PRF Grant #57814-UNI7

Title: Characterization of Methacrylate Porous Polymer Monoliths for Use as Oil Sorbers

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During the past academic year (2017-18), two NKU undergraduate students worked on this project in the Daniels lab. One student was a junior (both Fall and Spring semester) and the other was a first year student (Spring semester). During the 2018 Summer semester, five undergraduate students worked in the Daniels lab. All were NKU students: one rising senior (full time), one rising junior (part time), and three rising sophomore (one full time and two part time). The list of summer students does include the students from the academic year. With the much appreciated help of the five students, the awardee was able to advance this project in two ways: (1) synthesize poly(ethylene dimethacrylate-glycidyl methacrylate) (PEDMA-GMA) and pH responsive poly(2-(dimethylamino) ethyl-methacrylate (PDMAEMA) porous polymer monoliths (PPMs), and (2) characterize the methacrylate PPMs via Scanning Electron Microscopy (SEM). The advancements from this portion of the project will be used to advance the final prong in the last year of the award. The last objective is to obtain and analyze the behaviors of 8 analytes in a selected solution via Capillary Electrochromatography (CEC).

The first prong of the project was a wrought with hurdles. The synthesis of PEDMA-GMA was a very straightforward process and produced many different fabrications of PPMs, as detailed in the following section. However, the synthesis of PDMAEMA did not result in the same near effortless process. Much of the summer was spent researching and adjusting the conditions and parameters of the synthesis of this PPM (Figure 1). Promising progress was made (Figure 1, 219 and 221); the remainder of the academic year (2018-19) will focus on honing in on the parameters that produced monoliths that could potentially be cast into capillaries with micron diameters.

The second prong was characterization of the PPMs via SEM (Figure 2). This is still underway as the students continue to work with the SEM technician to acquire quality images of the PPMs. At least 8 different PEDMA-GMA PPMs were fabricated. Fabrication alterations included the use of different porogens, which are the compounds that allow the PPM to be more or less porous. The porogens incorporated into the PPMs were propanol, hexanol, octanol, and dodecanol. Fabrication alterations also included the changing of the ratio of the stimuli-responsive monomer to the non-stimuli responsive monomer; 75:25, 25:75, and 90:10 were explored. This allowed the discovery of a suitable ratio that will not destroy the PPM in the event of extreme environments (very high or low pH, for instance).

The American Chemical Society Petroleum Research Fund was extremely helpful in allowing the awardee to focus on undergraduate research opportunities and furthering foundational scientific knowledge. Work on these projects continues with a total of three undergraduate NKU students. Dissemination of these accomplishments has already taken place (August 2018, “Heather Bullen Research Celebration”, Northern Kentucky University, Highland Heights, KY 41099). More opportunities are being planned; the nearest opportunity will be the Kentucky Academy of Sciences Meeting in early November. Other regional opportunities in the Spring and Summer semesters will be taken advantage of.

Figure 1: Polymer 218-221. Polymers 219 and 221 were successful and fully polymerized. These spent six days in a 90 degree Celsius water bath. 70% DMAEMA:Styrene, all containing 5000 MicroL of propanol casting solution. 218's casting solution contained a 2.5mM dibasic sodium phosphate buffer that was made through dilution of a more concentrated allocate. 219 and 221 were made of 2.5 dibasic and monobasic (respectively) sodium phosphate buffers.

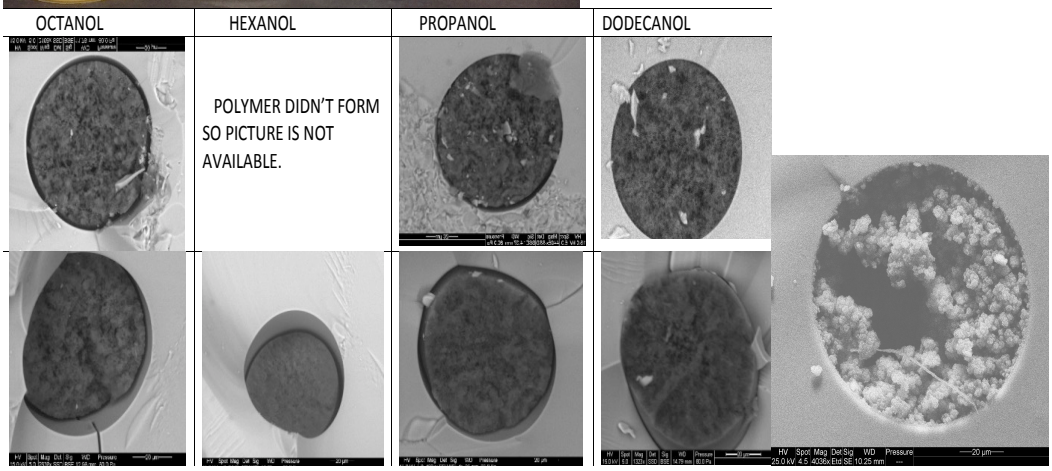

Figure 2: The diagram above is a collection of cast polymers. The top row is 75:25 GMA:EDMA and the bottom row is 25:75 GMA:EDMA. The columns, from left to right, depict the polymers cast with porogens of octanol, hexanol, propanol, and dodecanol.
polymers. The top row is 75:25 GMA:EDMA and the bottom row is 25:75 GMA:EDMA. The columns, from left to right, depict the polymers cast with porogens of octanol, hexanol, propanol, and dodecanol. The additional image to the right of the 4x2 table is the 75:25 GMA:EDMA with hexanol porogen that was able to polymerize at a later date.