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Toughness and adhesion in an acqueous environment

HUGH BROWN, University of Wollongong

Highly swollen crosslinked polymers gels are normally very brittle because there are no significant energy dissipation mechanisms that operate close to the crack tip. The presence of the low molecular weight swelling agent suppresses the viscoelastic process that would normally generate resistance to crack propagation in a crosslinked elastomer. We have examined the effect of forming a random copolymer of a hydrophilic monomer with a small amount of hydrophobic monomer so that the hydrophobic monomers associate. The association was demonstrated by the rheology of the uncrosslinked material. The breakup of these hydrophobic associations gives an energy dissipation mechanism and thereby was found to increase the toughness of the swollen gel. Adhesion of a hydrophobic material, such as PDMS, to a range of substrates is expected to be very different in an aqueous environment than in air. We have used the JKR technique to examine both the work of adhesion (contact formation) and the interface toughness between PDMS lenses and a number of substrates of different hydrophilicity both in air and under water. The water was found to have a profound effect on the measured adhesion.