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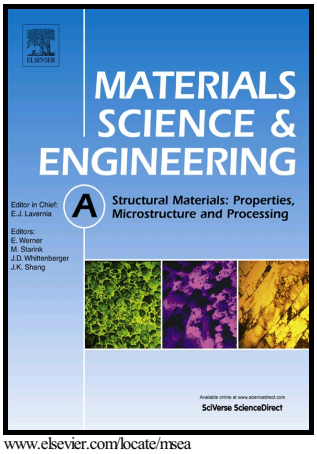

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Influence of sample geometry and microstructure on the hydrogen induced cracking characteristics under uniaxial load

A. Laureys[1], T. Depover[1], R. Petrov[1,2] and K.Verbeken[1]

[1] Department of materials, textiles and chemical engineering, Ghent University (UGent), Tech Lane Ghent Science Park - Campus A, Technologiepark 903, B-9052 Gent, Belgium

[2] Department of Materials Science and Engineering, Delft University of Technology, Mekelweg 2, 2628 CD Delft, The Netherlands

aurelie.laureys@ugent.be, tom.depover@ugent.be, roumen.petrov@ugent.be, kim.verbeken@ugent.be

Corresponding author:
Kim Verbeken
Tel.: 32-9-331-0453
E-mail: kim.verbeken@ugent.be

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Abstract. The present work evaluates hydrogen induced cracking in a TRIP (transformation induced plasticity) assisted steel and pure iron. The goal of this work is to understand the effect of the macroscopic stress distribution in the material on the hydrogen induced cracking phenomenon. Additionally, the effect of a complex multiphase microstructure on the characteristics of hydrogen induced cracking was investigated by comparing results for TRIP-assisted steel and pure iron as reference material. Tensile tests on notched and unnotched samples combined with in-situ electrochemical hydrogen charging were conducted. Tests were performed until the tensile strength was reached and until fracture. The resulting hydrogen induced cracks were studied by optical microscopy and scanning electron microscopy (SEM). Hydrogen induced cracks showed a typical S-shape and crack propagation was mainly transgranular, independently of the presence of a notch or the material's microstructure. This was also the case for the V-shaped secondary crack network and resulting stepped crack morphology characteristic for hydrogen induced damage. These observations indicate that the stress state surrounding the crack tip has a very large impact on the hydrogen induced cracking characteristics. The use of a notch or the presence of a different microstructure did not influence the overall hydrogen induced cracking features, but did change the kinetics of the hydrogen induced cracking process.

1. Introduction

Notches are responsible for many failures in a wide variety of constructions and applications, as such specimens are intrinsically more prone to failure than smooth ones. Notches in materials can, for instance, originate from manufacturing, e.g. welding, casting, forging or machining. When an external load is applied on notched specimens, a local triaxial stress region will result ahead of it. Notches and cracks are, therefore, referred to as stress raisers . The magnitude of the localized stresses decreases with the distance from the notch/crack tip. In case of a uniaxial tensile test with the notch oriented perpendicular to the applied stress, the maximum stress at the crack tip is proportional to the applied stress (σ_0), the length of the notch (a), and the radius of curvature of the notch tip (ρ_t) in following relation: