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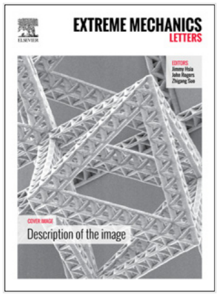

Flaw sensitivity in rate-sensitive high strength alloys: An assessment and future research directions

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Flaw sensitivity in rate-sensitive high strength alloys:

an assessment and future research directions

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Abstract

The tensile strength of metallic alloys may be sensitive to the presence of short cracks, particularly in the embrittled state (such as phosphorous or sulphur segregation to the grain boundaries in a high strength steel). Experimental evidence reveals that cleavage accompanied by plasticity can occur when the net section stress is on the order of the yield strength. If the solid were mildly strain hardening but rate-insensitive, then no cleavage would be predicted as the crack tip tensile stress would not attain the local cleavage value. In the present study, the role of rate sensitivity is assessed by placing a tensile cohesive zone at the tip of an edge crack within a visco-plastic solid, and the crack is subjected to remote tension. Thereby, crack initiation and growth is predicted from short flaws in the presence of bulk plasticity. The crack growth resistance curve for long flaws is also determined. Implications of the predictions are discussed for hydrogen embrittlement, and the significance of rate effects in elevating the stress level adjacent to the crack tip is quantified.

1 Introduction

High strength alloys, in the presence of an embrittling species such as hydrogen, commonly fail by a combination of grain boundary cleavage and local plasticity. The grain boundary flaws that initiate such failure are often sub-micron in length, see for example Wang et al [1-3]. This raises the question: how can the stress level ahead of a small flaw,