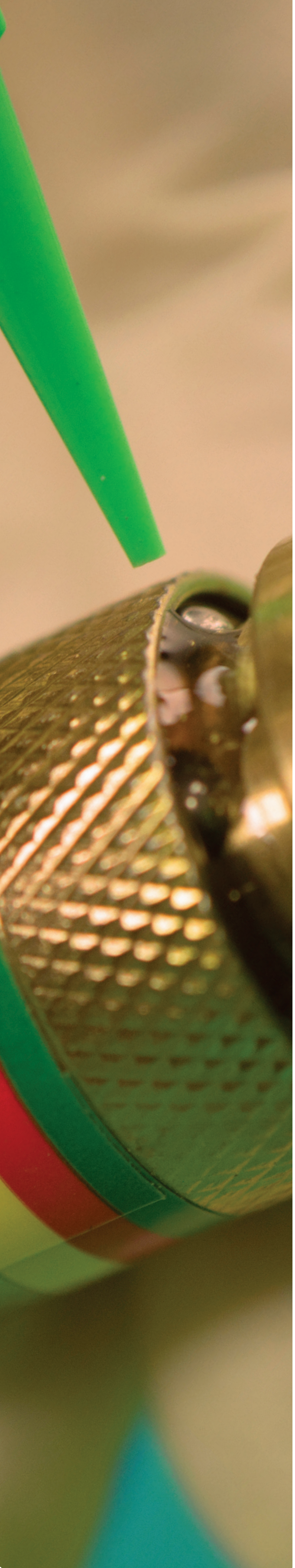

MASTERBOND®
CASE STUDY

EP46HT-2 Used in Research Work for High Temperature Carbon Capture/Fuel Generation

Master Bond Inc. 154 Hobart Street, Hackensack, NJ 07601 USA
Phone +1.201.343.8983 | Fax +1.201.343.2132 | main@masterbond.com

EP46HT-2: Used in Research Work for High Temperature Carbon Capture/Fuel Generation

Application

Hydrogen is a high-quality and renewable energy carrier produced primarily through steam reforming of fossil-based resources. The production of H_2 is accompanied by the greenhouse gas byproduct, CO_2. Membrane separation technology can be used to capture CO_2 while efficiently and inexpensively producing pure H_2.[1]

These high temperature carbon-capture operations require thermally-stable transport equipment. Few existing materials can withstand the high temperatures and aggressive environments needed for the distinctly important industrial gas carrier membranes.

Polybenzimidazoles are highly stable at temperatures well over 150°C. These aromatic polymers have been studied recently in applications such as separating effluent streams from water-gas shift reactors.[2]

While the most common polybenzimidazole polymer, *m*-PBI, is stable to up to 400°C, its limited solubility in common organic solvents presents a challenge in many industrial applications.[3]

Funded by the U.S. Department of Energy, researchers from the University of Texas at Austin and Virginia Tech investigated the influence of temperature on the gas transport properties of a series of polybenzimidazoles based on a newly synthesized series of tetraaminodiphenylsulfone, or TADPS, monomers.[4] The resulting polymers have a higher glass transition temperature than m-PBI and are thermally stable to above 400°C.

Key Parameters and Requirements

The permeabilities of H_2, He, N_2, CH_4, and CO_2 were all measured over a range of temperatures using a constant-volume, variable-pressure method. Due to the excessive temperatures and pressures experienced by the various membranes, the sample films were mounted on brass support disks using a heat and chemical-resistant epoxy--Master Bond EP46HT-2. The two-component adhesive system is primarily used in specialty aerospace, petrochemical, OEM, and electronic applications where high temperature and hostile chemical resistance is needed.

The EP46HT-2 was initially cured for 3 hours at 140°C. Following the manufacturer's directions and in order to reach optimal properties, a post cure of 3 hours at 180°C came next. Samples were attached to the permeation system and degassed overnight under vacuum at 190°C and equipped with a liquid nitrogen trap. The temperature-dependence permeabilities of the gases tested were measured.

Results

Stevens et al. reported that while the permeability of all the gases increased with increasing temperature, the activation energy of CO_2 decreased. Gas selectivity among CO_2/N_2, CO_2/CH_4, and N_2/CH_4 decreased with increasing temperature, while H_2/CO_2 selectivity increased among the TADPS-based samples.

The service temperature range of Master Bond EP46HT-2 extends from -73°C to +260°C, and its decomposition temperature being > 350°C, makes it an ideal choice for such temperature-dependent research. Also, because the epoxy is 100% reactive and does not contain solvents or diluents, there are no volatile compounds to interfere with gas readings.

These results, combined with the strongly size-filtering behavior of the polybenzimidazoles, point to the advancement of industrially applicable H_2-selective membranes. Developing new PBI materials with greater solubility could increase their transport properties, and potentially simplify the hollow fiber spinning process while catalyzing the design of better materials for gas separations.

References

[1] Bitter, Johannes H. and Tashvigh, Akbar Asadi. Recent Advances in Polybenzimidazole Membranes for Hydrogen Purification. *Ind. Eng. Chem. Res.* 2022(61): 6125-6134. https://doi.org/10.1021/acs.iecr.2c00645.

[2] Merkel, T.C., Zhou, M., et al. Carbon dioxide capture with membranes at an IGCC power plant. *Journal of Membrane Science.* 2012(389): 441-450.

[3] Lyoo, W.S., Choi, J.H., et al. Preparation of organo-soluble poly[(2,2'-m-phenylene)-5,5'-bibenzimidazole] with high yield by homogeneous nitration reaction. *Journal of Applied Polymer Science.* 2000(78): 438-445.

[4] Stevens, Kevin A., Moon, Joshua D., et al. Influence of temperature on gas transport properties of tetraaminodiphenylsulfone (TADPS) based polybenzimidazoles. *Journal of Membrane Science.* 2020(593). https://doi org/10.1016/j.memsci.2019.117427.