Project title: Investigation of hydrogen embrittlement of steels for the hydrogen transport energy future

Project ID *(optional)*: *Please leave blank*

Accept all year-round applications

Funding information: Self-funded students only

Project description:

**Introduction**

Hydrogen embrittlement (HE), the loss of the ductility due to the diffusion of atomic hydrogen in steels, has major consequences in pipelines. HE results in rapid cracking that makes it hard to detect and repair, posing a major threat for pipeline integrity. HE has been studied for more than a century, and yet the behaviour of hydrogen in steels has not been completely understood. In addition, the proposed mechanisms can only partially explain the experimental findings [1].

Computational Materials Science is becoming a very important tool, thanks to the availability of modern computing facilities which allow modelling of a great number of atoms for longer periods of time compared with two decades ago. Such advances in computing capabilities result in more accurate simulations [2], allowing major savings in the design of materials such as pipeline steel. The study of hydrogen embrittlement using computational tools is relatively novel and has an enormous potential to contribute to the understanding of the hydrogen embrittlement mechanisms.

**Project**

Hydrogen Embrittlement (HE) of High Strength Steels will be studied using a combination of computational and laboratory techniques. Density functional theory (DFT) calculations will be performed to study hydrogen adsorption in pipeline steel, calculate elastic constants and estimate diffusion coefficients of hydrogen. Molecular dynamics (MD) simulations will be carried out to elucidate crack initiation and propagation in different microstructures, and to study embrittlement. Tensile tests will be conducted on hydrogen-charged samples (cathodically or thermally charged) to evaluate the influence of HE on mechanical properties. Metallography, Optical Microscopy, Scanning Electron Microscope (SEM) and Electron Backscatter Diffraction (EBSD) will be used to examine the microstructure, grain boundaries; to study crack morphology, crack growth of HE failed samples and validate numerical results. The combination of techniques will provide a novel approach to elucidate the nature of HE in steels and help establish if the current gas transmission network could be used for hydrogen-rich gas transport in the future.

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References:

1. D. Hardie, E.A. Charles, A.H. Lopez, Hydrogen embrittlement of high strength pipeline steels, Corrosion Science, Volume 48, Issue 12, 2006, Pages 4378-4385, ISSN 0010-938X

2. Oila, A., Lung, C. & Bull, S. J Mater Sci (2014) 49: 2383. https://doi-org.libproxy.ncl.ac.uk/10.1007/s10853-013-7942-0

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production

public relations

publishing

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artificial intelligence

computer architectures

computer vision

computer graphics

cyber security

data science

human computer interaction

internet of things

machine learning

networks

quantum computing

software engineering

videogames

other

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animation

art

crafts

creative writing

dance

design

drama

fashion

film studies

fine art

graphic design

interior design

music

music technology

photography

theatre studies

other

Economics

econometrics

financial economics

macroeconomics

microeconomics

political economics

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Education

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secondary education

special needs education

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Engineering

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aerospace engineering

atomic engineering

automotive engineering

bioengineering

biomedical engineering

chemical engineering

civil engineering

communications engineering

control systems

cybernetics

dynamics

electrical engineering

electronic engineering

energy technologies

environmental engineering

fluid mechanics

gas engineering

geotechnical engineering

integrated engineering

manufacturing engineering

marine engineering

mechanical engineering

mechanics

mechatronics

nanotechnology

offshore engineering

petroleum engineering

robotics

solid mechanics

structural engineering

structural mechanics

systems engineering

thermodynamics

other

Environmental Sciences

climate science

hydrology

marine sciences

meteorology

pollution

soil science

other

Finance

actuarial science

banking

financial management

insurance

investment

taxation

other

Food Sciences

food hygiene

food production

other

Forensic and Archaeological Sciences

archaeological science

forensic science

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Geography

agricultural geography

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environmental geography

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human geography

marine geography

physical geography

political geography

remote sensing

social geography

transport geography

urban geography

other

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geochemistry

geophysics

geoscience

geotechnology

hydrogeology

marine geology

palaeontology

seismology

volcanology

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archaeology

asian history

australasian history

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history of religions

history of science

medieval history

military history

modern history

russian history

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world history

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linguistics

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polymers

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applied mathematics

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engineering mathematics

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medical statistics

operational research

probability

pure mathematics

statistics

stochastic processes

other

Medicine

anatomy

audiology

biomechanics

cardiology

complementary medicine

dentistry

endocrinology

epidemiology

neural engineering

neurology

nutrition

ophthalmology

optometry

pathology

pharmacology

pharmacy

physiology

physiotherapy

podiatry

radiology

speech science

tissue engineering

toxicology

other

Nursing & Health

adult nursing

community nursing

counselling

dental nursing

environmental health

health informatics

medical nursing

mental health nursing

midwifery

occupational health

occupational therapy

paediatric nursing

paramedical science

surgical nursing

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metaphysics

philosophy of science

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astrophysics

chemical physics

computational physics

electromagnetism

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experimental physics

medical physics

nuclear physics

optical physics

particle physics

quantum mechanics

solid state physics

space science

theoretical physics

other

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development studies

government

international relations

politics

public policy

other

Psychology

child psychology

clinical psychology

community psychology

counselling psychology

developmental psychology

educational psychology

forensic psychology

health psychology

neuropsychology

occupational psychology

organisational psychology

psychotherapy

sport psychology

other

Sociology

criminology

disability studies

gender studies

socio economics

social work

other

Sport & Exercise Science

sport coaching

sport development

sport performance

sport technology

sport therapy

other

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divinity

religious studies

theology

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animal welfare

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veterinary nursing

veterinary nutrition

veterinary pathology

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