Molecular Engineering of Polymeric Membrane Materials for H_2 Purification and CO_2 Capture

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Growing evidence indicates that the CO_2 emissions from the combustion of fossil fuels are contributing to global climate change. One approach to controlling CO_2 emissions to the atmosphere is carbon capture, utilization and sequestration (CCUS) from large point sources, such as H_2 and power plants. Pre-combustion capture from syngas has been considered as an economically viable route. In this scheme, gasification of fossil fuels produces syngas, which is further converted to CO_2 and H_2. The CO_2 must be removed and captured prior to H_2 utilization for refinery hydrogenation reactions or combustion in the power plant turbines.

Membrane technology is an attractive approach to H_2 purification and CO_2 capture because of inherent advantages such as high energy efficiency. This presentation will systematically examine the need of membrane technology as a low-cost and energy-efficient separation technology enabling the CCUS via pre-combustion route. I will discuss how we rationally design polymeric membrane materials to achieve the combination of high CO_2 permeability and high CO_2/H_2 selectivity. More specifically, this talk will discuss the molecular engineering of poly(ethylene oxide) (PEO) containing polymers for improvement in mixed-gas CO_2/H_2 separation performance. Interestingly, these materials exhibit unconventional increase in mixed-gas CO_2/H_2 selectivity as CO_2 feed partial pressure increases. The structure and property correlation in these PEO containing polymers will also be interpreted using a modified free volume model.