

## Abstract

Positron annihilation lifetime spectroscopy (PALS) was applied to study the mechanism of ethanol diffusion through commercial nitrile rubber gloves. Even though the untreated raw samples were very different in their colors and area densities ( $\text{g}/\text{cm}^2$ ), the correlation between the ethanol diffusion coefficient from permeation test and the free volume from PALS measurement is well consistent with the Vrentas-Duda model. Via combining the PALS technique and the Vrentas-Duda theory, it is revealed that (a) the diffusion coefficient is correlated to the number of free volume holes rather than the average size of holes, (b) the diffusion process is not regulated by the size of ethanol molecule but by the size of critical volume for polymer segments to migrate, (c) nitrile group does not present in the free volume hole where the diffusion of ethanol molecule takes place, but is embedded in polymer matrix, and therefore, does not directly interact with ethanol molecule, and (d) nitrile group affects the average size, but not the number of free volume holes. The experiment demonstrates that the PALS technique, being mainly used in pure academic researches, might have application in the glove industry due to its ability in measuring terminal free volume quantities, which are directly related to the permeation of small organic molecules through protective gloves.