

## 11、 Mechanically Assisted Cracking

### Time-of-flight neutron imaging of H infusion into super duplex stainless steel during electrolytical hydrogen charging under tensile loading

**Jinshan Pan**<sup>1</sup>, Xiaoqi Yue<sup>1</sup>, Carl Dahlberg<sup>1</sup>, David Lindblom<sup>1</sup>, Armin Halilovic<sup>1</sup>, Ulf Kivisäkk<sup>2</sup>, Robin Woracek<sup>3</sup>, Thawatchart Chulapakorn<sup>3</sup>, Winfried Kockelmann<sup>4</sup>

<sup>1</sup>KTH Royal Institute of Technology, Stockholm, Sweden

<sup>2</sup>Alleima, Sandviken, Sweden

<sup>3</sup>ESS ERIC, Lund, Sweden

ISIS Facility, Harwell Campus, UK

**Abstract** Hydrogen embrittlement (HE) has been a challenge for many applications of alloys. Hydrogen (H) absorption causes H accumulation at traps such as grain/phase boundaries, dislocations, and precipitates, leading to microstructural degradation that may lead to cracking under mechanical loading. HE has been studied extensively and many mechanisms have been proposed. However, achieving a fundamental understanding of HE requires real-time information of H infusion and accumulation, as well as the H-microstructure interactions. Previously we utilized synchrotron high-energy XRD (HEXRD) for operando study of HE of a super duplex stainless steel (SDSS) under electrolytic H-charging and tensile loading. The results from a fine-grained SDSS show dynamic heterogeneous microscopic strain evolution in the microstructure, i.e., lattice expansion in the austenite and compression of the ferrite, but no crack formation [1]. However, for a coarse-grained SDSS, the measurement show H-induced microstructural deformation exceeding the critical threshold of cleavage cracks in ferrite when the load was rased to 100% of actual yield strength.

Recently, we performed time-of-flight (ToF) neutron imaging of the coarse-grained SDSS during electrolytic H charging under tensile loading, aiming to to investigate the H infusion and microstructure degradation leading to crack formation. The ToF neutron imaging vs. H charging time provides real-time information of H accumulation in the microstructure and deformation damage such as crack initiation. The neutron transmission data shows the signal attenuation due to increased H content in the microstrucutre, while the ToF Bragg edge data also holds the potential for the strain evolution of the austenite and ferrite phases (data to be analysed). Here we report real-

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time observation of the H accumulation in the microstructure and the heterogeneous strain evolution in the microstructure, leading to crack formation.

**Keywords:** Hydrogen embrittlement, Super duplex stainless steel, synchrotron XRD, Neutron imaging

[1] C. Örnek, T. Müller, U. Kivisäkk, F. Zhang, M. Långberg, U. Lienert, K.H. Hwang, E. Lundgren, J. Pan, *Corros. Sci.*, **2020**, 175, 108899.