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STRUCTURAL ANALYSIS OF THE ENHANCEMENT OF MECHANICAL STRENGTH IN INTERPENETRATING NETWORK HYDROGELS

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Hydrogels with high modulus and fracture strength have been obtained by interpenetrating a tightly cross-linked poly(ethylene glycol) (PEG) network with a loosely cross-linked poly(acrylic acid) (PAA) network^{1,2,3}. In this presentation, small-angle x-ray and neutron scattering (SAXS/SANS) are used in conjunction with swelling measurements to determine the structure of PEG/PAA interpenetrating polymer networks (IPNs) and to measure the average PEG chain extension within the IPN. At pH 7.4, the PEG chains within the IPN are extended to 45-70% of their maximum achievable length as a result of the ionized PAA network expansion within the IPN. Near these high extension ratios, the force required to further strain the PEG chains is increased due to the entropic effects of finite chain extensibility. This leads to PEG/PAA IPN hydrogels with a three-fold increase in both compressive modulus and fracture strength compared to PEG single networks with the same polymer volume fraction. The structure, mechanical properties, and mechanisms of strength enhancement for PEG/PAA IPN hydrogels are notably different than for the high toughness double-network hydrogels described by J.P. Gong⁴.

References

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