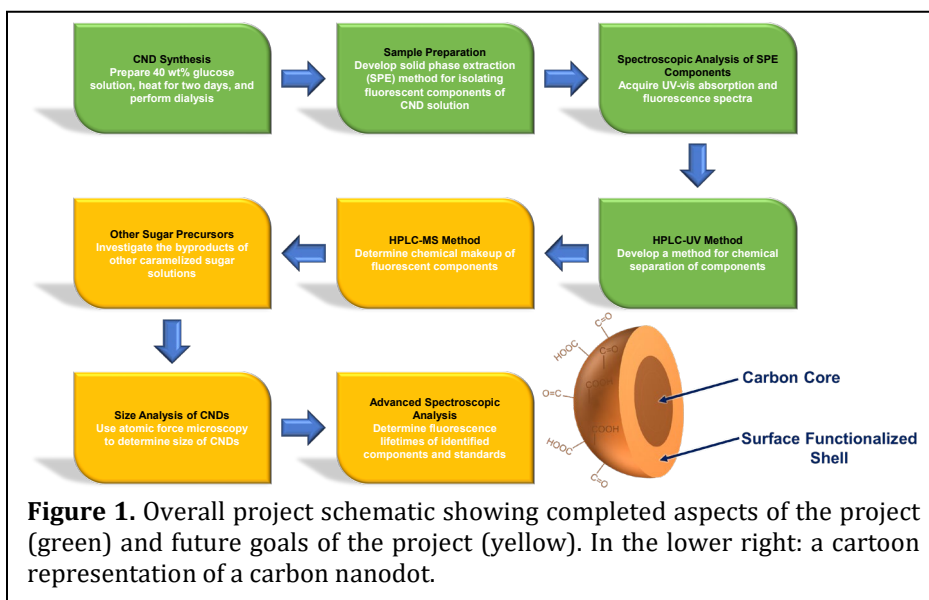
Over the past decade, there have been many publications that describe the preparation of fluorescent carbon nanodots (CNDs) in a fashion that typically involves the thermal or photochemical treatment of organic materials in aqueous solutions. CNDs are of interest because they are chemically inert, able to be surface functionalized, and have potential applications ranging from biochemical sensors to solar cells.¹ While many authors have formulaically shown the formation of UV-absorbing, blue-emitting fluorescent products by this method, there have been few reports attempting to purify and identify chemistry key to producing the fluorescent product(s). In fact, a lack of quality purification of CND solutions has been shown to limit the utility of previously published results.²

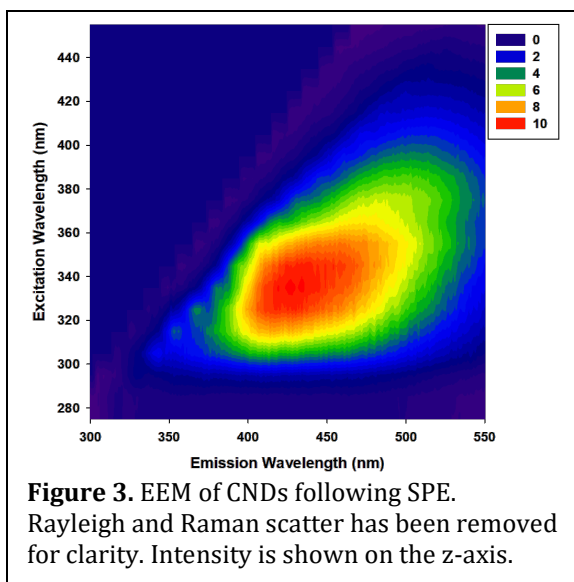
My previous work has focused on developing a purification method for CND solutions, studying the absorption and fluorescence properties of CNDs, and developing a HPLC-UV method for CNDs (Fig. 1). CNDs were synthesized by preparing a 40 wt% solution of glucose in water and cooking the solution for 48 hours at 120 °C. Following CND synthesis, the CND solution was dialyzed using 500 MWCO tubing. The dialyzed CND solution was then purified using a C18 functionalized SPE column. The effectiveness of SPE was determined by studying the absorption of CNDs before and after extraction (Fig. 2). As is shown, a major absorption band is present in the CND solution before SPE and after elution from the SPE column; however, this is missing from the SPE filtrate. We have also studied the fluorescence properties of CNDs using excitation-emission matrices (EEMs), giving us a sense of the fluorescence behavior of CNDs across an entire range instead of just at a select point (Fig. 3).

Following CND purification, HPLC-UV was selected as a chemical separation method for the fluorescent components of CND solutions. A C18 500 Å HPLC column

resulted in analyte elution within the dead time of the column. Now, with a C18 1200 Å HPLC column, decent retention and separation has been achieved. HPLC-UV method development is currently being finalized. Results from AFM, MALDI, and experimentation with HPLC column pore size indicate CND particles are between 1-2 nm in solution and just above the 500 MWCO.

During the timeframe of the Baumann Scholarship, the next steps of this project are to adapt the HPLC-UV method to HPLC-MS to determine the fluorescent component structures. Additionally, we would experiment with other sugar precursors to determine if CND formation can be generalized to other sugars and carbohydrates. Sugars of interest are fructose, galactose, sucrose, and maltose. Fluorescence and MS data will be used to compare the products of each synthesis.





References:

1. Markuson DiPrince, M.K., Uppala, H.G.K., Marsh, E.L., Smith, L., Destino, J.F., Sidebottom, D.L., Baruth, A.G. Implementing Glucose-Derived Carbon Nanodots in Dye-Sensitized Solar Cells to Increase Efficiency. *ACS Appl. Energy Mater.* In submission.
2. Essner, J., Kist, J. Polo-Parada, L., Baker, G. Artifacts and Errors Associated with the Ubiquitous presence of fluorescent impurities in carbon nanodots. *Chem. Mater.* **2018**, 30, 6, 1878-1887
5. Presentation of research results (past and future conferences, publications, seminars, etc.)

Presentations

- March 2020 – Pittsburgh Conference and Exposition (Pittcon)
 - o Chicago, IL
- August 2020 – CURAS SURF End of Summer Poster/Research Presentation
 - o Creighton University (Omaha, NE)
- February 2021 – CURAS Research and Scholarship Fair
 - o Creighton University (Omaha, NE)
- March 2021 – Pittsburgh Conference and Exposition (Pittcon)
 - o New Orleans, LA
- April 2021 – Creighton Honors Day
 - o Creighton University (Omaha, NE)
- TBA 2021 – St. Albert’s Day Research Symposium
 - o Creighton University (Omaha, NE)

Publications

Markuson DiPrince, Max K., Uppala, Harsh G.K., Marsh, Eric L., Smith, Logan, Destino, Joel F., Sidebottom, David L., Baruth, Andrew G. Implementing Glucose-Derived Carbon Nanodots in Dye-Sensitized Solar Cells to Increase Efficiency. *ACS Appl. Energy Mater.* In submission.

6. Post-graduate plans (job market, graduate school, medical school, etc.)

Medical School

7. Number of semesters completed in research, including the current semester (summers count as two semesters).

8

8. Anticipated graduation date:

May 2021

Applicant signature

Chemistry research director's signature