386f Polymerization Induced Phase Separation and Its Effects on Water Uptake, Flux, and Other Properties of Crosslinked Poly(Ethylene Glycol)

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All current ultrafiltration membranes are finely porous and are, therefore, subject to fouling by particulates, organics, and other wastewater components, resulting in a dramatic decline in the water flux (Ho 1999). Our approach to enhancing the severely limited fouling resistance of conventional ultrafiltration membranes is based on coating them with highly water permeable, nonporous, fouling resistant polymers. Crosslinked poly(ethylene glycol) (PEG) is used as the base material for the coatings because it is highly hydrophilic and has shown resistance to protein attachment (Ostuni 2001).

UV-induced radical polymerization of PEG diacrylate (PEGDA), which contains 13 PEO units, and PEG acrylate (PEGA), which contains 7 PEO units, was used to prepare crosslinked PEG films. The composition of the initial polymerization mixture used was between 20/80 and 100/0 for (PEGDA +PEGA)/water, with the focus being on those samples prepared with higher initial water concentration. The reason for this is twofold: (1) at higher water content the films exhibit both greater water uptake as well as higher water flux, and (2) many of the samples have undergone Polymerization Induced Phase Separation (PIPS), as evidenced by the opacity of the films after polymerization.

The impact of PIPS on the properties of the final films is quite dramatic. Despite having a higher apparent crosslinking density, films prepared with only PEGDA and water exhibit a higher water flux than those made with a mixture of PEGA, PEGDA, and water. The films comprised of only crosslinker and water also exhibit greater opacity, as measured by absorbance of visible light. Microscopy and MWCO experiments provide insight into the structural basis for this counter-intuitive phenomenon, i.e. higher water flux at higher crosslinking density. The formation of water pockets and channels in the nascent hydrogel during the polymerization process is believed to play a key role in these effects.

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