Nanoporous thermally rearranged polymer membranes for selective transport of small molecules and ions

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We demonstrate that polymers with an intermediate cavity size, a narrow cavity size distribution and a shape reminiscent of bottlenecks connecting adjacent chambers, such as those found elegantly in Nature in the form of ion channels and aquaporins, yield both high permeability and high selectivity. Central to our approach for preparing these intermediate sized cavities is controlled free volume element formation via spatial rearrangement of the rigid polymer chain segments in the glassy phase. It is known that a rearrangement, such as intramolecular cyclization, in glassy polymers could lead to changes in polymer structure for gas transport. For this purpose, aromatic polymers interconnected with heterocyclic rings (e.g., benzoxazole, benzithiazole, polypyrrolone and benzimidazole) are of interest because phenylene-heterocyclic ring units in such materials have a flat, rigid-rod structure with high torsional energy barriers to rotation between two rings.