

396c Coupled Diffusion in Biochemical Protective Suits

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First responders and military personnel require protection from chemical agents. The state-of-the-art comprises a sealed suit that must maintain flexibility of movement and excellent barrier properties (i.e. effectively zero permeation to life-threatening agents). Often, a multilaminate polymeric material is used and butyl rubber or another elastomer with very low permeation comprises one of the layers. There exists a very real need to understand the transport properties of agents in the varying layers of protective gear. In particular, the use of co-agents to defeat such protective suits has received little attention in the literature yet represents a very real threat. Coupled transport phenomena are well known in multicomponent systems - the presence of one component diffusing through a medium can be strongly influenced by the presence of another diffusing species. Here we present a new theoretical approach and confirming experimental data on multicomponent diffusion in crosslinked polymers.

We present a new model based on an underlying free-energy; mixing and elastic deformation are included. The underlying free-energy function allows the use of the chemical potentials directly as the driving force for diffusion within the framework of non-equilibrium thermodynamics. This provides a theoretically grounded treatment that explicitly yields the concentration dependence of the diffusion coefficients in an a priori manner. Predictions for the permeance of both species are provided and are in agreement with observed behavior both in the literature and from our own laboratory.