The Influence of Iron Oxide Corrosion on the Susceptibility to Hydrogen Embrittlement

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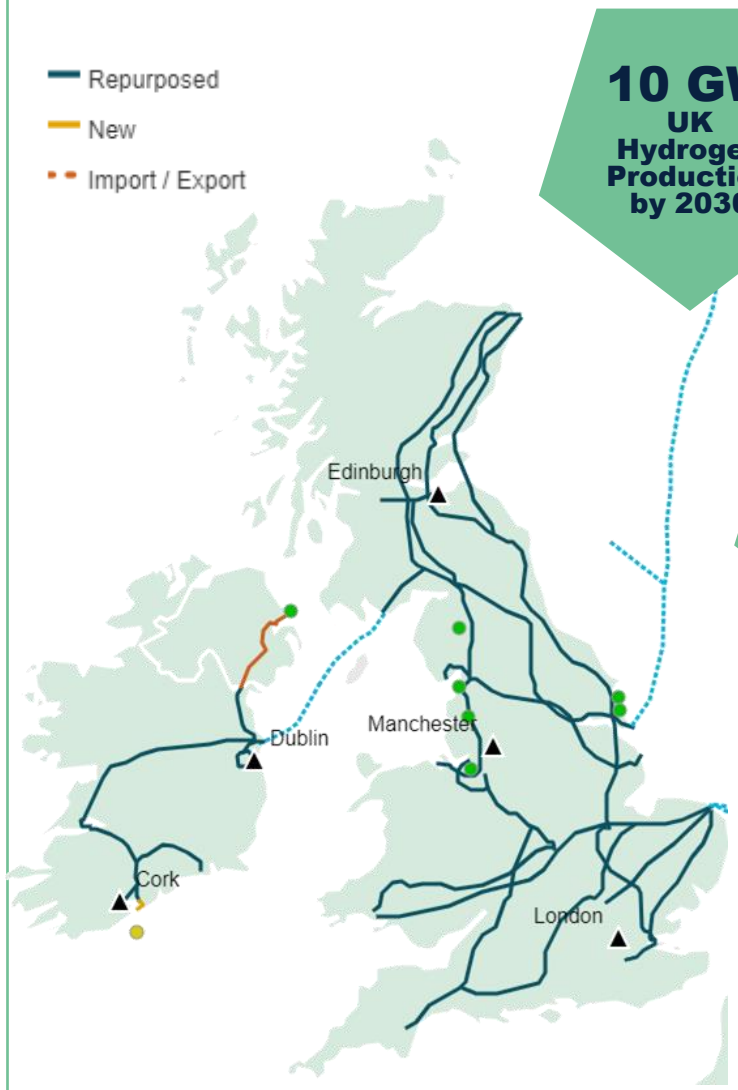
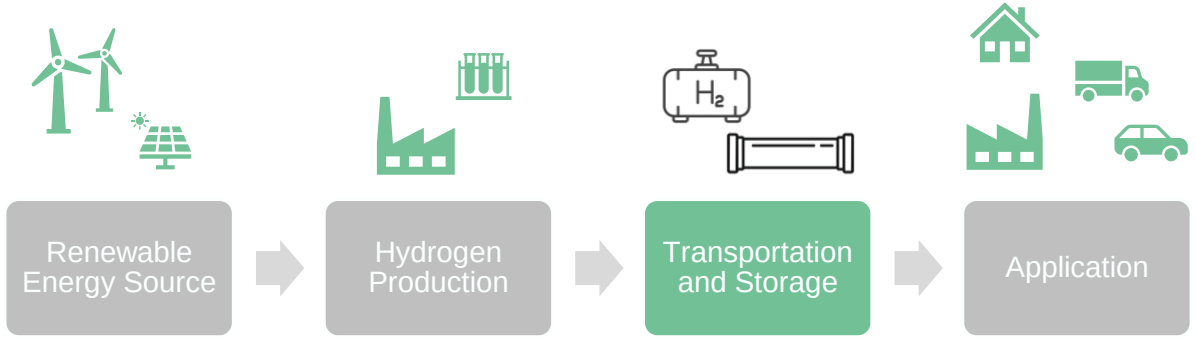
Current Gas Pipelines



10 GW
UK Hydrogen Production by 2030

80%
Pipeline Repurposing

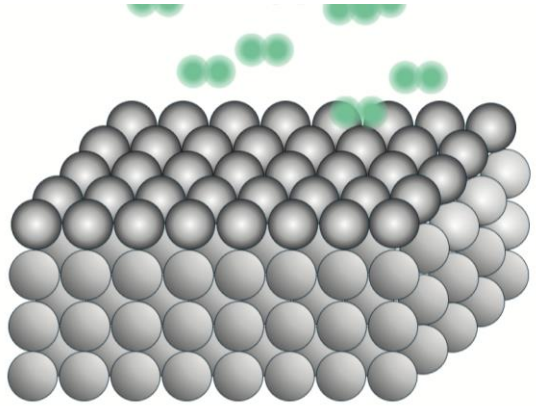
60%
Reduction in Cost

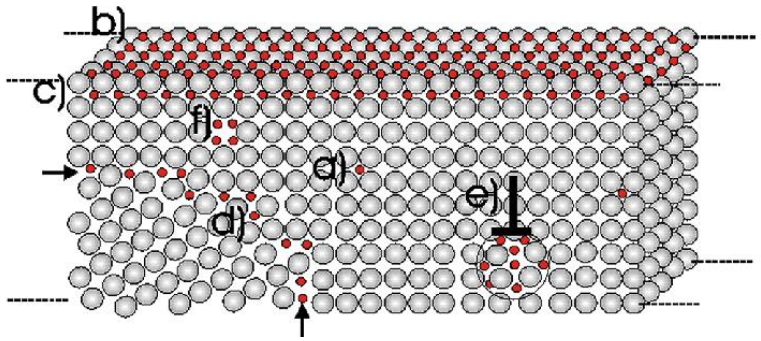


Source: European Hydrogen Backbone

Hydrogen Uptake and Embrittlement

Physisorption → Chemisorption → Absorption → Diffusion

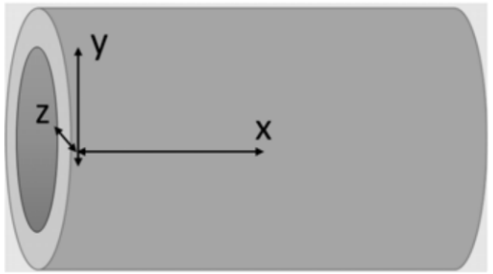




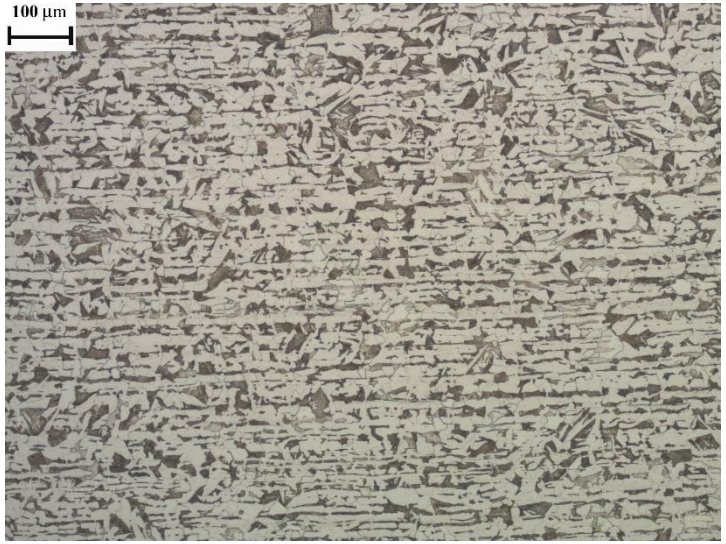
Hydrogen traps in the steels: a) interstitial sites; b) surface traps; c) subsurface traps; d) grain boundary traps; e) dislocation traps; f) vacancy traps

Trapping Sites	Type
Dislocations	Reversible
Low-Angle Grain Boundaries	Reversible
Vacancies	Reversible
Martensite Interfaces	Reversible
Carbides/Precipitates	Irreversible
Inclusions (e.g., MnS)	Irreversible
Microvoids/Cracks	Irreversible
Lattice Defects (Vacancy Clusters)	Irreversible
High-Angle Grain Boundaries	Irreversible

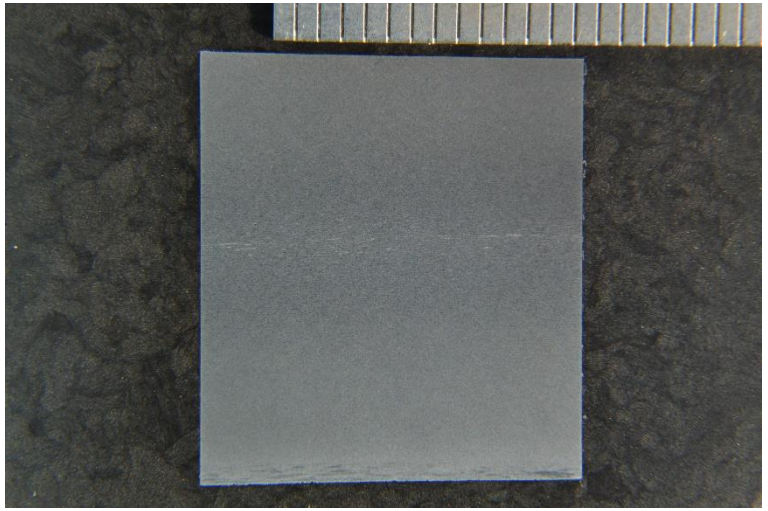
Pipeline Microstructure – X52 and X65

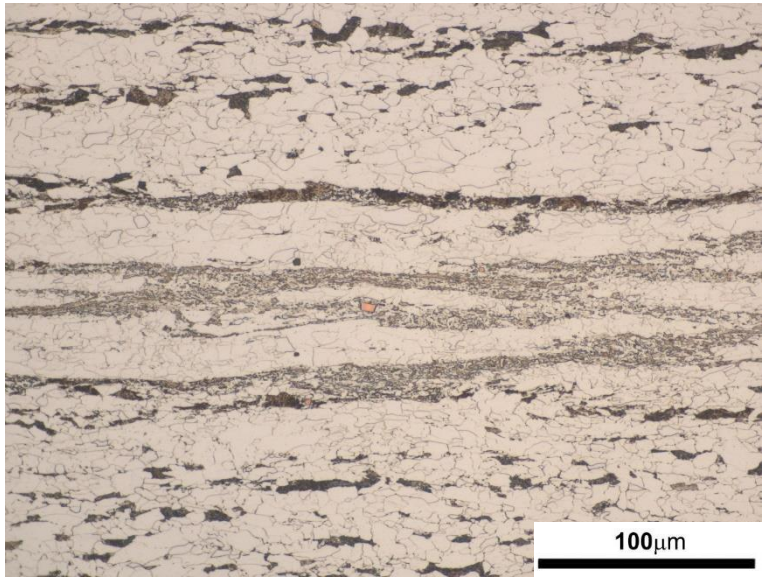


x = pipe axial direction
y = pipe hoop direction
z = through thickness direction



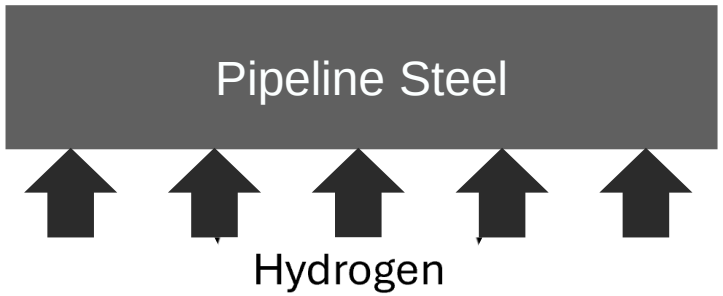
X52

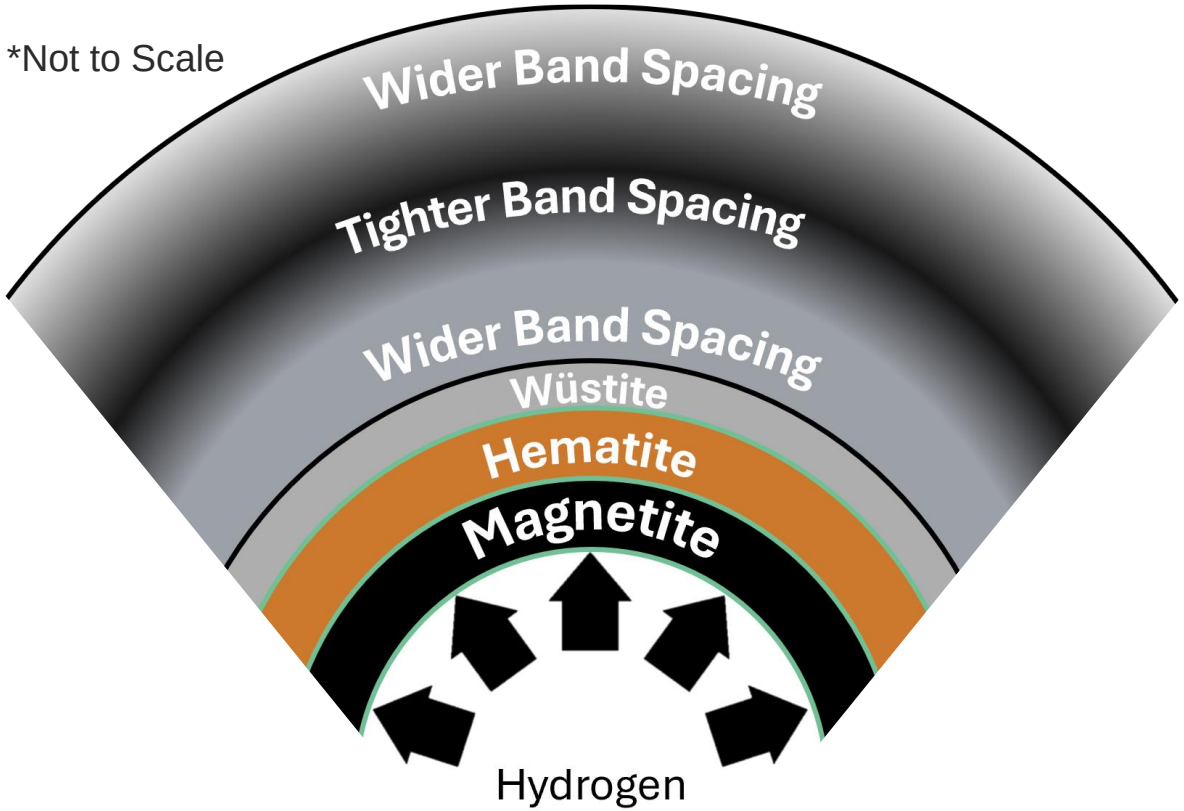




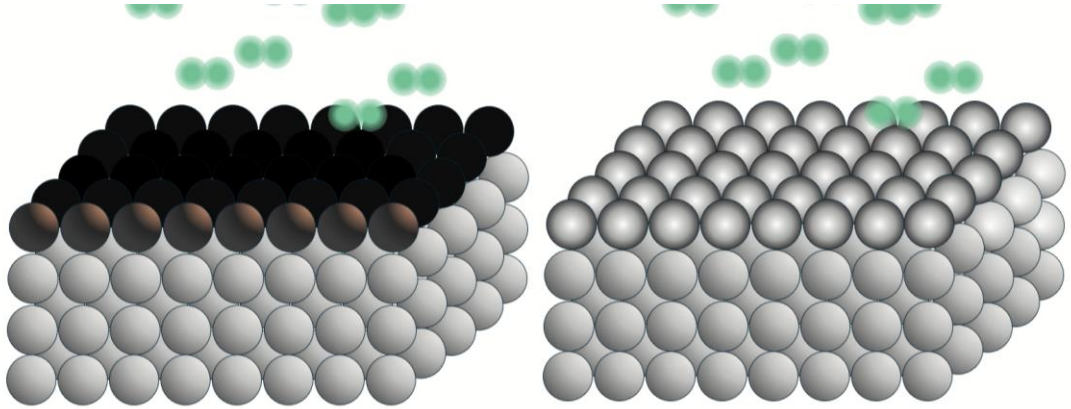
X65

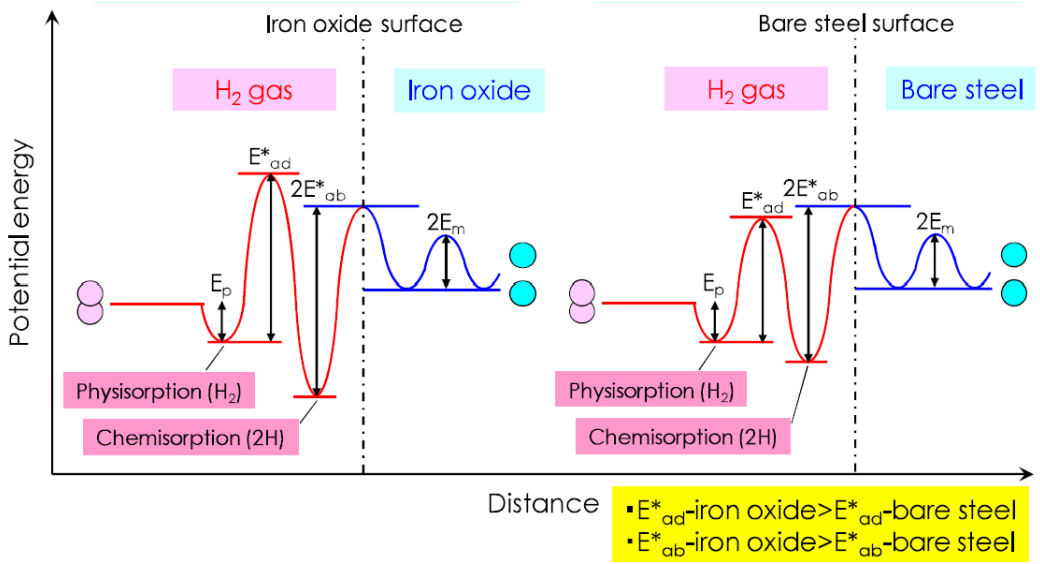
Hydrogen Embrittlement in Pipelines – Current Research Focus





Hydrogen Uptake and Iron Oxides





Physisorption → Chemisorption → Absorption → Diffusion

Hydrogen Permeation Cell (DS Cell)

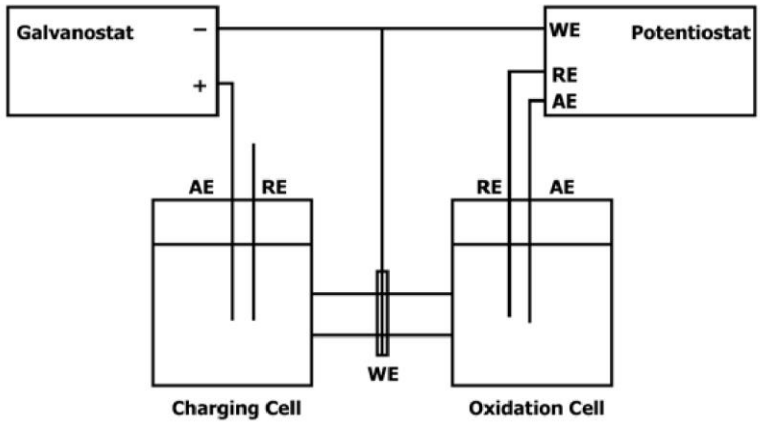
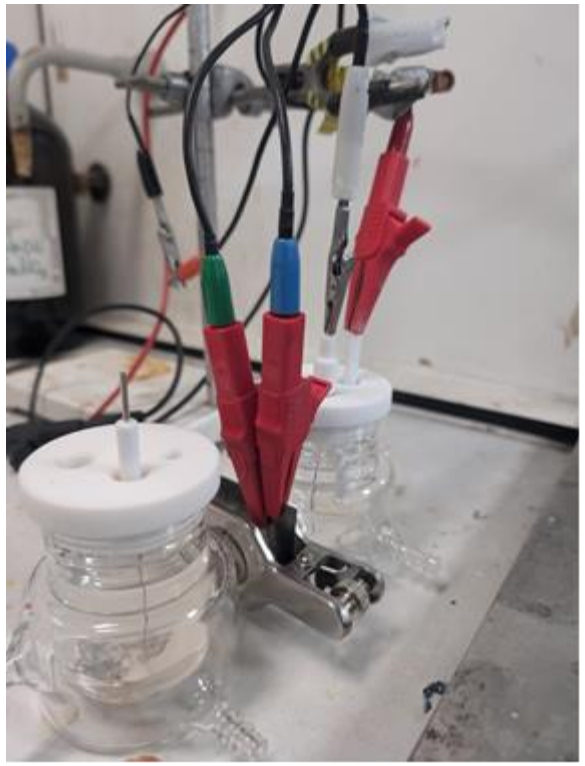


FIG. 2 Electrochemical Hydrogen Permeation Cell Assembly and the Measuring Apparatus



"Practice for Evaluation of Hydrogen Uptake, Permeation, and Transport in Metals by an Electrochemical Technique," May 01, 2018, ASTM International, West Conshohocken, PA. doi: 10.1520/G0148-97R18.

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