Engineering polymer microstructure and MOF–polymer interfaces for membrane-based separations

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The chemical and petrochemical industries consume nearly 30% of global energy use, nearly half of which is a result of chemical separations. A major opportunity exists in identifying more efficient, productive, and environmentally friendly processes that operate in a continuous fashion. One attractive possibility is membrane-based separations, but significant materials challenges exist in designing membranes that can selectively distinguish between molecules with sub-angstrom differences in size and nearly identical thermodynamic properties. To survey these challenges and describe emerging opportunities, a brief overview of the current state-of-the-art in membrane-based materials and applications will be presented. Next, design strategies will be presented for overcoming current materials limitations by using novel classes of polymers and composite materials formed with polymers and metal–organic frameworks (MOFs). Finally, results will be presented to demonstrate how the structure and chemistry of membrane materials can be designed to control separation performance and manipulate chemical and physical stability. Using a combination of techniques from chemical synthesis, materials characterization, and transport characterization, the aim of this presentation is to highlight the exciting interdisciplinary opportunities for scientists and engineers to tackle global challenges in chemical separations today.

Bio: Zachary P. Smith is an Assistant Professor in the Department of Chemical Engineering at the Massachusetts Institute of Technology. Prof. Smith's research focuses on the rational design, synthesis, and characterization of polymers and porous materials for clean technology applications related to energy-efficient separations. He has published over forty peer-reviewed articles, holds four patents, and is a co-founder of Flux Technology. He has also been awarded the AIChE 35 under 35 Award and the Department of Energy Early Career Award.