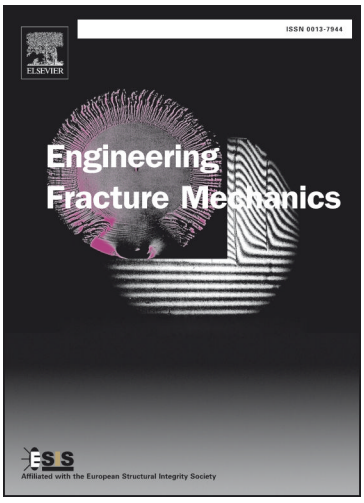

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PII: S0013-7944(17)30949-9
DOI: https://doi.org/10.1016/j.engfracmech.2017.10.018
Reference: EFM 5721

To appear in: *Engineering Fracture Mechanics*

Received Date: 11 September 2017
Revised Date: 19 October 2017
Accepted Date: 20 October 2017

Please cite this article as: Zhang, W., Liu, X., Wang, J., Tang, J., Hu, J., Lu, T., Suo, Z., Fatigue of Double-Network Hydrogels, *Engineering Fracture Mechanics* (2017), doi: https://doi.org/10.1016/j.engfracmech.2017.10.018

Fatigue of Double-Network Hydrogels

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Abstract: The discovery of tough hydrogels of many chemical compositions, and their emerging applications in medicine, clothing, and engineering, has raised a fundamental question: How do hydrogels behave under many cycles of stretch? This paper initiates the study of the fatigue behavior of the classic PAMPS/PAAM double network hydrogels discovered by Gong and her co-workers (Advanced Materials 15, 1155, 2003). We reproduce the hydrogels, and prepare samples of two types, with or without a crack cut before the test. When an uncut sample is subject to cyclic stretches, internal damage accumulates over thousands of cycles until a steady state is reached. When a cut sample is subject to cyclic stretches, the crack extends cycle by cycle if the amplitude of stretch is above a certain value. A threshold of energy release rate exists, below which the crack remains stationary as the sample is cycled. We find a threshold around 400 J/m^2 for hydrogels containing PAAM networks of a low density of crosslinkers, and around 200 J/m^2 for hydrogels containing PAAM networks of a high density of crosslinkers. The experimental findings are compared to the Lake-Thomas model adapted to the double-network hydrogels.

keywords: double-network hydrogel, fatigue fracture, threshold, shakedown

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