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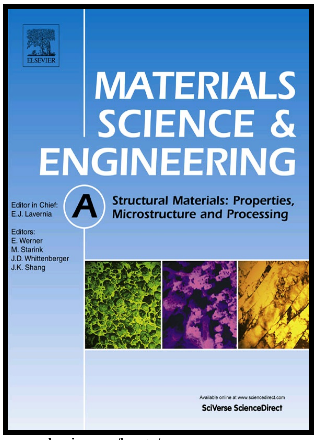

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PII: S0921-5093(18)30939-0
DOI: https://doi.org/10.1016/j.msea.2018.07.014
Reference: MSA36678

To appear in: *Materials Science & Engineering A*

Received date: 22 May 2018
Accepted date: 5 July 2018

The role of intergranular fracture on hydrogen-assisted fatigue crack propagation in pure iron at a low stress intensity range

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Abstract

Hydrogen-assisted fatigue crack growth (HAFCG) in pure iron at a relatively low stress intensity range exhibits brittle-like intergranular (IG) fracture, while the macroscopic crack acceleration is not significant. The present study focuses on the mechanism of IG fracture in terms of the microscopic deformation structures near the crack propagation paths. We found that the IG fracture is attributed to hydrogen-enhanced dislocation structure evolution and subsequent microvoid formation along the grain boundaries. The impact of such IG cracking on the macroscopic fatigue crack growth (FCG) acceleration is evaluated according to the dependency of IG fracture tendency on the hydrogen gas pressure during testing. It is demonstrated for the first time that increased hydrogen pressure results in a larger fraction of IG fracture and correspondingly faster FCG. On the other hand, the gaseous hydrogen environment also has a positive role in decelerating the FCG rate relative to air due to the absence of oxygen and water vapor. The macroscopic crack propagation rate in hydrogen gas is eventually determined by the competition between the said positive and negative influences.