SLATT UNDERGRADUATE STUDENT FELLOWSHIP
FINAL REPORT

SLATT SCHOLAR:	Lukas Cepkauskas
FACULTY ADVISOR:	Ruilan Guo
REPORT PERIOD:	August 2017 – May 2018
PROJECT TITLE:	Segmented Copolymers of Triptycene-containing Hydrophobic Oligomers for Increased Mechanical Stability and Proton Conduction
CONNECTION TO ND ENERGY'S RESEARCH AREAS (CHECK ALL THAT APPLY):	**(X) Energy Conversion and Efficiency** **( ) Sustainable and Secure Nuclear** **( ) Smart Storage and Distribution** **( ) Transformation Solar** **( ) Sustainable Bio/Fossil Fuels** **( ) Transformative Wind**

MAJOR GOALS AND ACCOMPLISHMENTS:

List your major research goals and provide a brief description of your accomplishments (1-2 sentences). Indicate the percentage completed for each goal. Please use a separate sheet to share additional details, technical results, charts, and graphics.

MAJOR RESEARCH GOALS	ACTUAL PERFORMANCE AND ACCOMPLISHMENTS	% OF GOAL COMPLETED
Design polysulfone membranes with bulky moieties (triptycene and/or phenolphthalein) to increase membrane free volume and permeability.	I first synthesized the phenolphthalein-0 (PPH0) and triptycene-0 (TRP0) oligomers. We then designed and synthesized a random and a segmented copolymer with phenolphthalein-DCDPS (PPH0) and triptycene-DCDPS (TRP0) oligomers of varying molecular weights. After taking measurements of the membranes' physical properties, we found that the random copolymer exhibited better oxygen and nitrogen permeability than the individual oligomers. We synthesized a 15K segmented copolymer, and we are working on synthesizing the 10K and 5K. In synthesizing the segmented copolymers, we faced many difficulties in determining the correct ratio of reactants as well as the ideal reaction time, as the reaction would cross link and form a gel if either of the parameters were off. We eventually optimized the reaction time and ratios for the segmented copolymers.	75
Study the effect of morphology (random vs ordered) on the transport properties of polysulfone-based membranes	We have determined transport properties for the random copolymer but have not yet determined transport properties for the segmented (ordered) copolymer.	50

RESEARCH OUTPUT:

Please provide detailed information below regarding any output resulting from your research project.

CATEGORY	INFORMATION
EXTERNAL PROPOSALS	
EXTERNAL AWARDS	
JOURNAL ARTICLES	
BOOKS AND CHAPTERS	
PUBLIC PRESENTATIONS, SEMINARS, LECTURES	College of Science Joint Annual Meeting (COS JAM); Synthesis and Characterization of Triptycene-containing Polysulfones for Gas Separation Membranes; May 4, 2018, Jordan Hall of Science, Notre Dame, IN

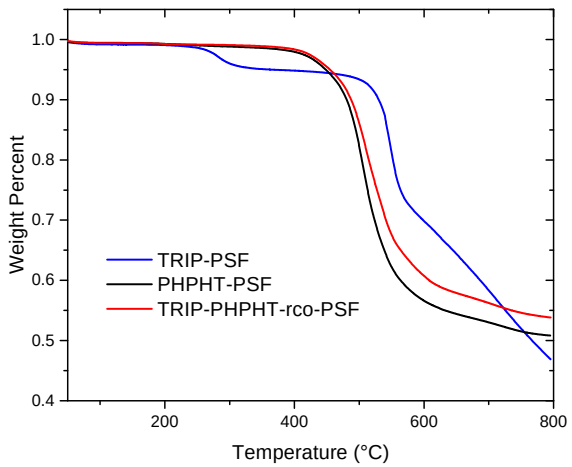
	2018 AIChE Annual Meeting, Gas Transport in Poly(arylene ether sulfones) with Finely Tuned Microstructure and Morphology; October 28 - November 2, 2018; David L. Lawrence Convention Center, Pittsburgh, PA
AWARDS, PRIZES, RECOGNITIONS	
INTERNAL COLLABORATIONS FOSTERED	Joseph Aboki; Department of Chemical and Biomolecular Engineering; Assistance with synthesis Tanner Corrado; Department of Chemical and Biomolecular Engineering; Gas transport properties
EXTERNAL COLLABORATIONS FOSTERED	
WEBSITE(S) FEATURING RESEARCH PROJECT	
OTHER PRODUCTS AND SERVICES (e.g., media reports, databases, software, models, curricula, instruments, education programs, outreach for ND Energy and other groups)	

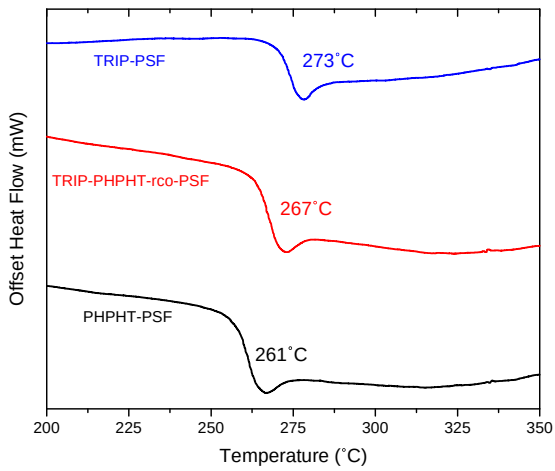
MAJOR GOALS AND ACCOMPLISHMENTS
(Additional Details, Technical Results, Charts and Graphics)

COS-JAM ABSTRACT:

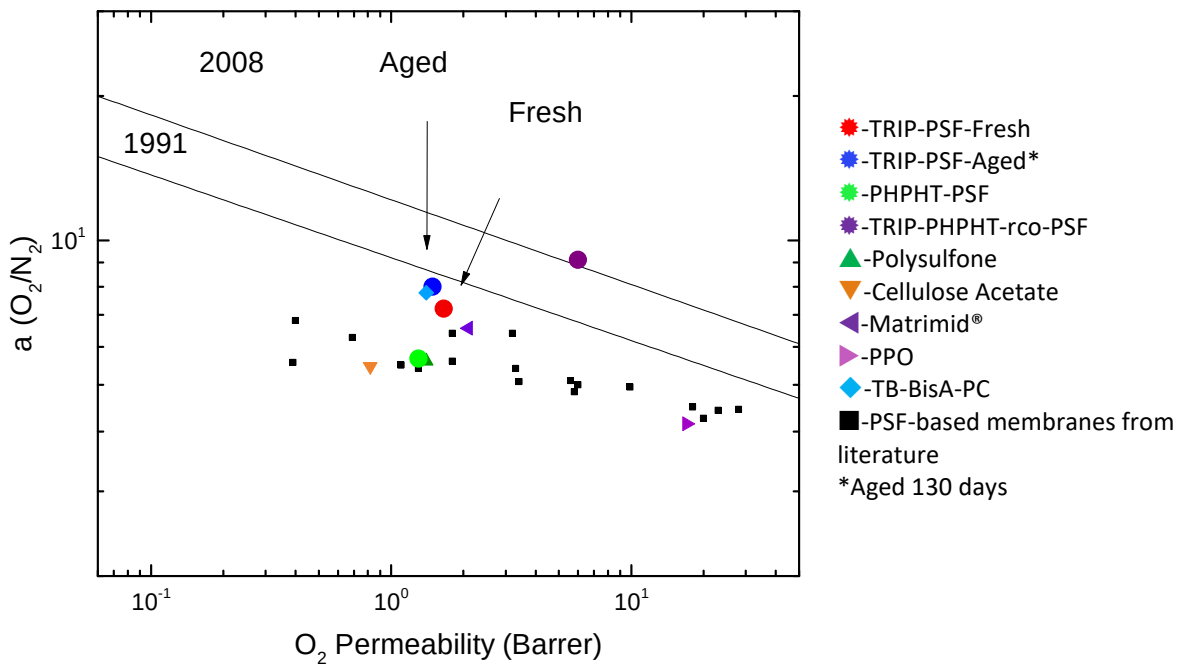
Polysulfones are widely used commercially in membrane-based gas separation processes due to their ease of synthesis, low cost, as well as excellent thermal and mechanical stability; however, there is significant room for improvement of polysulfone membrane performance through innovative molecular design. Our group has recently developed phenolphthalein-based polysulfone membranes which showed good permeability and selectivity compared to previously reported commercial polysulfone membranes. In this project, a series of new polysulfone membranes have been synthesized from a standard diphenylene sulfone with either triptycene and/or phenolphthalein as the bulky bridging unit in the polymer backbone. The composition and morphology of this new series of polysulfones were systematically varied to investigate the influence of the rigid, bulky triptycene and/or phenolphthalein units as well as the arrangement on the fractional free volume, chain rigidity, permeability and selectivity of the membrane. The incorporation of the triptycene unit in polysulfones is expected to further increase the fractional free volume and chain rigidity of the membrane which will lead to even improve gas transport properties.

THERMAL PROPERTIES:

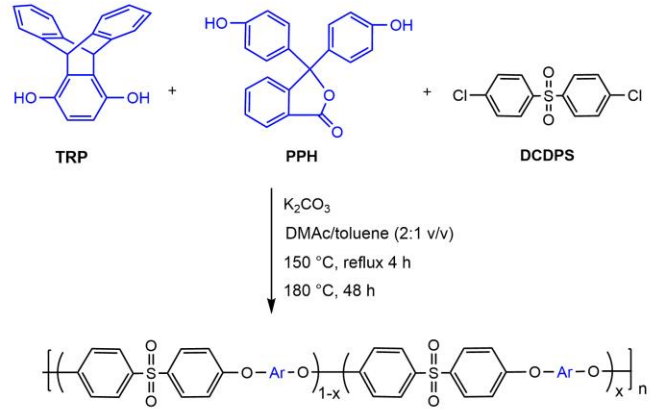




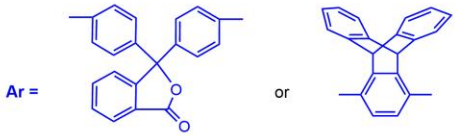
GAS TRANSPORT PROPERTIES:



SYNTHESIS OF TRIP-PHPHT RANDOM COPOLYMER:

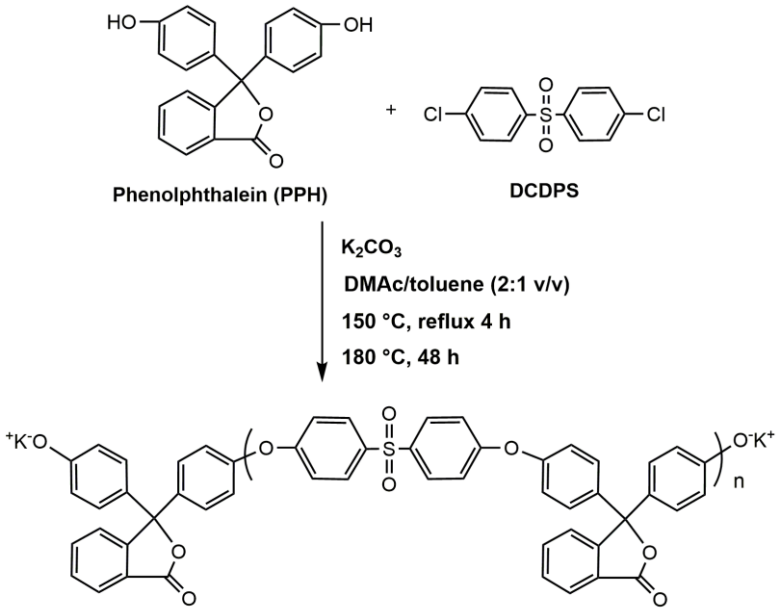


Phenolpthalein-containing Unsulfonated Poly(arylene ether sulfone) Random Copolymer (TRP-PPH)



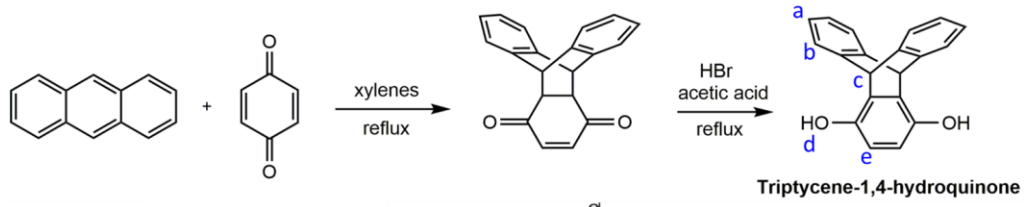
Phenolphthalein (PPH) **Triptycene-1,4-hydroquinone (TRP)**

SYNTHESIS OF PPH0 OLIGOMER:

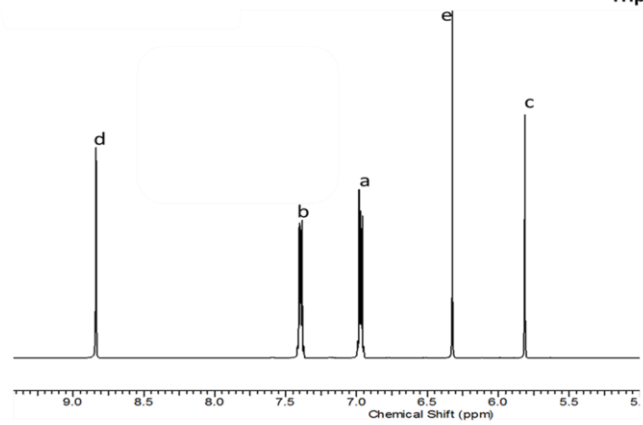


Phenoxide terminated PPH0 hydrophobic oligomer

SYNTHESIS OF TRIPTYCENE HYDROQUINONE (TRP):

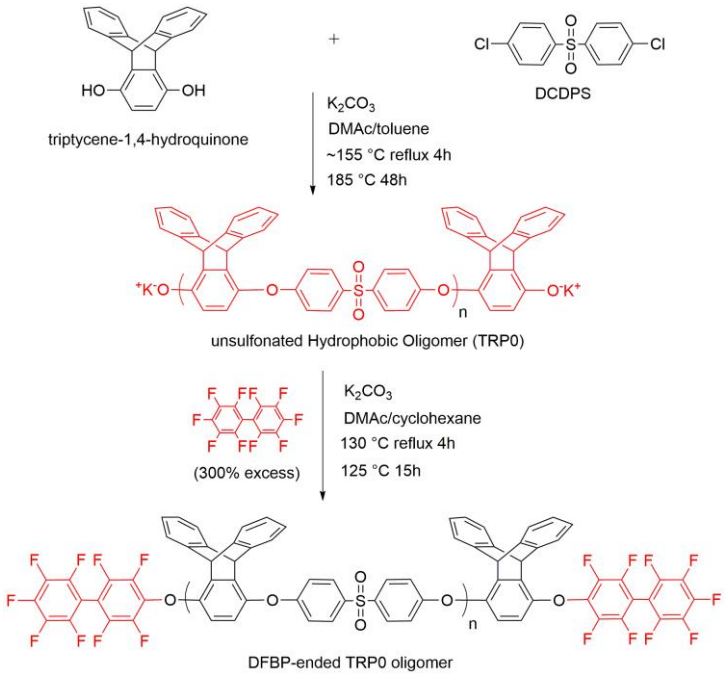
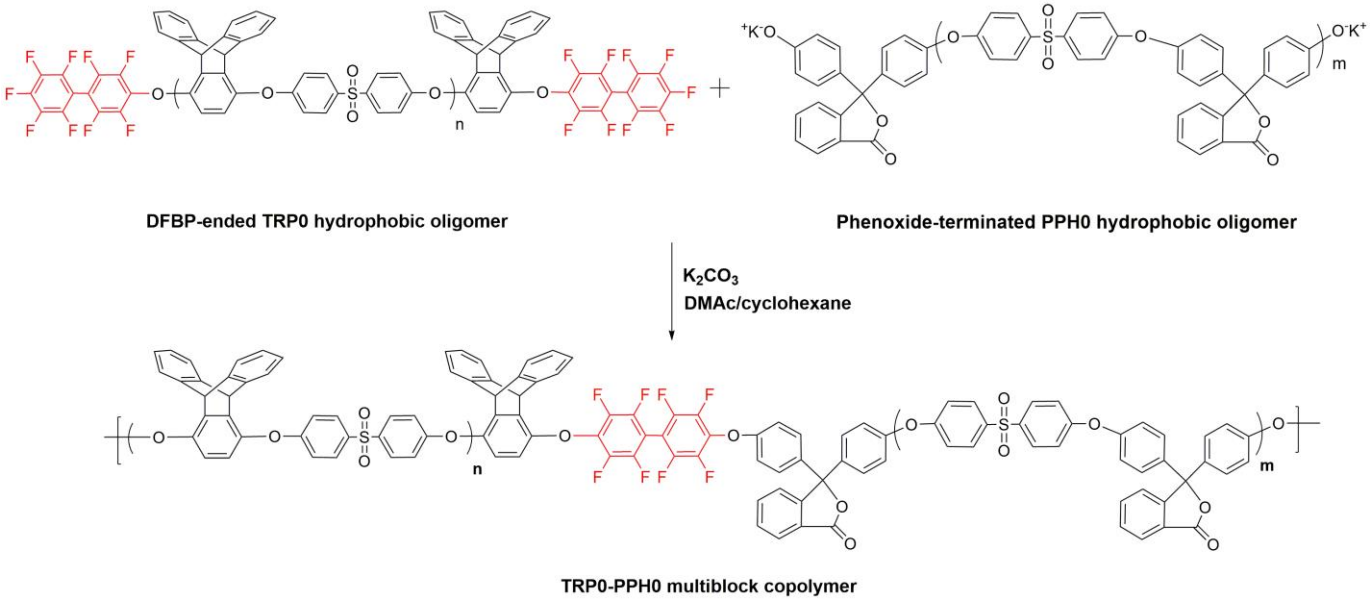


Triptycene-1,4-hydroquinone



^{1}H NMR spectra of Triptycene-1,4-hydroquinone in DMSO-d_6.

SYNTHESIS AND END-CAPPING OF TRP0 OLIGOMER:



SYNTHESIS OF TRP0-PPH0 MULTIBLOCK COPOLYMER: