Polymer membranes will be critically important in addressing urgent global needs in the 21st century for reliable, sustainable, efficient access to clean energy and clean water. This presentation will focus on recent advances and applications of polymer membranes for gas separations and water purification, particularly on fundamental structure/property relations important in developing membranes with improved properties. For water purification, this presentation highlights results from a systematic study, carried out over several years in collaboration with Professor Jim McGrath at Virginia Tech, of desalination properties of a new family of highly chlorine tolerant, sulfonated polysulfones. The fundamentals of ion and water transport in these (and related) materials will be discussed. In gas separations, this presentation will discuss structural features important in the use of polymers as rate-controlling membranes for gas separations. First, materials having desirable combinations of high permeability and high selectivity based upon solubility selectivity (e.g., butane removal from natural gas, CO₂ separation from H₂ or N₂) will be presented. Second, polymers can also be tailored to achieve high permeability and high selectivity based upon high diffusivity selectivity. In both cases, materials with high permeability and high selectivity may be prepared.

Benny Freeman is the Kenneth A. Kobe and Paul D. and Betty Robertson Meek & American Petrofina Foundation Centennial Professor of Chemical Engineering at The University of Texas at Austin. He has been a faculty member for more than 20 years. He completed his graduate training in Chemical Engineering by earning a Ph.D. from the University of California, Berkeley in 1988. In 1988 and 1989, he was a postdoctoral fellow at the Ecole Supérieure de Physique et de Chimie Industrielles de la Ville de Paris (ESPCI), Laboratoire Physico-Chimie Structurale et Macromoléculaire in Paris, France. Dr. Freeman’s research is in polymer science and engineering and, more specifically, in mass transport of small molecules in solid polymers. He currently directs 15 Ph.D. students, 1 postdoctoral fellow, and 5 visiting scientists performing fundamental research in gas and liquid separations using polymer membranes and barrier packaging. His research group focuses on structure/property correlation development for desalination and vapor separation membrane materials, new materials for hydrogen separation and natural gas purification, nanocomposite membranes, reactive barrier packaging materials, and new materials for improving fouling resistance and permeation performance betting tips in liquid separation membranes. His research is described in more than 300 publications and 15 patents/patent applications, and he has co-edited 5 books on these topics. He has won a number of national awards, including the Roy W. Tess Award in Coatings from the PMSE Division of ACS (2012), the ACS Award in Applied Polymer Science (2009), the AIChE Institute Award for Excellence in Industrial Gases Technology (2008), and the Strategic Environmental Research and Development Program Project of the Year (2001). He is a Fellow of the AAAS, AIChE, ACS, and the PMSE Division of ACS.