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Online Proceedings

POSTER SESSION 2

Balcony, Easel 111

12:45 PM to 2:15 PM

Interfacially Constrained High Reverse Selective Membrane Material within Nanoporous Systems

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CO₂ separation from flue gases constitutes to nearly 40% of the CO₂ emission in the United States. Developments resulting from this work address factors key to increasing the transport properties in polymer membrane systems. In particular, this work explores method to engineer porous structure to enhance the selectivity of polymeric membrane. The polymer system of interest in this study is poly(l-trimethylsilyl-1-propyne) (PTMSP), a glassy polymer of extraordinary high free volume compared to conventional polymers. It is “reverse-selective” for CO₂ separation from flue gases such as nitrogen or hydrogen, i.e., transports CO₂ gas faster in respect to lighter flue gases. Based on prior studies that showed that enhanced transport properties for PTMSP if constrained to thin films, here we present our data for PTMSP if constrained in nanoporous functionalized anopore alumina oxides (AAO) “sieve” membranes. Impregnation was achieved via vacuum solution impregnation. The overall CO₂ permeability of impregnated membranes was found to be ~80,000 Barrer, which is almost two times higher than that of bulk PTMSP membranes. Selectivities of CO₂/Helium and CO₂/Nitrogen in impregnated membranes were found to be ~7.0 and 9.0, respectively; these are also noticeably higher than the corresponding selectivities of 6.0 and 6.6 found in bulk membranes. Furthermore, we investigated the temporal stability of these membranes that are notorious for their fast aging in the form of ultrathin films. The origin for physical aging is the collapse of the free volume. A two week aging study of PTMSP revealed a significantly slowed down physical aging process if confined in nanoporous AAO by about a factor of 20 over thin films. The exposure to the radial constraint within the pores helped stabilize the free volume and reduce the occurrence of free volume collapse.

POSTER SESSION 2

Balcony, Easel 114

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Surface Energy of Graphene Determined by Intrinsic Friction Microscopy

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The building material of graphite, a two-dimensional material of single atomic width, possesses remarkable electrical, thermal, and mechanical properties. Due to its exceptional properties, research in graphene is actively pursued for applications such as electronics, solar-cell technology, and sensing materials. A critical question is how graphene may be combined with other materials (e.g. polymers) to form unique hybrid materials with novel functional properties. Thereby of great importance is the surface energy of single layer to multilayer graphene. Following this, we are exploring the surface energy of few-atomic-layer graphene as a function of the number of atomic layers present. To this end, we prepared few-atomic-layer graphene materials through a simple technique involving cleaving bulk graphite with tape and transferring the cleaved material to a suitable substrate. Such materials can be readily identified under optical microscope and further characterized by atomic force microscopy (AFM) — a scanning probe technology that provides nano-scale information of materials by probing the surface with a tip of atomic-scale width. After initial topographical identification, the surface energy and friction values of graphene were determined using Intrinsic Friction Analysis (IFA). This technique analyzes energetically the thermally active adhesive modes of interactions between the probing tip and the graphene surface. With knowledge of the surface energy of the probe, the sample surface energy can be deconvoluted from the energy information. We have employed this technique on few-layer graphene materials of multiple thicknesses. Our results reveal an energy-friction iso-line that is representative for planar systems with thermally active internal modes that are restricted to vibrational modes. While we observe for decreasing thickness increasing friction forces, the surface energies are decreasing from bulk graphite of 63 mJ/m² to graphene of 48 mJ/m².