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PROCEEDINGS

Experimental Investigation on Pure-Shear Ratcheting Behavior of Double-Network Tough Hydrogels

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ABSTRACT

The last decades have witnessed the real and huge potential applications of hydrogels in various areas, including biomedicine, soft robotics, and flexible electronics. The fatigue of hydrogels challenges their reliability and longevity in service, but the related works are not sufficient. In this work, stress-controlled cyclic fatigue tests of a double-network tough hydrogel, consisting of polyacrylamide and alginate polymer networks, under pure shear deformation are investigated. The effects of peak stress, loading rate, peak stress holding time, and environmental relative humidity on the fatigue of the double-network tough hydrogel are considered. The results show that with the increase in peak stress, relative humidity, and peak stress holding time, the peak, valley and ratcheting stretch increase and the apparent modulus decreases. However, with the increase in stress rate, the peak, valley and ratcheting stretch decrease and the apparent modulus increases. The ratcheting stretch increases and then decreases with the increasing loading cycles, while the apparent modulus first decreases and then increases with the increasing loading cycles. These experimental results were interpreted qualitatively by the competition between the unzipping of ionic bonds and water loss of the hydrogels during the fatigue test. This work reveals the ratcheting behavior of double-network tough hydrogels and might inspire studies on the fatigue of other tough hydrogels.

KEYWORDS

Stress-controlled cyclic fatigue test; double-network hydrogel; pure-shear experiments; ratcheting behavior; water loss

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