MSE-7: Hierarchical Nanoporous Polymers

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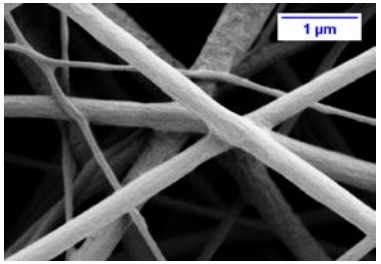
Problem Statement:

Current oil/water separation methods (in the context of oil pollution remediation) are inefficient and inapplicable only to emulsions. This project investigated how to fabricate polymer-based superhydrophobic/superoleophilic membranes with hierarchical pore sizes to effectively separate oil from water.

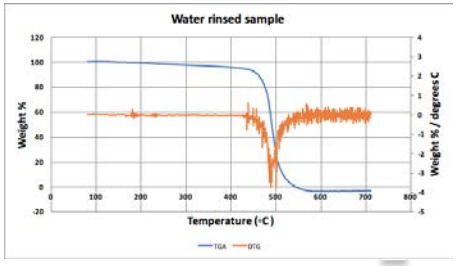
Approach:

1. Production: formulated PEO/PVDF blended solutions, electrospun fibers, and dissolved sacrificial polymer (PEO) to introduce hierarchical pores.
2. Characterization: SEM + ImageJ used to measure fiber diameter and porosity; TGA to determine polymeric compositions of membranes; contact angle analysis to determine hydrophobicity and/or oleophilicity.
3. Oil and water separation test.

Results:



Electrospun Fibers, 1:1 PEO to PVDF ratio (4.6k molecular weight PEO)



TGA Results - Water-Rinsed 1:1 PEO (4.6k MW) to PVDF sample (final rinse heated to 70°C)

- SEM – showed morphologies of each prototype, formulated with varying experimental parameters (polymer wt.%, polymer ratio, molecular weight of the sacrificial polymer PEO).
- TGA – showed effective dissolution of sacrificial polymer after three water rinses, final rinse at 70°C.

Discussion & Conclusions:

- TGA showed dissolution of the sacrificial polymer after water rinses, suggesting presence of hierarchical pores:
  - Previous samples heated to 30°C and SEM showed no intra-fiber pores.
  - Heating to 70°C therefore required.
- Membranes with water contact angles greater than 150° and with oil contact angles between 0° and 10° considered superhydrophobic/superoleophilic.
- Efficacy tested under oil/water separation test, resulting in suggestion of lead prototypes.

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