The Chemical Engineering
Fall Seminar Series
Presents

Dr. Benny Freeman

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Friday, August 26th 1:15 – 2:15
Life Science Tower (LSE) 106
Light refreshments served

Structure Property Relations in Polymers for Gas Separation

Abstract

This presentation will discuss structural features important in the use of polymers as rate-controlling membranes for gas separations. In particular, 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) or diffusivity selectivity (e.g., CO₂ removal from natural gas) will be presented. For example, cross-linked poly(ethylene oxide) (XLPEO) polymers, which are flexible, rubbery polymers identified as promising materials to remove polar and acid gases, such as CO₂, from mixtures with light gases, such as H₂. One member of this family of materials was reported to have a CO₂ permeability coefficient of approximately 500 Barrer and a CO₂/H₂ mixed gas selectivity of 30 at -20°C. Such materials achieve high selectivity based upon their high solubility selectivity favoring CO₂ transport. Polymers can also be tailored to achieve high selectivity based upon high diffusivity selectivity. In this case, highly rigid, glassy polymers with proper free volume element size and size distribution are desirable. Polyimides with ortho-position functional groups may be solution-processed to form conventional films and membranes. Such materials can undergo thermal rearrangement to form highly rigid benzoxazole or benzothiazole structures having very high permeability coefficients and high selectivity. For example, one member of this family was prepared having a CO₂ permeability coefficient of 1610 Barrer and a CO₂/CH₄ selectivity, under mixed gas conditions, of 42-46, depending on the partial pressure of CO₂ in the mixture. These thermally rearranged (TR) polymers are insoluble in common solvents, giving them good chemical stability, and highly thermally stable, which are important attributes for membranes that would be used in chemically or thermally aggressive environments.
Biosketch

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 and 2 postdoctoral fellows performing fundamental research in gas and liquid separations using polymer membranes and barrier packaging. His research group focuses on include 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 in liquid separation membranes. His research is described in more than 300 publications, and he has co-edited 5 books on these topics. He has won a number of national awards, including 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 AIChE, ACS, and the PMSE Division of ACS. He has served as chair of the Polymeric Materials: Science and Engineering Division of the American Chemical Society, chair of the Gordon Research Conference on Membranes: Materials and Processes, President of the North American Membrane Society, chair of the Membranes Area of the Separations Division of the American Institute of Chemical Engineers, and he is currently Chair of the Separations Division of AIChE. He is a co-founder of Advanced Hydro, Inc.