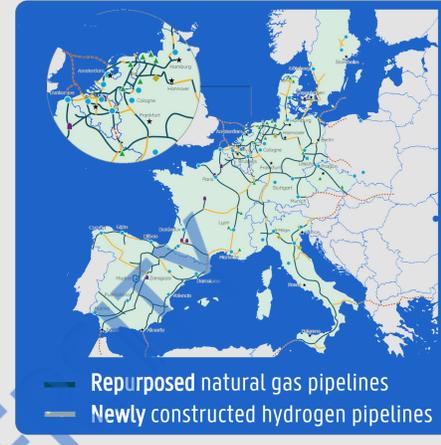


SOETE LABORATORY – EMSME (EA08)

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Experimental-numerical evaluation of the effect of hydrogen on the HAZ of a girth weld at multiple scales



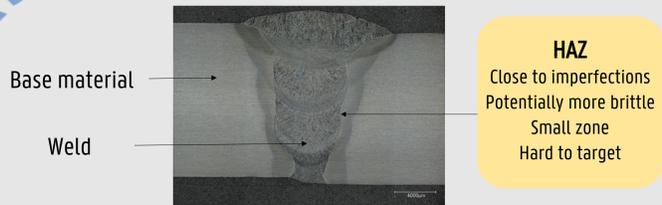
Introduction

In the energy transition towards a low carbon economy, the EU strives to provide a hydrogen grid of almost 53000 km by 2040. Reusing existing pipelines for the transport and storage of hydrogen gas will be necessary to achieve this goal.

However, steels are prone to **hydrogen embrittlement**: hydrogen reduces their ductility and fracture toughness. The engineering assessment criteria to accept the weld flaws are to a large extent based on those properties. Therefore, **weld imperfections and the heat affected zones** need particular attention in the research on the structural integrity of pipelines in the presence of hydrogen.



Different microstructures in pipelines



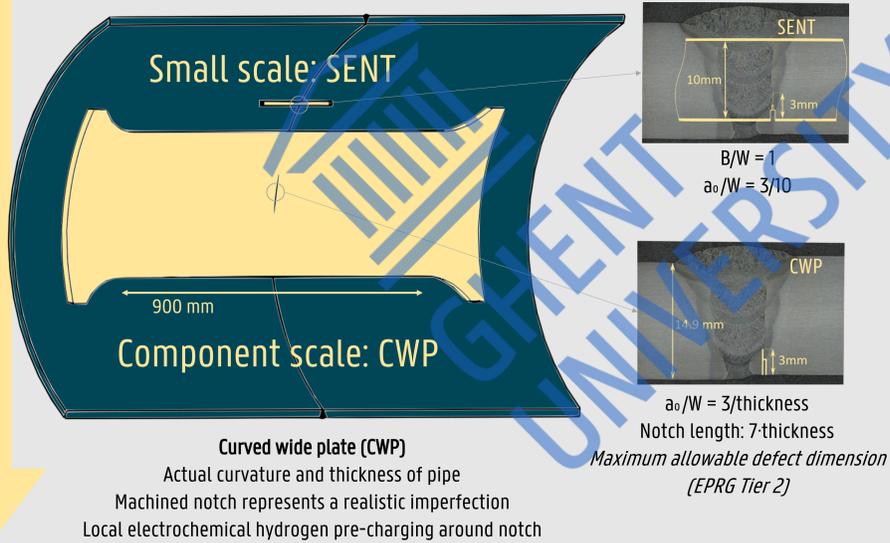
Microstructural investigation



Microstructural effects
Macromechanical effects

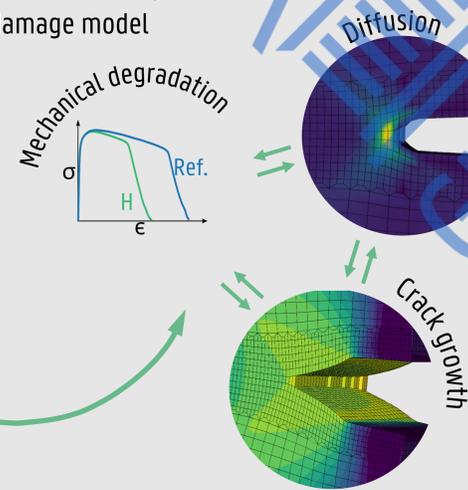
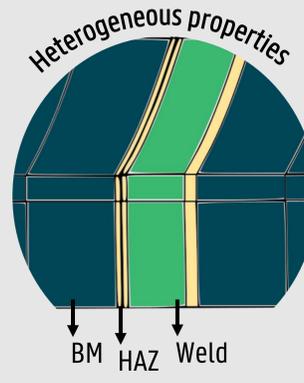
Mechanical testing

Initial notch/crack tip targets the coarse grain HAZ



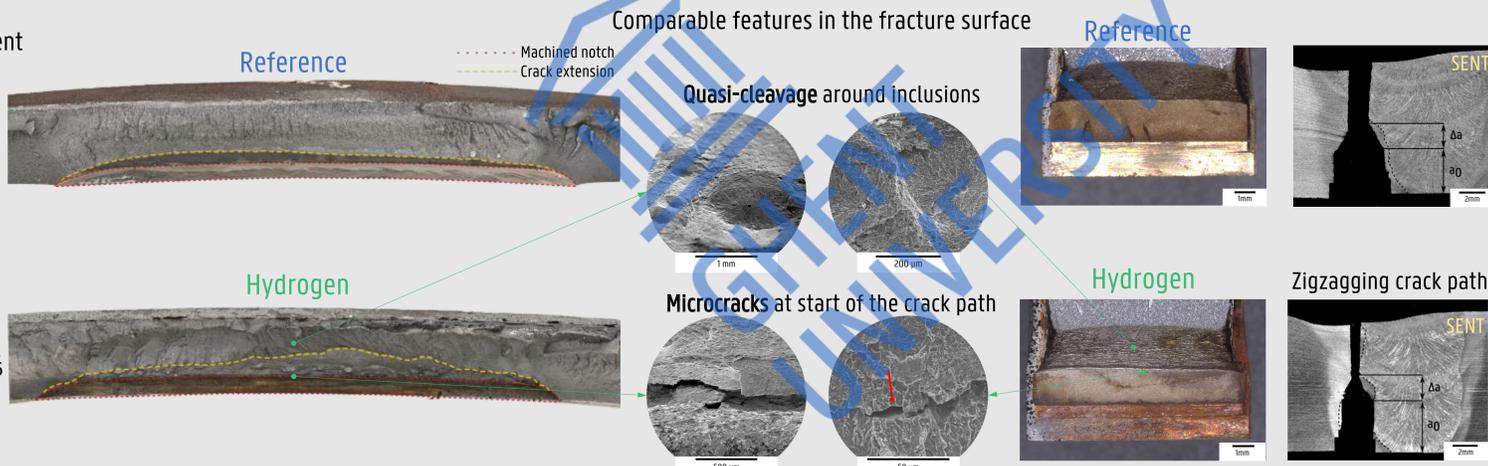
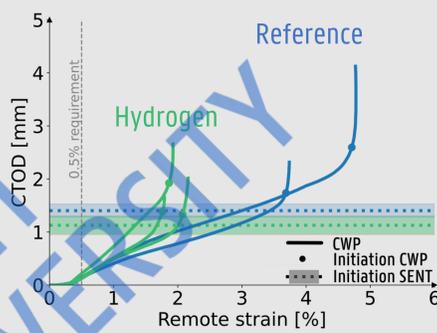
Numerical simulation

Coupled thermo-mechanical analysis
Gurson based damage model



Similarities between the different scales

Strain capacity loss but still meeting the 0.5% remote strain requirement



Objectives

- Develop and perform dedicated **tensile and fracture toughness** tests on welded samples with hydrogen charging.
- Investigate **scale effects** by up-scaling experiments.
- Validation and calibration of numerical **diffusion-degradation-damage model** with welded parts.
- Define **acceptability** of (girth weld) flaws in the presence of hydrogen.
- Prediction of **fitness for service** of pipelines transporting hydrogen gas

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