

QUARTERLY PROGRESS REPORT

February 26, 2018 to May 25, 2018

PROJECT TITLE: Removal of Heavy Metals from Landfill Leachate using Polyelectrolyte Complex Membranes

PRINCIPAL INVESTIGATOR(S):

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COMPLETION DATE: November 30, 2018

PROJECT WEB SITE: <http://www.cece.ucf.edu/sadmani/>

Work accomplished during this reporting period:

Fabrication of nanofiber membranes via electrospinning (Pertinent to Task 1 of research objective – membrane fabrication will be carried out throughout the entire research study)

Nanofiber membranes (NM) are fabricated from polyelectrolyte complex solutions via electrospinning to investigate heavy metal removal from landfill leachate. For this purpose, homogeneous polyacrylic acid (PAA)/polyallylamine hydrochloride (PAH) complex solutions are produced by dissolving PAH into 25% PAA aqueous solutions at different molar ratios of (2:1, 4:1, and 8:1). We will continue to optimize and fine-tune the fabrication process.

In addition, the PAA/PAH fibers were functionalized with dopamine. Dopamine contains amine and catechol functionalities that are capable of scavenging metals. This was done as a contingency plan so that if the PAA/PAH fibers do not bind strongly with the ultrafiltration (UF) membrane substrate, dopamine will further increase the strength of binding between the PAA/PAH fiber and the UF membrane. Dopamine functionalization involved immersing the PAA/PAH mats in 1 g/L dopamine solution (1:1 of dopamine and 1-ethyl-3-(3-dimethylamionopropyl) carbodiimide (EDAC), pH adjusted to 5.5 with 1M HCl) for 12 hours and then rinsing with DI water. PAA/PAH

fibers and PAA/PAH/dopamine fibers were then compared in terms of metal ion removal efficiency.

Characterization of fabricated NMs (Pertinent to Task 2)

We continued to examine the NMs under scanning electron microscopy (SEM) to investigate fiber size, integrity, and stability. Both free standing fibers and NM-laminated UF membranes were examined under SEM. SEM images of cross-sections of NM-laminated UF membrane demonstrated layers of fibers attached on the membrane surface (Fig. 1). The impact of dopamine functionalization on the fibers was also studied. Dopamine was found to improve the hydrophilicity of fibers and increased their stability. Fibers with dopamine have shown the ability to absorb metal nanoparticles.

Evaluation of adsorption of heavy metals by fabricated NMs and NM-laminated UF membrane (pertinent to Task 3)

Following the Cu ion removal test (First Quarterly Report), the efficiency of the removals of other metals using the fabricated fibers were continued using a standard of mixture of various metals. When investigating the removal of Pb and As (from DI water), no significant reduction by the given amount of fibers was observed likely due to the competition between the other metals in the standard mixture for the limited adsorptive sites of the fibers. The tests were repeated using standard solutions of Pb and As individually. Up to 42% Pb ion removal from DI water was observed when using fibers with PAA:PAH ratio of 8:1; however, varying PAA/PAH ratios didn't impact Pb removal efficiency from the tested solutions. No significant As removal was observed during these tests.

The bench-scale membrane apparatus has been assembled (see Fig. 2). Selected metal ions will be spiked and rejection of heavy metals by the NM-laminated membranes will be studied starting from the next week. These experiments will be followed by rejection experiments using real landfill leachate samples to investigate the impacts of leachate matrices on heavy metal removal by NM-laminated UF membranes.

TAG Meetings:

No TAG meeting was held during this reporting period.

Metrics:

1. List research publications resulting from THIS Hinkley Center project.
None.
2. List research presentations resulting from (or about) THIS Hinkley Center project.

1) Johnci Tanelus, Amirsalar Esfahani, Lei Zhai, Anwar Sadmani, “Removing Landfill Leachate Heavy Metals using Electrospun Nanofibers”, UCF Showcase of Undergraduate Research Excellence (SURE), Spring 2018.

3. List who has referenced or cited your publications from this project.

None.

4. How have the research results from THIS Hinkley Center project been leveraged to secure additional research funding? What additional sources of funding are you seeking or have you sought?

Our proposal requesting for funding from the Hinkley Center for an additional year was not successful. We will seek additional funding from the Environmental Research and Education Foundation.

5. What new collaborations were initiated based on THIS Hinkley Center project?

No change.

6. How have the results from THIS Hinkley Center funded project been used (not will be used) by the FDEP or other stakeholders?

None to date.

Pictures:

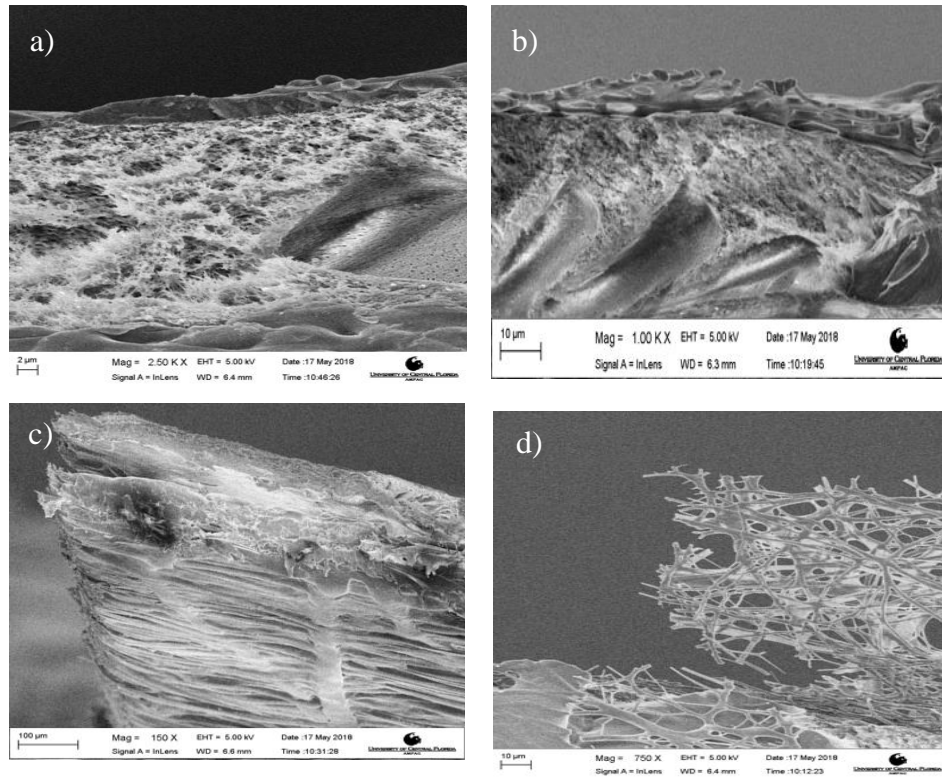


Figure 1. SEM images of a) to c) NM-laminated UF membrane cross-section showing fiber layer on top; d) Fiber mat.

