Water sorption and diffusion in primary and secondary emulsion polymer films

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Waterborne latex films have attracted academic and industrial interest as protective coatings. The challenge mainly lies in preventing water ingress through coatings that contain hydrophilic species and particle/particle boundaries. A standard method to synthesize latex is emulsion polymerization (**Em**), which uses surfactants. Alternatively, the use of secondary dispersions (**SD**) of polymers in water avoids the addition of surfactants. It is hypothesized that the removal of surfactant from coatings will improve their barrier properties. Using the technique of NMR relaxometry, three ^{1}H peaks in the relaxation time (T_2) spectra of films after soaking in liquid water. These three peaks correspond to different environments: molecularly dissolved water (and mobile polymer); interfacial water; and water in voids or channels. The kinetics of vapour sorption and the diffusion coefficient of water in the polymer films were also determined gravimetrically. The combined effects of particle boundaries and surfactant addition were investigated through comparison to the properties of (1) solvent-cast polymer films (of the same monomer composition), (2) Em polymers after dialysis to remove partially the water-soluble species, and (3) SD. The water vapour diffusion through all of the films was Fickian over water activities ranging from 0 to 0.9. Compared to all of the other waterborne polymer systems, the SD films show the lowest equilibrium vapour sorption and permeability coefficient at high water activities (a_w = 0.9) and also the lowest water diffusion coefficient at low activities (a_w = 0.3). The results reveal that particle boundaries and surfactant both increase vapour sorption. The diffusion coefficients of water are comparable in magnitude in all of the polymer systems but are inversely related to water activity because of molecular clustering.