20th European Mechanics of Materials Conference - EMMC20
Florence, Italy | May 27th-29th, 2026
www.emmc20.unifi.it

Investigation of hydrogen embrittlement of 316L steel by in-situ synchrotron tomography under hydrogen gas pressure.

Gianpaolo Pillon[1], Henry Proudhon[2], Yazid Madi[3], Victor Okumko[4], Andrew King[5], Laura Henry[6], James Ball[7], Jonathan Wright[8], Thilo F. Morgeneyer[9]

[1] Centre des Matériaux, MINES Paris, Université PSL, CNRS UMR, 7633, 78000 Versailles, France, France. gianpaolo.pillon@minesparis.psl.eu
[2] Centre des Matériaux, MINES Paris, Université PSL, CNRS UMR, 7633, 78000 Versailles, France, France. henry.proudhon@minesparis.psl.eu
[3] Centre des Matériaux, MINES Paris, Université PSL, CNRS UMR, 7633, 78000 Versailles, France, France. yazid.madi@minesparis.psl.eu
[4] Centre des Matériaux, MINES Paris, Université PSL, CNRS UMR, 7633, 78000 Versailles, France, France. victor.okumko@minesparis.psl.eu
[5] Synchrotron SOLEIL, 91190 Saint-Aubin, France, France. andrew.king@synchrotron-soleil.fr
[6] Synchrotron SOLEIL, 91190 Saint-Aubin, France, France. laura.henry@synchrotron-soleil.fr
[7] European Synchrotron Radiation Facility, 38000 Grenoble, France, France. james.ball@esrf.fr
[8] European Synchrotron Radiation Facility, 38000 Grenoble, France, France. jonathan.wright@esrf.fr
[9] Centre des Matériaux, MINES Paris, Université PSL, CNRS UMR, 7633, 78000 Versailles, France, France. thilo.morgeneyer@minesparis.psl.eu

Paper ID: 282
Symposium S12: Experimental mechanics and microstructural characterization of materials
Extended Abstract

Abstract

316L austenitic stainless steels are widely used in the energy industry for their corrosion resistance and their low susceptibility to H2 embrittlement. However, their resistance to hydrogen may depend on its microstructure and its evolution, such as delta ferrite and strain induced martensite. In-situ synchrotron micro-tomography tensile tests are carried out to investigate the effect of microstructure on damage mechanisms under air, hydrogen gas pressure and a pre-charged ‘internal hydrogen’ sample. Tomography data for the sample tested under hydrogen gas pressure manifests important surface damages propagating via the ferrite layers present in the as-received microstructure

toward the sample center. Damage mechanisms are similar for the internal hydrogen sample, and both samples reveal surface quasi cleavage that could be associated with martensitic transformation. However, at the center, the rupture micro-mechanisms are different. Samples tested under hydrogen gas pressure exhibit a mixed rupture composed of H-assisted shearing, ductile aligned damage and quasi cleavage while the internal H2 sample shows a ductile central slant area.

Keywords:

316L in-situ synchrotron tomography delta-ferrite hydrogen embrittlement martensitic transformation