Wolfson Department of Chemical Engineering Seminar

Wednesday, March 5th, 2025 at 12:30

Zoom:
https://gtiit.zoom.us/j/99834963175?pwd=ObVTy3OpfSDPCPtXRWzmbd6wVl4ESf.1

Development of poly(ionic liquids)-based membranes for CO_2 removal

Manman Zhang

PhD Final-Seminar

Advisor: Prof. Raphael Semiat
Prof. Xuezhong He
Department of Chemical Engineering, Technion-Israel Institute for Technology
Department of Chemical Engineering, Guangdong Technion - Israel Institute of Technology

Abstract: The development of poly(ionic liquids) (PILs)-based membranes shows a significant leap in gas separation technology, particularly for CO_2 separation. In this research work, different chemical structures of PILs were synthesized to prepare membranes for CO_2/N_2 separation. Different side chains, cyano- and carboxyl- groups were connected to the polymeric backbones with imidazolium cation ionic liquid (IL) monomers. These synthesized PILs were prepared as composite membranes by coating the PIL-based casting solutions on polysulfone (PSF) membranes. The effect of side chain groups on the membrane properties was investigated by testing the membranes' CO_2 permeance and CO_2/N_2 selectivity. The results demonstrate that the cyano-based side chain showed better CO_2 separation performance than the carboxyl-based side chain of PILs and the best membranes increased by 200% and 195% compared to PSF membranes. Based on this work, the imidazolium-based PILs were copolymerized with functionalized polymers, polyacrylamide (PAM) and poly (butyl acrylate) (PBA), respectively, to explore the influence of chemical structures of PIL-based copolymers on physical and chemical properties of derived membranes, particular for gas separation properties. The PIL-based copolymers enhanced the CO_2 separation performance that can obtain the resultant membranes with CO_2 permeance of 76 GPU and CO_2/N_2 selectivity of 53, and provided a facile solution by casting the designed PIL-based copolymers on PSF membranes for the application of CO_2 capture from flue gases. To further improve the properties of PIL-based membranes, novel amino-functionalized PILs with high CO_2 affinity were synthesized, and fabricated into composite membranes by casting the PIL-based solutions on the PSF membranes as fixed-site CO_2 carriers. Meanwhile, the mobile carrier of 2-(1-piperazinyl) ethylamine sarcosine (PZEA-Sar) was introduced into the membranes to provide a synergistic effect with the fixed-site and mobile carriers for promoting CO_2 facilitated transport. The obtained membranes can achieve high CO_2 selectivity of 173.5 and have surpassed the Robeson upper bound 2008, exhibiting a promising prospect for real application. Overall, this research work focuses on the design and synthesis of different chemical structures of PILs, which are expected to provide a robust method to adjust the chemical structures of PILs for paving the way for advanced CO_2 capture technologies suitable for industrial applications.