Understanding of selective gas transport through polymeric membranes

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Polymeric gas separation membranes are limited by the intrinsic trade-off between permeability and selectivity, rooted by free volume theory. The concept of free volume has long been regarded as a central paradigm in understanding gas transport behavior in polymeric membranes. While the solution-diffusion model and free volume concepts have been instrumental in guiding membrane material development, they are no longer sufficient to fully explain discrepancies between measured pore sizes and observed gas permeability. For instance, polyimide (PI), which is one of the high selective polymers, shows its cavity size ranging from 4.0 to 5.5 Å. However, H_2, with a small kinetic diameter (~2.89 Å), exhibits high permeability, whereas CH_4 (~3.84 Å) is well below the measured cavity size yet shows much lower permeability. This highlights that they are no longer sufficient to describe exactly discrepancies between measured pore sizes and selective gas permeabilities. To this end, our group recently developed a breakthrough technology to give an answer mentioned above. To do so, I will give a talk dealing with the veiled correlation between the free volume elements and gas separation performances using common polymeric membranes.