PROPERTIES OF CROSSLINKED PHEMA HYDROGELS

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SUMMARY

Poly (2-hydroxy ethyl methacrylate) (PHEMA) and a series of copolymers of PHEMA with various oligo (ethylene glycol) dimethacrylates, with the number of ethylene glycol units varying between one and nine, were prepared. The effect of sorbed water and the degree of crosslinking on the dynamic mechanical properties of these polymers, and the nature and state of water in the polymer was investigated using a variety of techniques. Polymer samples of varying hydration were prepared by conditioning at different relative humidities. The kinetics of sorption and desorption were also studied.

The amounts of freezing and non-freezing water in the polymer samples were determined using differential scanning calorimetry. Some fine structure to the melting endotherm was observed. The size and structure of the endotherm was found to be dependent on a number of factors including the time frozen, the temperature at which the sample was frozen and the immediate past history of the sample. Crosslinking led to a large decrease in the relative amount of freezing water. $^1$H solution NMR was also used to measure the relative amounts of mobile and bound water at differing temperatures. The decrease in mobile water at 258 K was measured with time and found to decrease in an exponential manner.

Proton enhanced magic angle spinning $^{13}$C NMR was used to measure both the $^{13}$C relaxation in the rotating frame, $T_{1p}(C)$, and the spin lock cross polarisation time, $T_{SL}$. $T_{1p}(C)$ values decreased with increasing amounts of sorbed water, especially when the sample Tg fell below the measuring temperature. This was most noticeable for the carbonyl and quaternary carbons. The carbonyl $T_{SL}$ also showed a decrease as sorbed water increased.

Mechanical properties were measured using a free oscillation torsion pendulum. The greatest effect noted being a decrease in the glass transition
temperature, Tg, with increasing water sorption. β,γ and water induced transitions were also noted and found to vary with copolymer type and water content. A number of equations were used in order to try and predict the change in Tg due to sorbed water and crosslinking. These met with varying success.