

Dual Diffusion of Gases in Glassy Polymer Revealed by Transient Mass Measurement using Quartz Crystal Microbalance

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Quartz crystal microbalance (QCM) is capable of simultaneous measurement of diffusivity D and solubility S of gases in thin film samples due to exceptionally high sensitivity to the sample's areal mass density m (≈ 1 ng/cm²). Since one side of the sample has to adhere to a QCM sensor (typically a 1 inch diameter, 0.33 mm thick quartz disk with thin metal electrodes), D can be measured only in a transient diffusion experiment, by recording a thin film sample's m as a function of time after a step-change in penetrant gas's pressure and then fitting a theoretical equation to the experimental data by adjusting both D and S . This presentation shows how for all three studied gases (nitrogen, carbon dioxide, and iso-butane) the transient diffusion across a spin-cast glassy polymer film exhibits non-Fickian behavior, which is best modeled by Dual Diffusion Model (DDM) introduced by L.Wang et al. in 2012. The DDM postulates independent diffusion of penetrant's molecules occupying two types of absorption sites in the polymer matrix with corresponding values of diffusivity and solubility for each of the two concurrent mechanisms.