Nano-Featured Gas Separation Membranes for Energy and Enviromental Appliations

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Abstract

Urbanization and the rapid growth of the human population put enormous pressure on the environment, necessitating the development of more sustainable energy production methods. A hydrogen economy driven by renewables is very appealing in the long run [1]. Nevertheless, concerted efforts should also be made to reduce the carbon footprint of existing energy technologies. Compared to more traditional CO_2 capture technologies, such as chemical absorption, physical adsorption, and cryogenic distillation, membrane-based separation processes are more promising due to their low energy consumption, small device footprints, practicality in operation, and customizability. Current membrane materials, however, have poor operational stability and a trade-off between permeability and selectivity, making them unsuitable for industrial purposes. Efforts have been made in recent years to design industrially appealing CO_2 capture membranes with high durability and selectivity by manipulating the microenvironment of gas transport pathways. The physical approach involves optimizing the size, distribution, and tortuosity of transport channels to enhance CO_2 diffusion [2]. In contrast, the tuning of chemical environments focuses primarily on improving structural stability, solubility and facilitating CO_2 transportation.
During my presentation, I will discuss key steps and novel strategies we have taken to develop high-performance membranes for CO_2 capture. Specifically, I will cover four classes of our recently developed membrane materials: hybrid molecular seives [1], polyethylene glycol-based rubbery polymers [3], microporous polymers [4, 5], and nanocomposite membranes [6, 7].

Keywords: Micrporous polymers, PEG based rubbery polymers, nanocomposite membranes, CO_2 capture

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