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Water transport, free volume, and polymer dynamics in crosslinked polymer networks BRADLEY FRIEBERG, CHRISTOPHER SOLES, National Institute of Standards and Technology — Many technologies rely on amorphous polymer membranes that selectively transport small molecules or ions, which has led to a significant scientific interest in elucidating the mechanisms of transport. A recurring theme among several different materials systems is that free volume and polymer chain dynamics facilitate transport. In order to understand the interplay between free volume, transport and polymer dynamics we quantify these properties for a model epoxy network. The epoxy chemistry allows for systematically varying both the structural rigidity of the network as well as the cross-link density. We performed positron annihilation lifetime spectroscopy measurements to characterize the unoccupied volume and correlated the unoccupied volume to the equilibrium moisture uptake and effective diffusion coefficient. We have recently extended this work to include polymer dynamics measured by quasi-elastic neutron scattering on the NIST High Flux Backscatter Spectrometer. These measurements reveal a strong correlation between the MSD and the transport kinetics, which was even stronger than the correlation previously observed between free volume and water diffusion. These observations challenge previous theories that suggest free volume governs transport.

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