FAISAL, N. 2025. Hydrogen at RGU: innovation and supporting its existing ecosystem (Hy-ONE and other projects). Presented at Scotland's hydrogen innovation network (SHINe) webinar: using innovation to overcome hydrogen barriers, 11 February 2025, [virtual event].

Hydrogen at RGU: innovation and supporting its existing ecosystem (Hy-ONE and other projects).

FAISAL, N.

2025

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11 Feb 2025 - Webinar: Using Innovation to Overcome Hydrogen Barriers

Scotland's hydrogen innovation network (SHINe)

Hydrogen at RGU

Innovation and supporting its existing ecosystem (Hy-ONE & other projects)

Prof Nadimul Faisal

School of Computing, Engineering and Technology

Robert Gordon University, Aberdeen

n.h.faisal@rgu.ac.uk ; hy-one@rgu.ac.uk

Robert Gordon University (RGU)
Aberdeen

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Hydrogen research team at RGU

HYDROGEN PRODUCTION
- ELECTROLYSIS MATERIALS
- BOOSTING EFFICIENY
- SOLID OXIDE ELECTROLYSIS
- H2 FROM NULCEAR

HYDROGEN STORAGE
- STORAGE MATERIALS
- VESSEL PROTOTYPE DEVELOPMET
- COMPOSITE MATERIALS
- VESSEL AND COMPONENT TESTING

HYDROGEN UTILISATION
- ENVRIONMENTAL IMPACT ANALYSIS OF PRODUCTION
- HYDROGEN POLICY DEVELOPMENT

HYDROGEN INTEGRATION
- DECARBONISING BUILDINGS
- UPS SYSTEMS

Prof James Njuguna

National Subsea Centre

Prof Nadimul Faisal

Prof Mamdud Hossain

Prof Radhakrishna Prabhu

Dr Anil Prathuru

Dr Dallia Ali

Dr Ruissein Mahon

Dr Bridget Menyeh

Dr Gbenga Oluyemi

Dr Leon Moller

Dr Carlos Fernandez

Dr Vinoth Ramalingam

Dr Shohel Siddique

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Recent hydrogen projects (examples)

- Hy-ONE
- METASIS
- METALYSIS
- THERMOSIS
- Consumer Perceptions Toward Hydrogen Fuel Cell Vehicles

Scottish Government
Riaghaltas na h-Alba
gov.scot

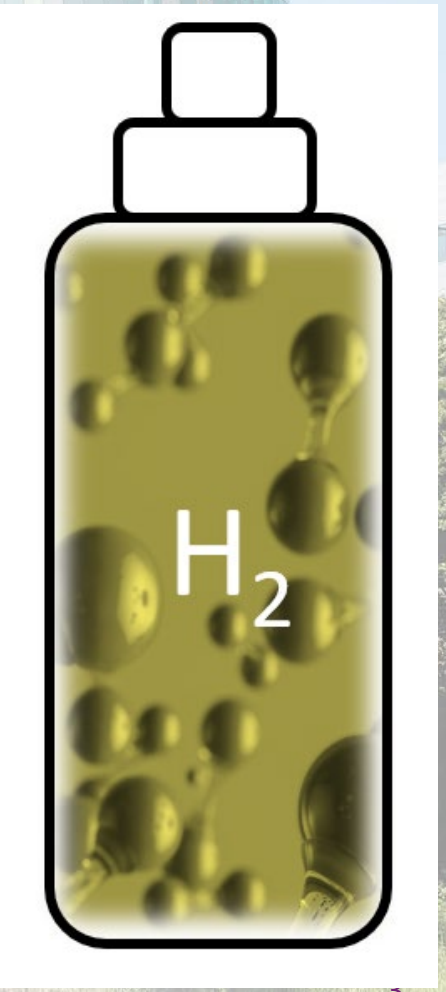
UKRI Engineering and Physical Sciences Research Council

HENRY ROYCE INSTITUTE

NATIONAL NUCLEAR LABORATORY

University of St Andrews

TRANSPORT SCOTLAND
CÒMHDHAIL ALBA



Hy-ONE

- Scotland's Comprehensive Hydrogen Storage Testing Facility https://www.hy -one.co.uk/
- Funded by ScotGov : Emerging Energy Transition Fund, Hydrogen Innovation Scheme, Stream 2; and Robert Gordon University
- Project No. EETF/HIS/ APP/007
- Total budget: £3.9m

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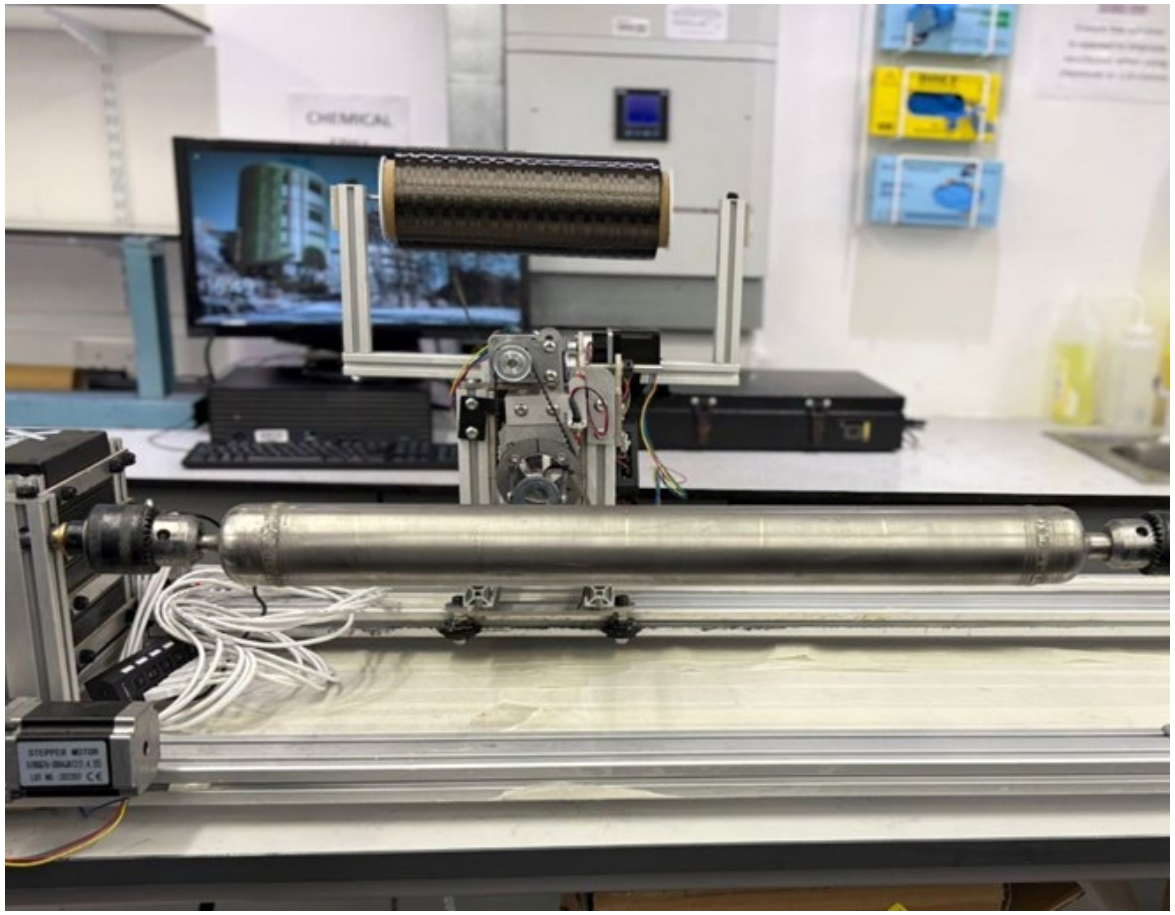

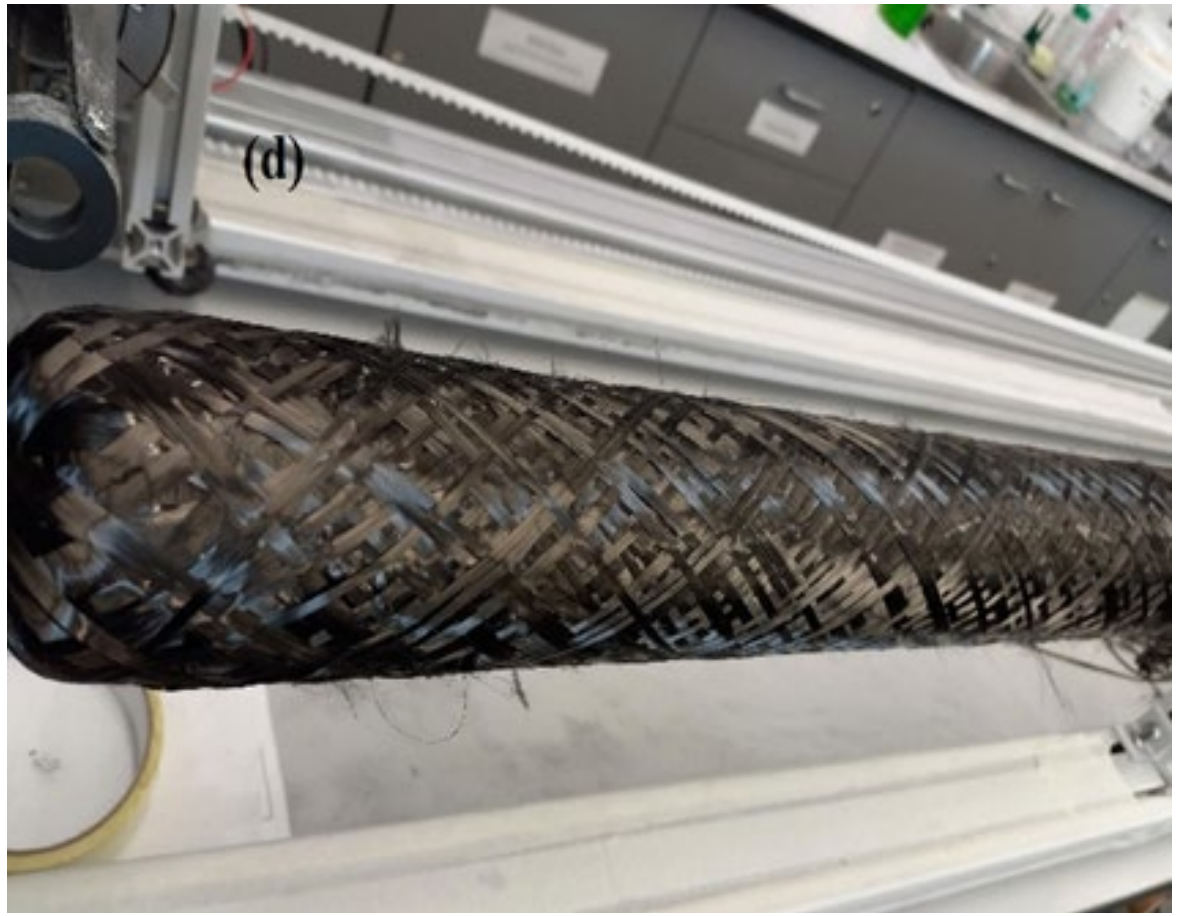

Filament Winding – Composite cylinder manufacturing

Hy-ONE objectives

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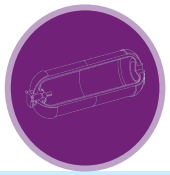
HY-ONE
SCOTLAND'S HYDROGEN STORAGE TESTING FACILITY AT ROBERT GORDON UNIVERSITY



PROTOTYPE AND CONCEPT DEVELOPMENT

- Hy-One will engage with prototypes and concepts through the different scales of TRL1 to TRL9, particularly supporting early -stage concept evaluation.
- Providing advice for businesses in terms of developing prototypes and concepts and a guide to storage vessel developers and manufacturers on the best practices for testing, improving, and evaluating upcoming and new technologies.

HYDROGEN CLUSTER DEVELOPMENT

- Hy-One will facilitate the development of a hydrogen cluster in Scotland. Support the creation of job opportunities within the sector through technological development and economy expansion.
- Facility and hydrogen cluster will also provide confidence in the mobility of smaller scale hydrogen storage as a business and a social behaviour in support of the technological developments.
- Facility will provide training and development for the local and regional supply chain within the hydrogen cluster.

HYDROGEN VESSEL AND COMPONENT TESTING

- Hy-One will provide technical reports on current and future understandings of technology and influence governmental standards for the development of compressed hydrogen storage vessels.
- Hydrogen exposure permeation and leakage testing for materials, valves, tanks, links and connections of the storage vessels.
- Using sensors, measurement equipment and data acquisition system
- Exposure testing for absorption/desorption quantification
- Above ground, underground, underwater and component testing

CERTIFICATION

- Hy-One will also provide comprehensive certifications and compliance qualifications aligned with the current national standards, practices and guidelines
- Allowing suitable compressed storage vessels developed in Scottish hydrogen supply chain and support further renewable hydrogen production and the integration of hydrogen into our energy systems.

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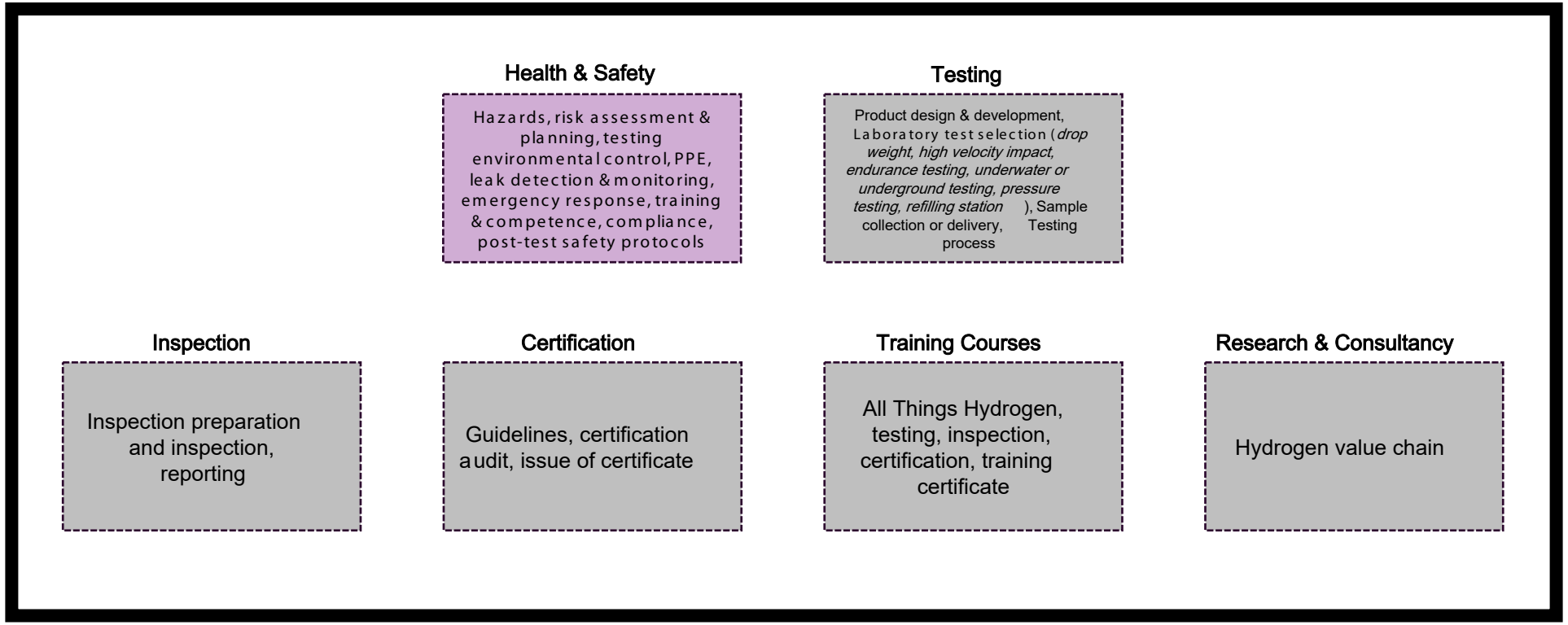
HY-ONE
SCOTLAND'S HYDROGEN STORAGE TESTING FACILITY AT ROBERT GORDON UNIVERSITY

Hy-ONE workspace



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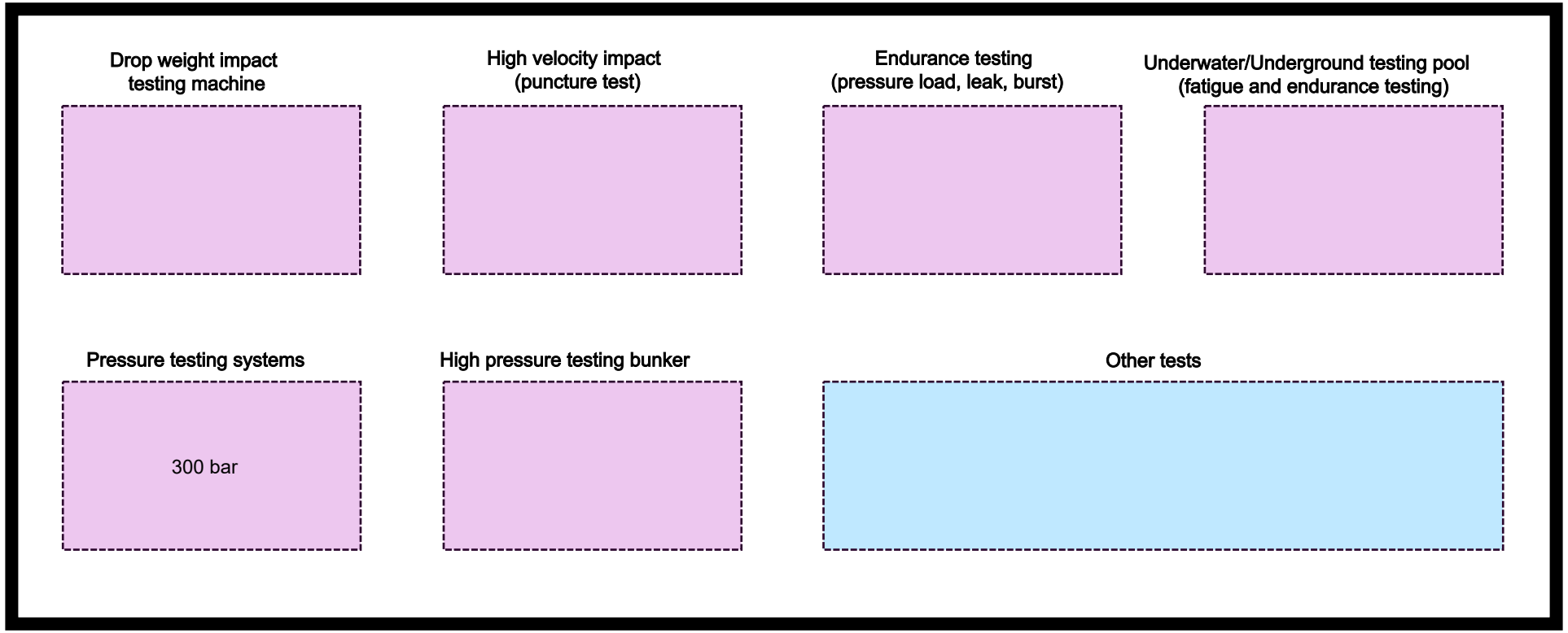
HY-ONE
SCOTLAND'S HYDROGEN STORAGE TESTING FACILITY AT ROBERT GORDON UNIVERSITY

Hy-ONE testing workspace



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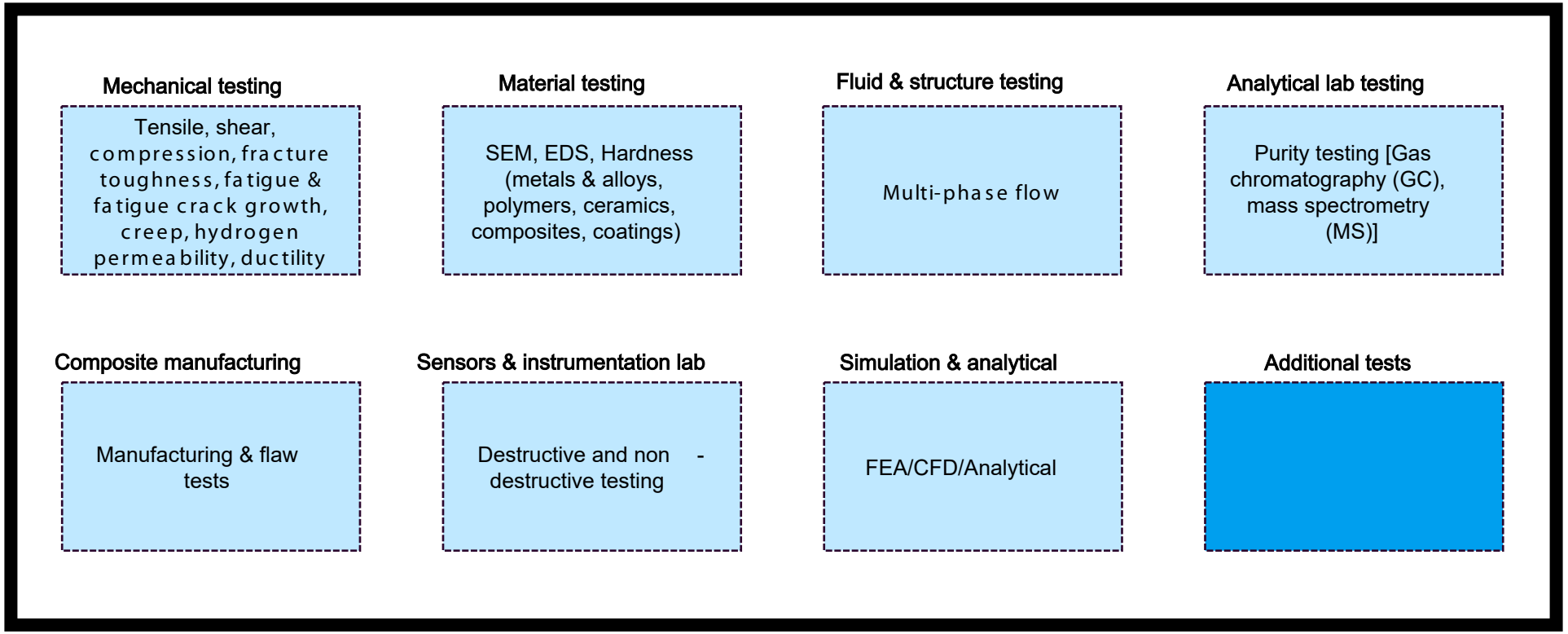
SCOTLAND'S HYDROGEN STORAGE TESTING FACILITY AT ROBERT GORDON UNIVERSITY

Hy-ONE testing workspace (other tests)



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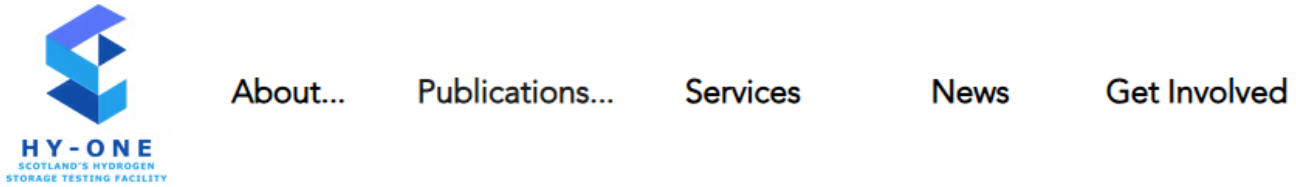
HY-ONE
SCOTLAND'S HYDROGEN STORAGE TESTING FACILITY AT ROBERT GORDON UNIVERSITY

How to work with us?

- Membership model to access state -of-the-art facilities
- Strategic partnership
- Research collaboration programmes (<6 months; ⩾ 12 months)
- Case studies
- Targeted investigation on given topics
- Networking
- Public engagement
- Impact road-mapping and assessments



hy-one@rgu.ac.uk

METASIS team

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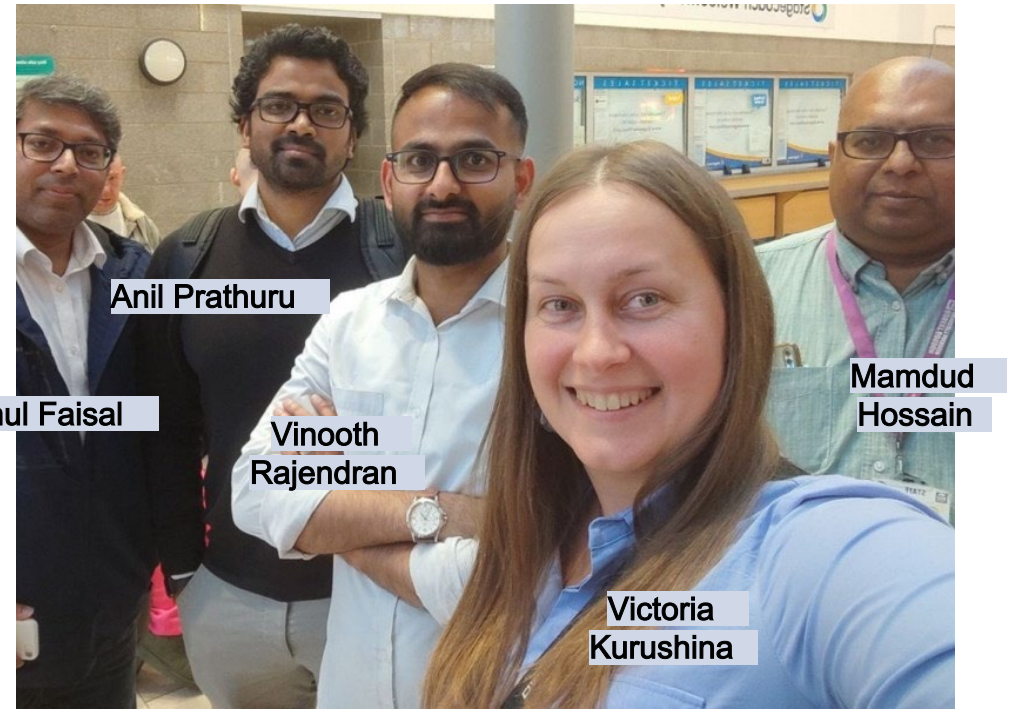
Scalable meta material thermally sprayed catalyst coatings for nuclear reactor high temperature solid oxide steam electroly sis (METASIS)

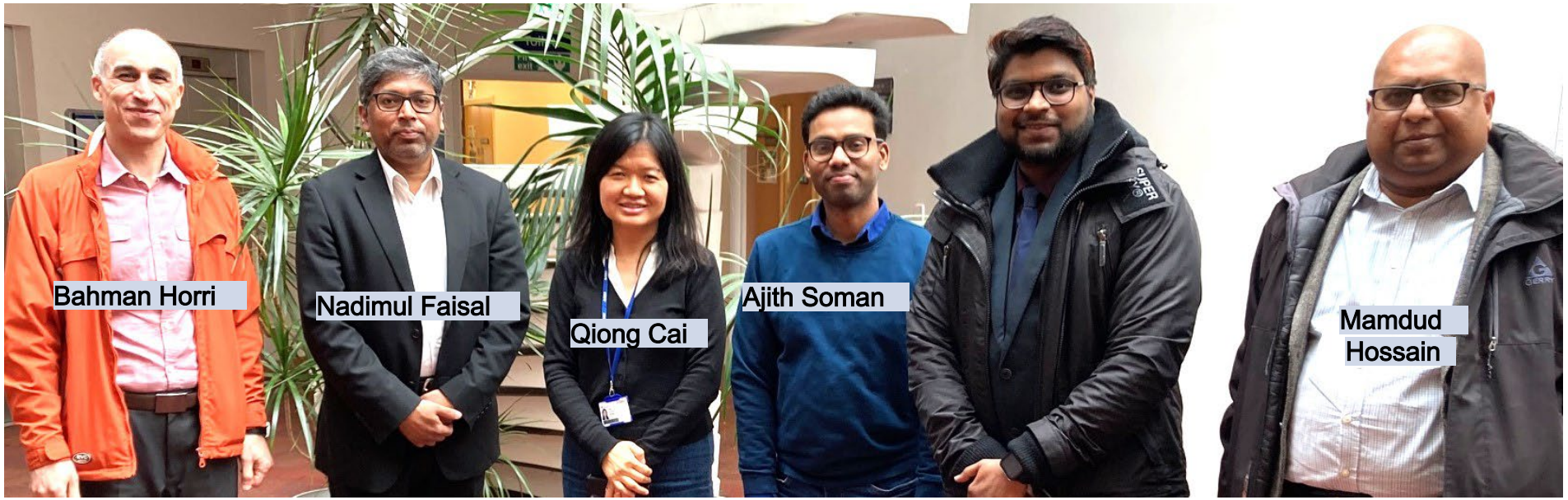
EP/W033178/1

UKRI Engineering and Physical Sciences Research Council



ROBERT GORDON UNIVERSITY ABERDEEN
Prof Nadimul Faisal
Prof Mamdud Hossain
Dr Anil Prathuru

UNIVERSITY OF SURREY
Dr Bahman Horri
Prof Qiong Cai



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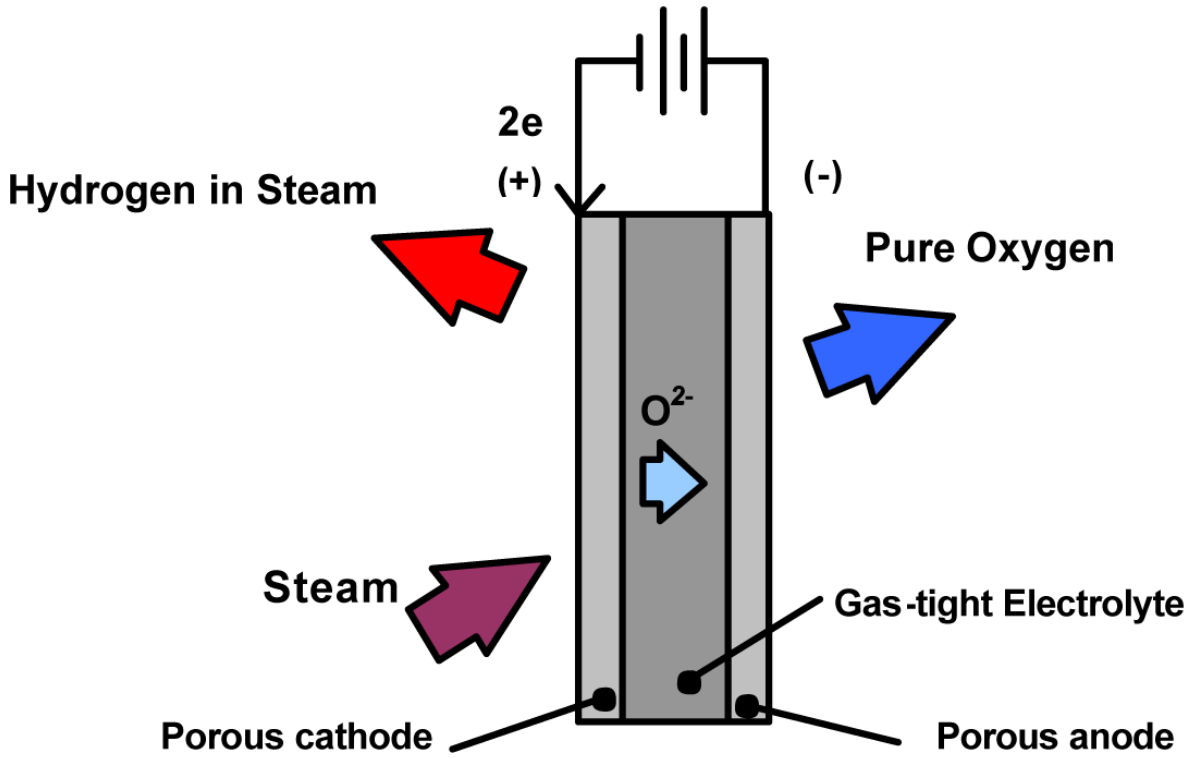
Solid oxide steam electrolysis (SOSE)



Industrial sectors where large amounts of high temperature heat energy are available: -

- nuclear power plants
- solar thermal plants
- geothermal plants
- steel plants
- ammonia and methanol production plants
- paper mills
- petrochemical plants

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Some numbers…UK

Ambition of the nuclear sector - produce 75 TWh of hydrogen by 2050

Electrolyser carbon footprint
SOSE (0.577 kg CO_2-eq./kWh)
AWE (0.651 kg CO_2-eq./kWh)
PEM (0.676 kg CO_2-eq./kWh)

Total heat waste from UK industry and electricity generation was nearly 391,000 GWh per year (in 2018)

Current hydrogen production cost using nuclear power and waste heat is €3.3 –6.8 (or £2.79 -5.74)/kg H_2

According to UK NNL estimates, the levelised cost of nuclear coupled hydrogen in 2050 is expected to be in the range of £1.24-2.14/kg H_2 for steam electrolysis

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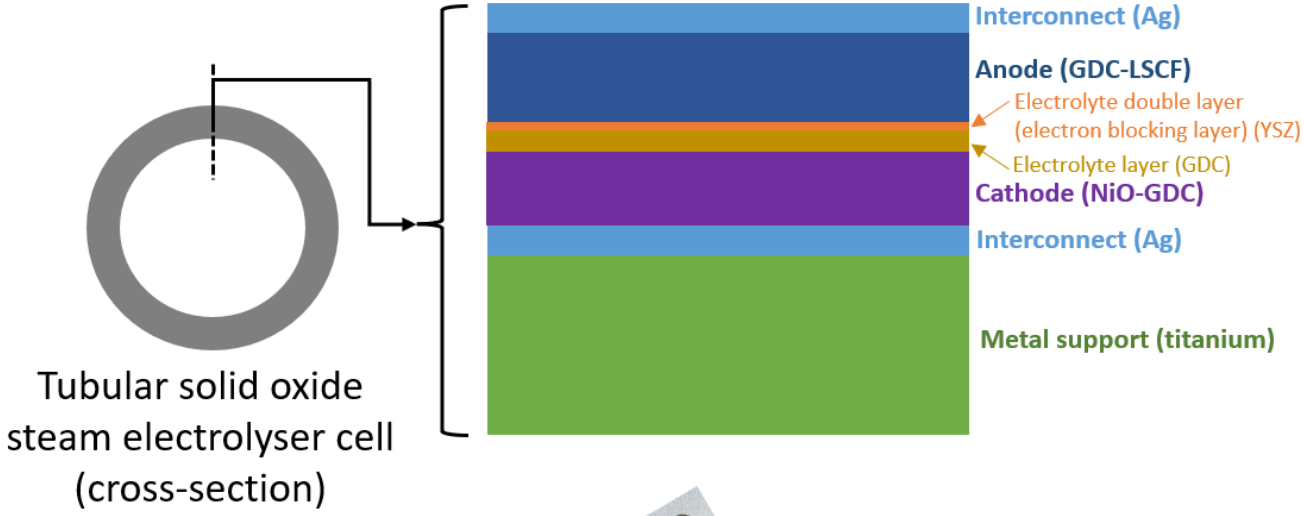
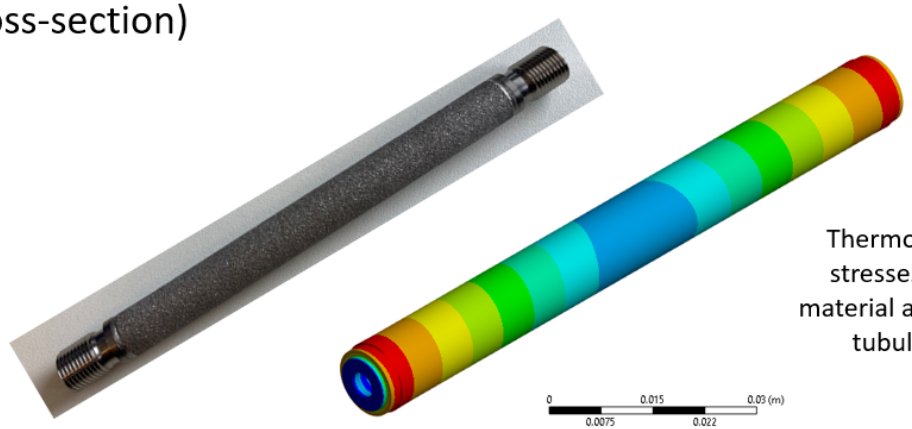
METASIS project

Design & modelling

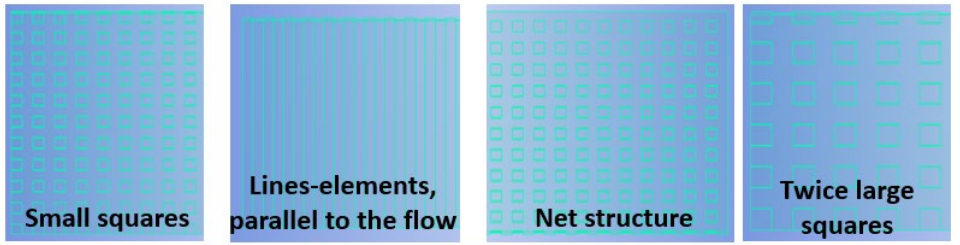


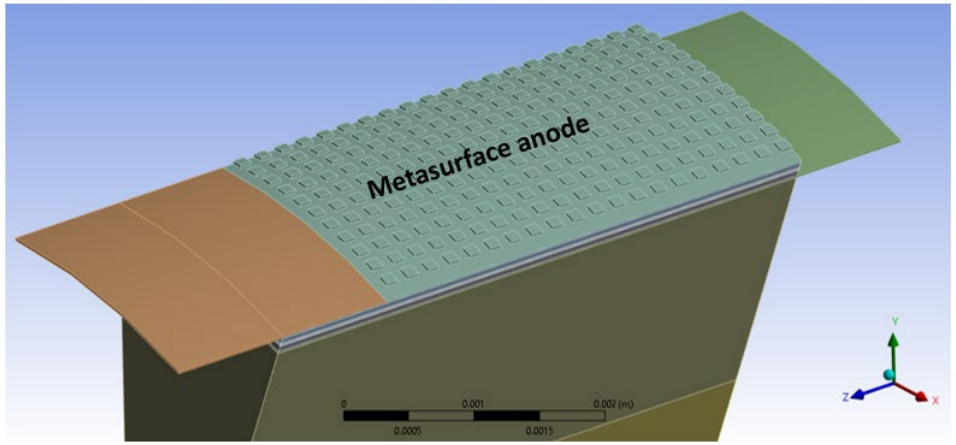
Tubular solid oxide steam electrolyser cell (cross-section)

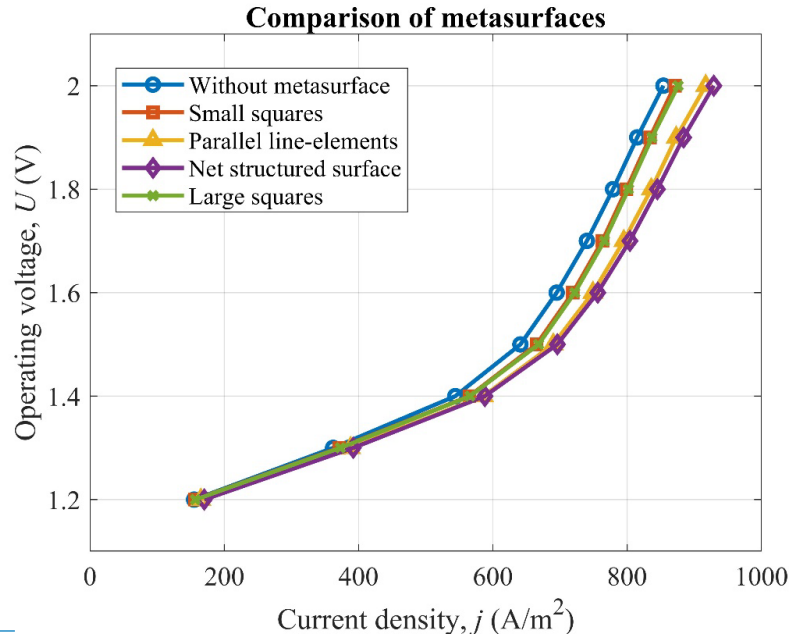


Thermomechanical stresses in a multi-material and multi-layer tubular system

Metasurface patterned anode for enhanced performance of solid oxide electrolyser







Victoria et al. Journal of Power Sources (2025); https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5015628

Victoria et al. Engineering Fracture Mechanics (2025); https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5021100

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METASIS project

Cell fabrication stages

Electrodeposition of silver on SS & Ti tubes

Half cell fabrication (dip coating slurries, current collector & cathode functional layer)

Full cell fabrication (electrolyte and anode layers, anode current collector and sealing)

Ultrasonicated slurries, high - temperature sintering (950 -1100 C)

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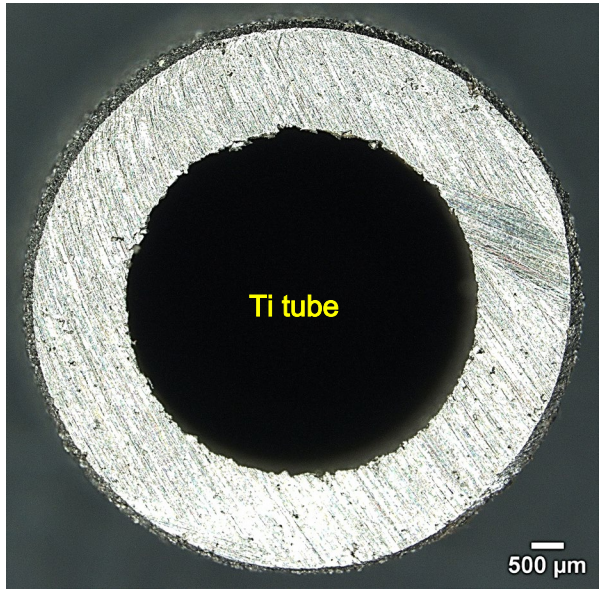
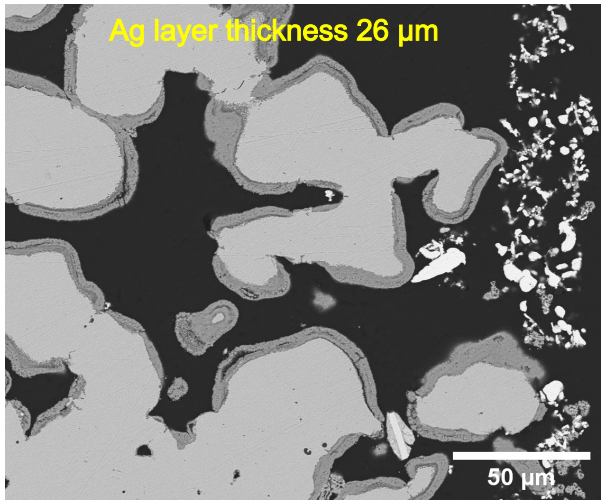
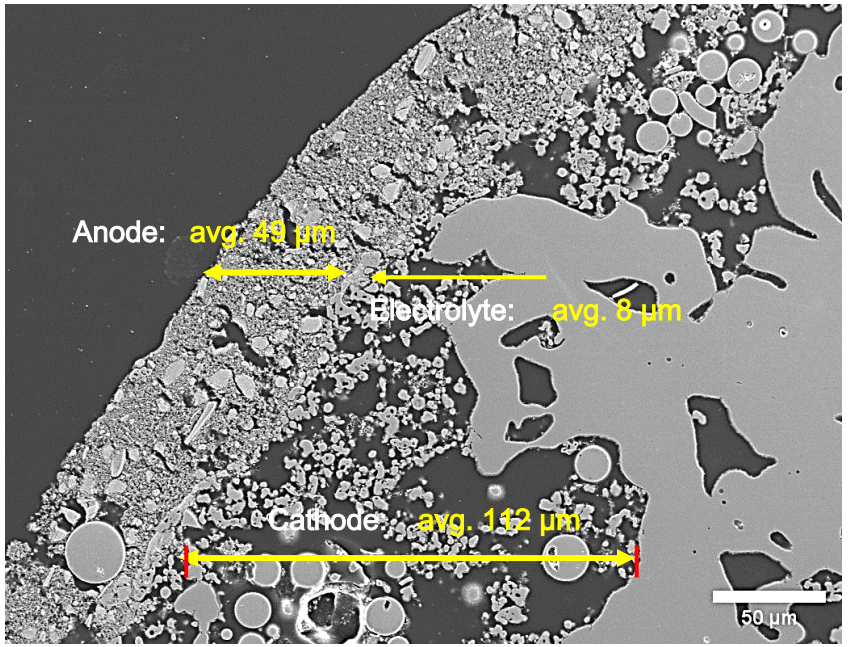
METASIS project

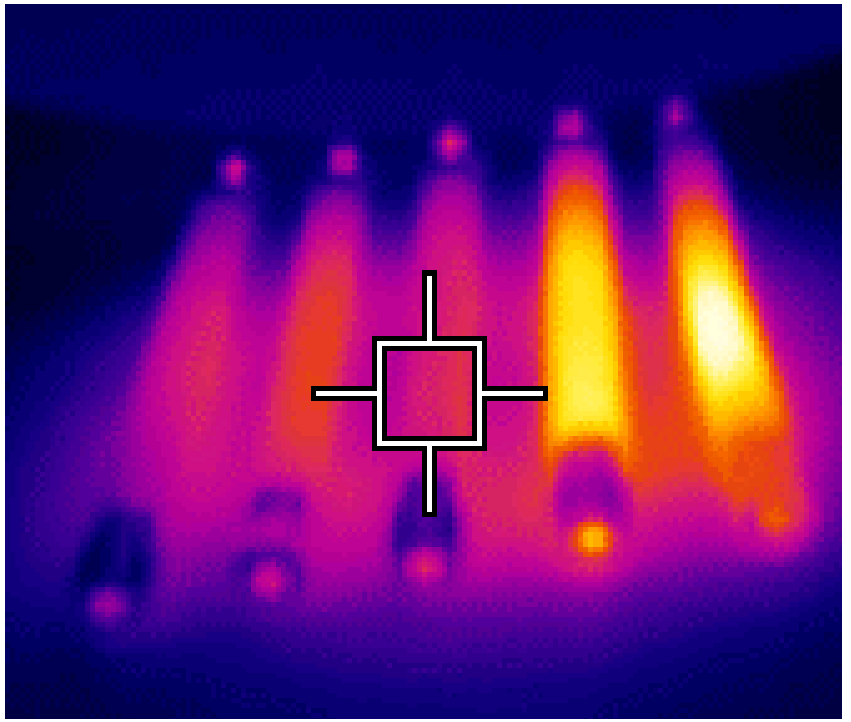
Manufacturing

- Electrodeposition
- Dip coating
- Air plasma spray coating









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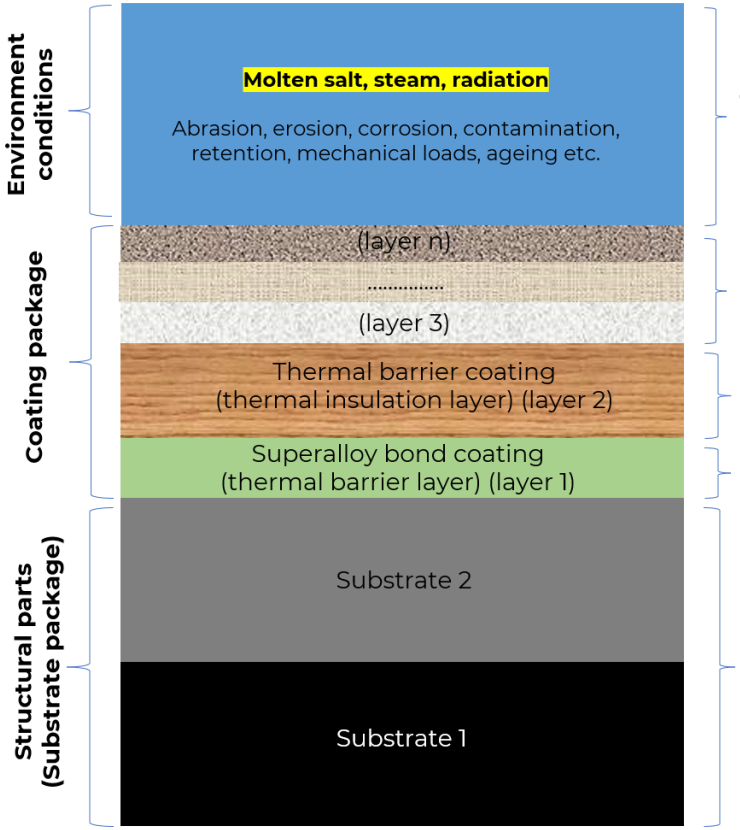
METALYSIS Project



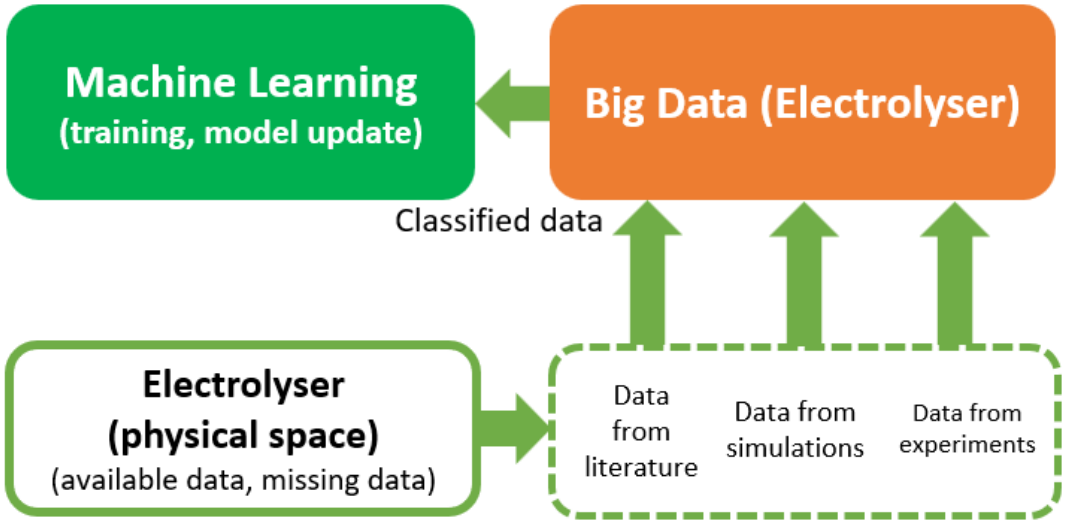
Challenges (measurement, material loss/degradation/retention/contamination)

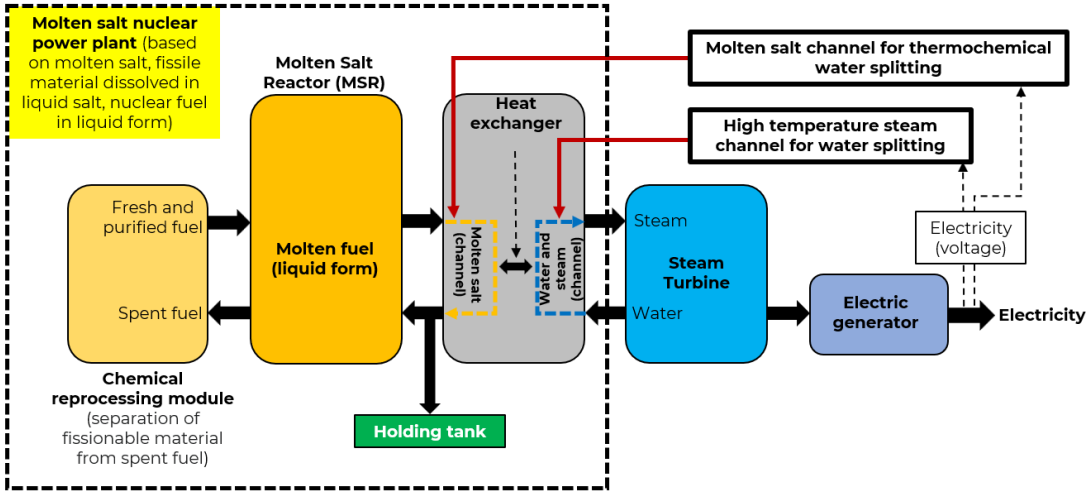
Functional multiple layers (sacrificial layer with low porosity, resistant against molten salt corrosion, good thermal stability, hardness, and wear resistance, no oxidation or colour change, better thermo-physical properties, and improved chemical inertness against foreign deposits). Need to have lower thermal conductivity values than bottom layer.

Thermal insulating layer (with good adhesion properties).

Thermal barrier layer (to enhance mechanical bonding with top layer, low thermal conductivity, low thermal expansion coefficient); Heat treatment of the layer could provide highest strengthening effect and can influence grain size.

Superalloys substrate (which can be used at high temperature. Creep and oxidation resistance are the prime design criteria).





MCAP034

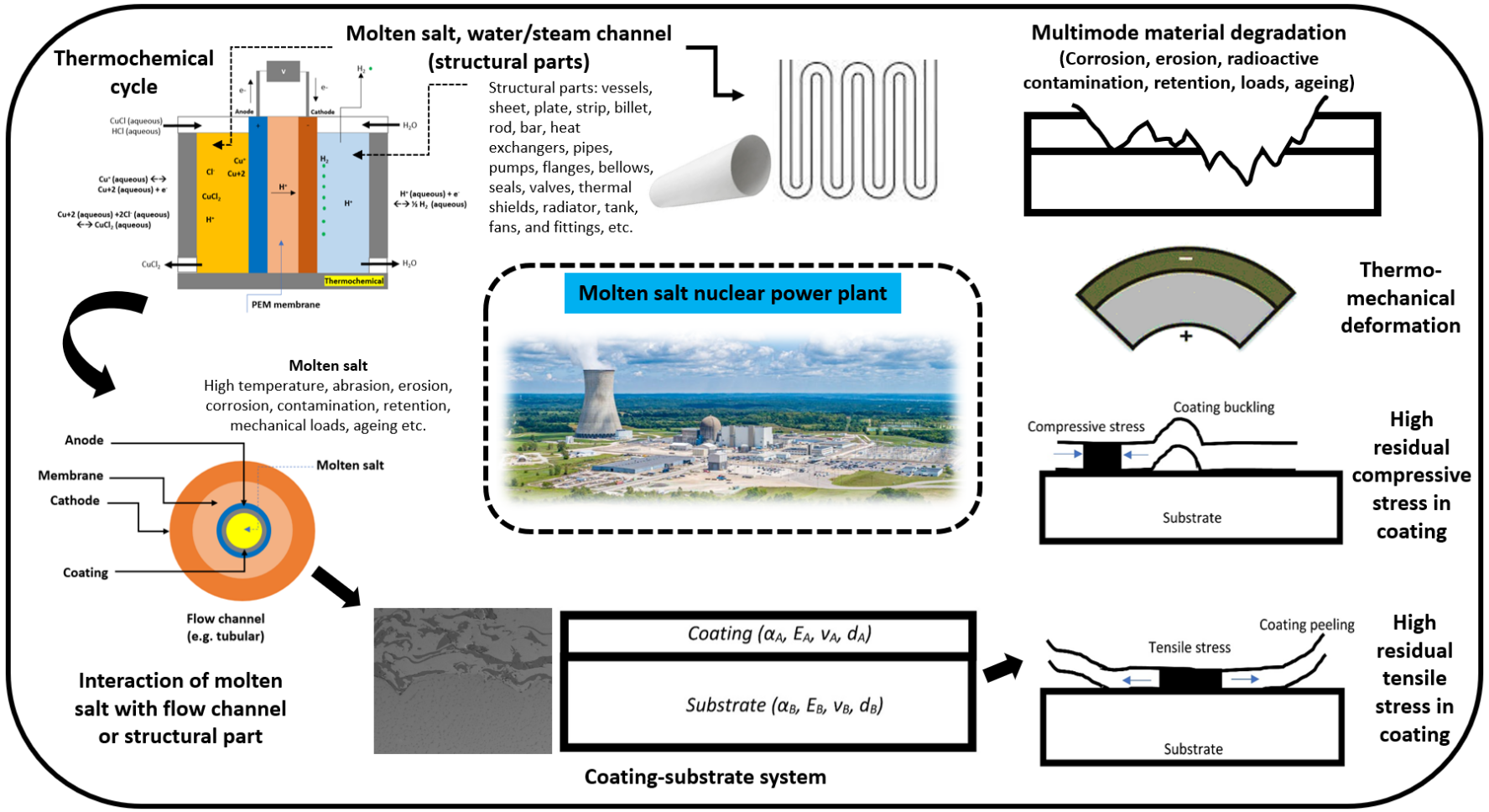
Structural materials and meta -data for high temperature electrolysis (METALYSIS)

Muthukrishnan et al., High Temperature Corrosion of Materials (2024);
https://link.springer.com/article/10.1007/s11085 -024 -10312-4

HENRY ROYCE INSTITUTE

Investigators
Prof Nadimul Faisal
Prof Mamdud Hossain
Dr Anil Prathuru

THERMOSIS Project



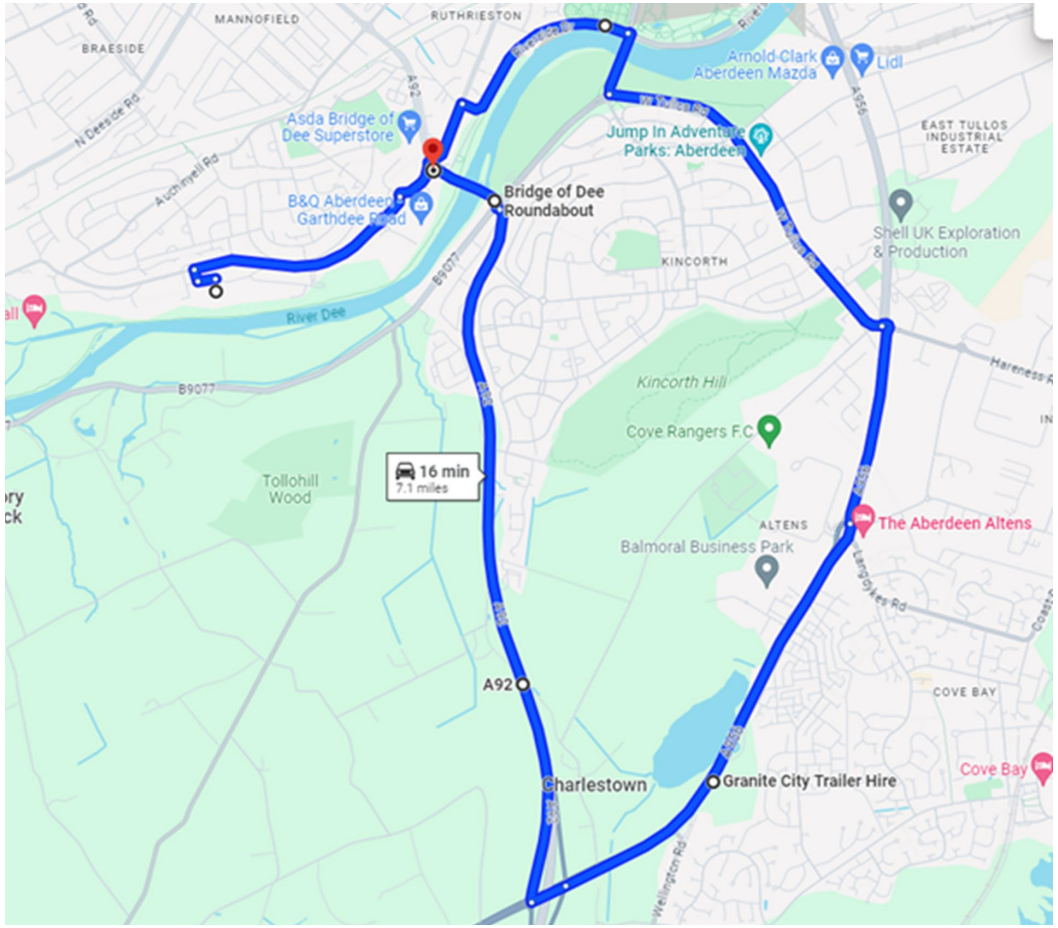
GC_596

Thermally sprayed coatings for thermochemical electrolysis at nuclear reactors (THERMOSIS)

Investigators
Prof Nadimul Faisal
Prof Mamdud Hossain
Dr Anil Prathuru

Consumer Perceptions Toward Hydrogen Fuel Cell Vehicles: A Demonstrator Project

Aim: Developing public awareness of hydrogen fuel cell technology and assess real world response of potential consumers to hydrogen fuel cell cars through a typical road drive experience (drive clinic).

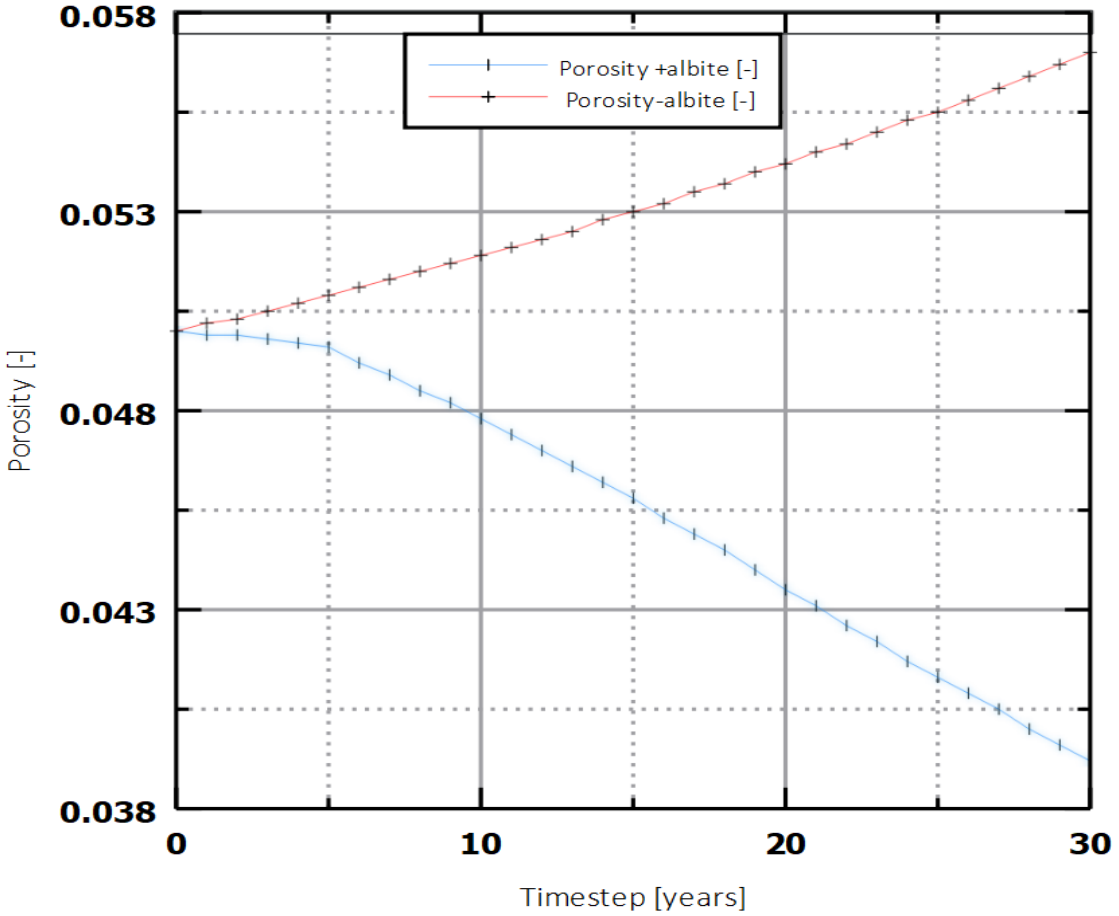


Investigators

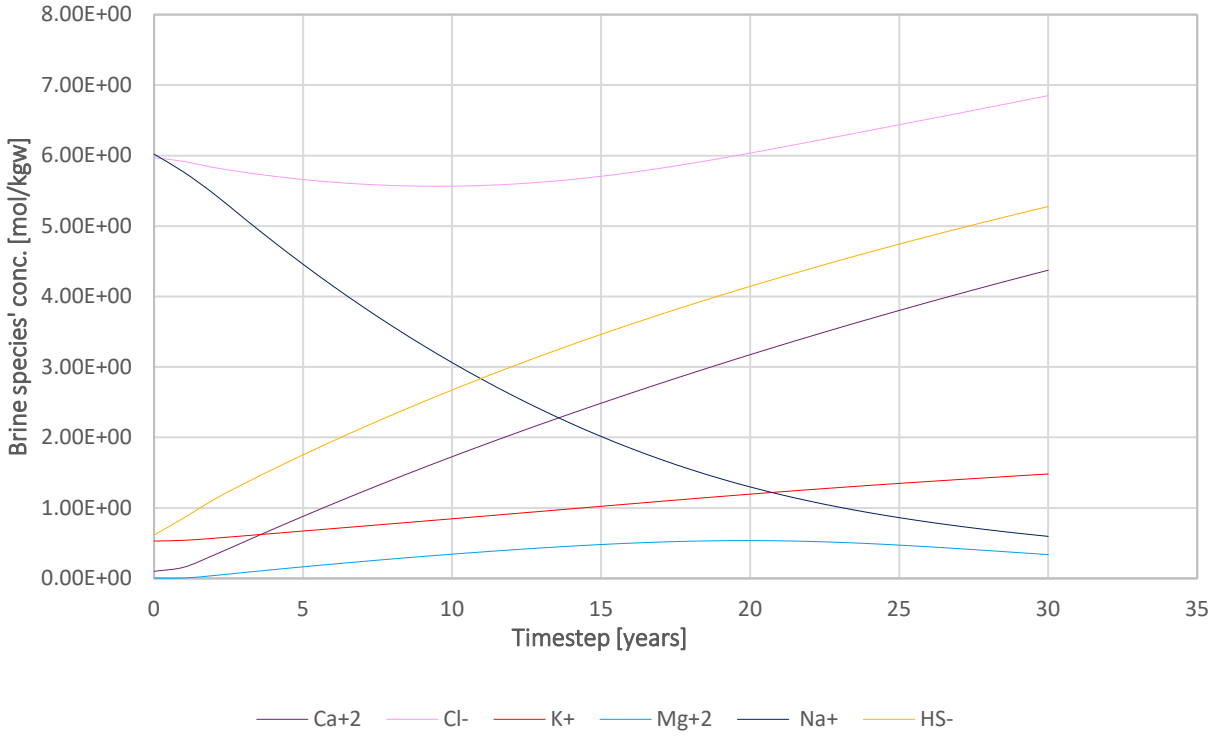
Prof James Njuguna
Prof Nadimul Faisal
Dr Bridget Menyeh
Tiwaoluwa Oladigbo
Alexander Oburoh

Underground Hydrogen Storage: Evolution of Porosity and Mineralogy

Maintaining the integrity of underground hydrogen storage systems through monitoring of porosity and mineralogy evolution



Underground Hydrogen Storage: Evolutions of the caprock porosity with and without albite in the model



Underground Hydrogen Storage: Distributions and concentrations of Ca^{2+}, $Cl-$, $K+$, $Mg2+$, $Na+$ and $HS-$ in the caprock brine

Investigators
Dr Gbenga Oluyemi
Dr Ruissein Mahon
Dr Ityona Amber
Kennedy Antwi

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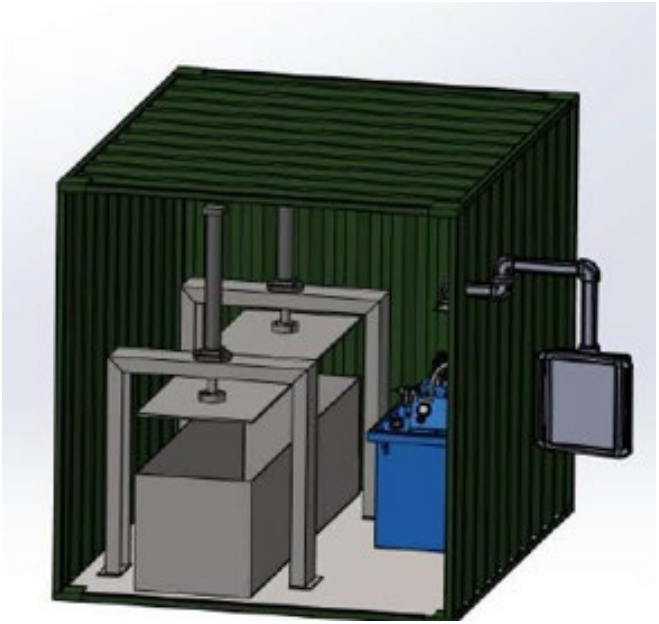
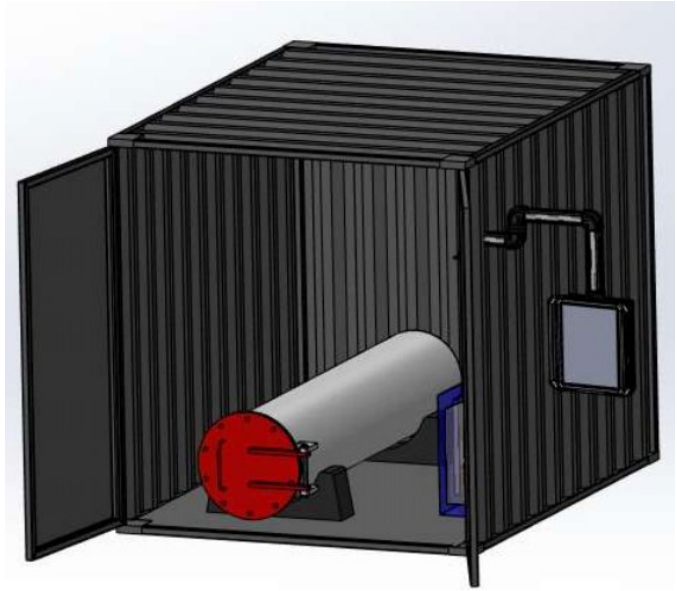
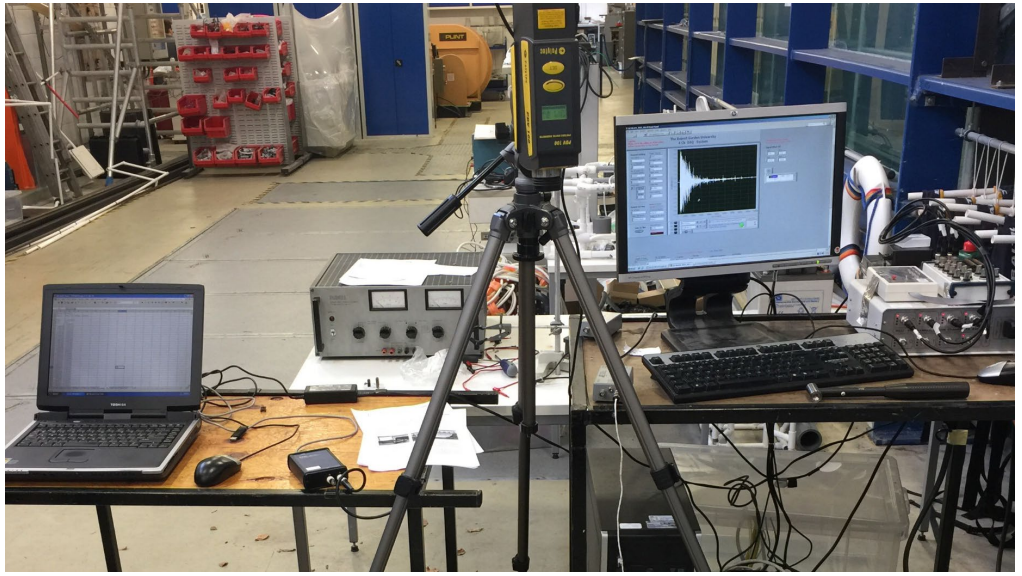
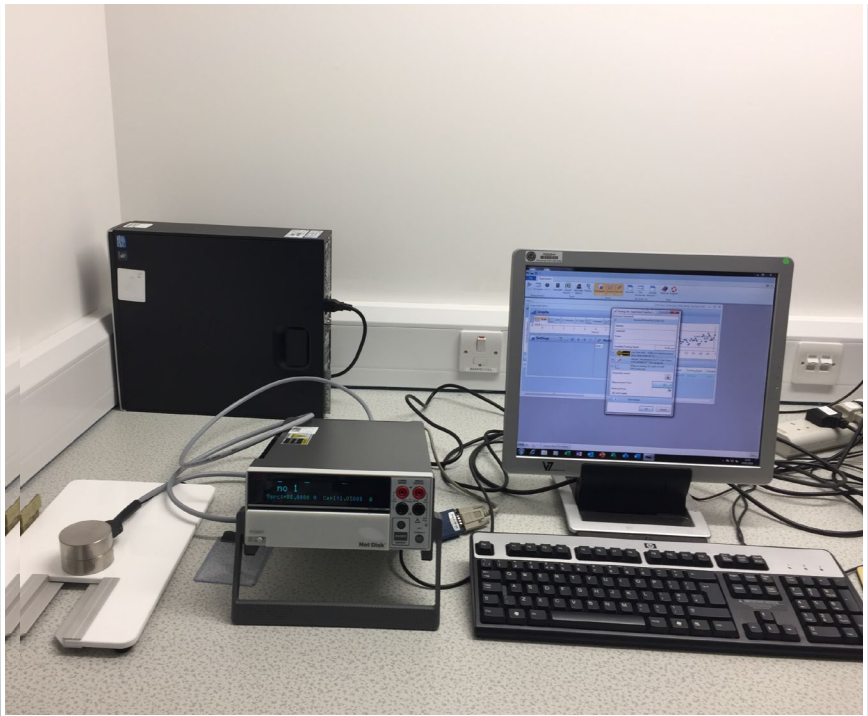
Experimental Facilities








XYZ 710 VMC
HD




INSTRON
INSTRON

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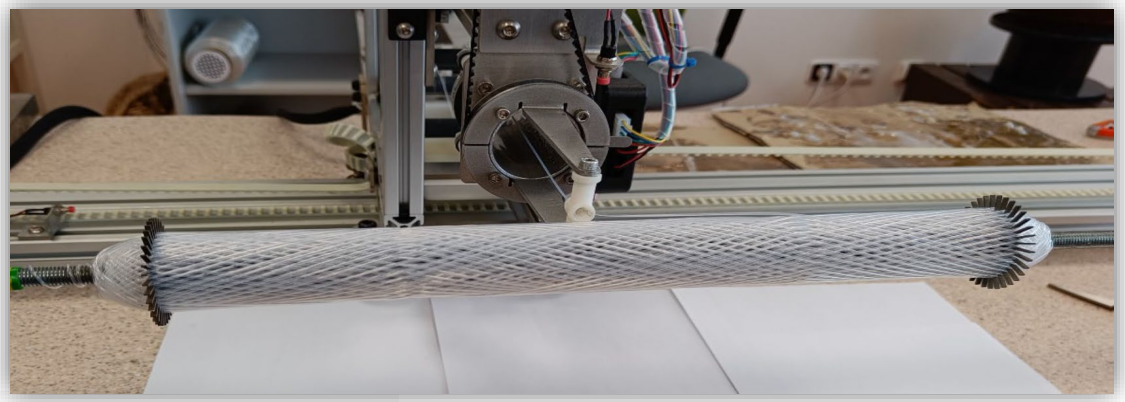
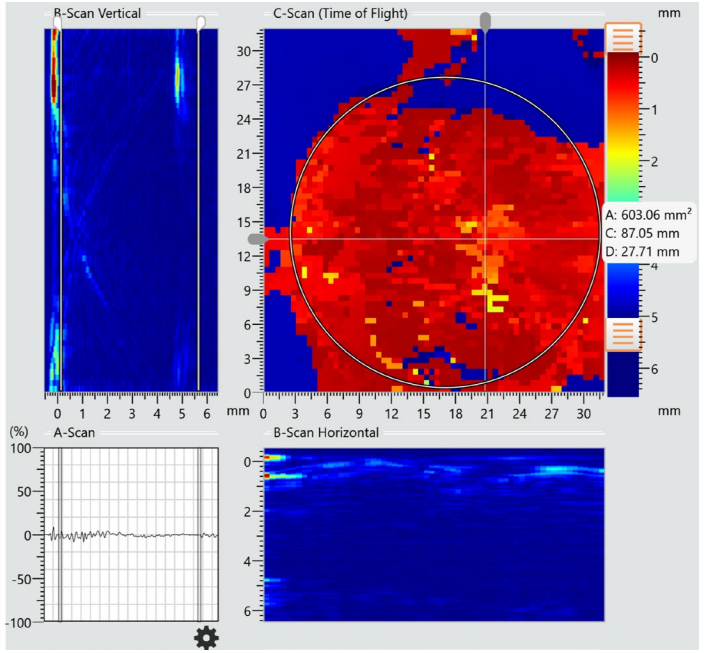
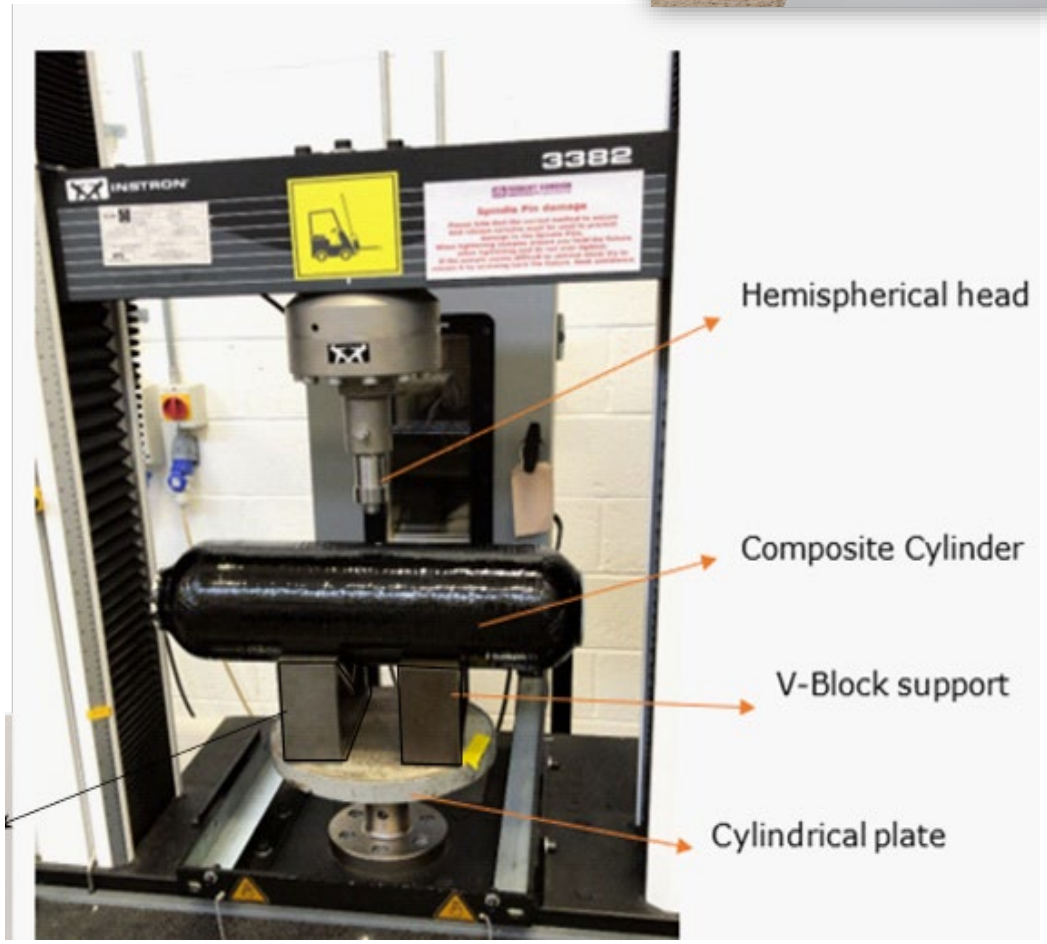
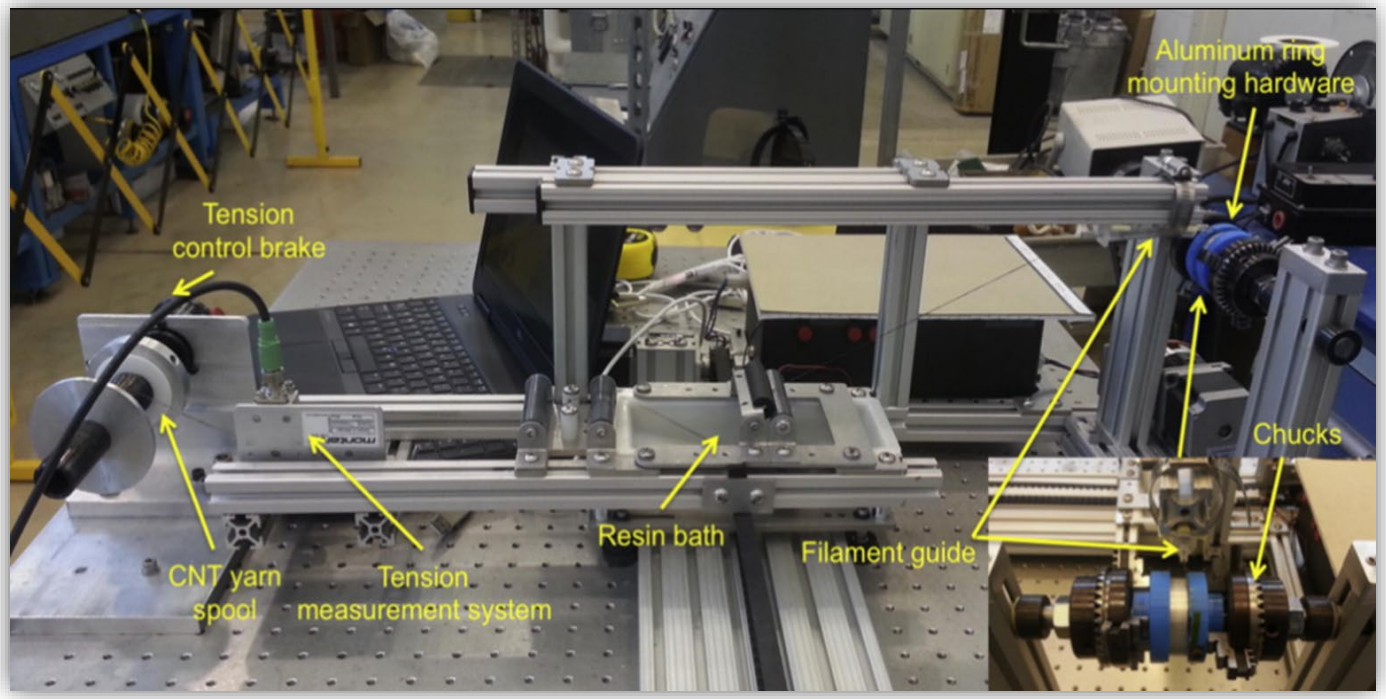
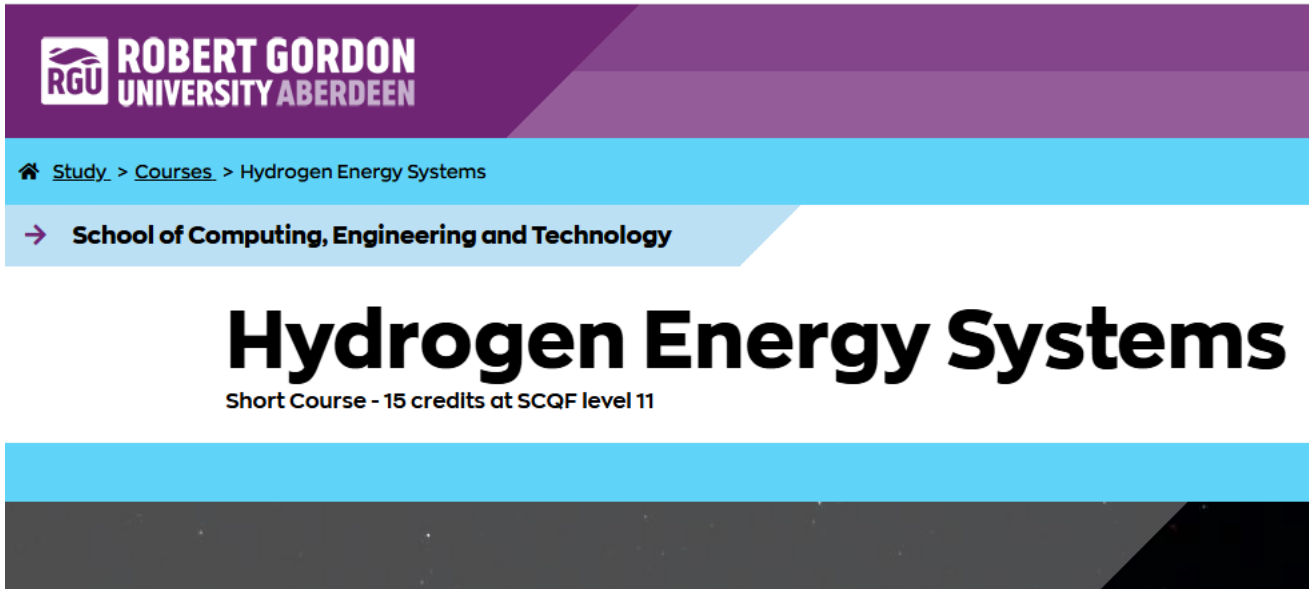








Hydrogen Upskilling Course, Public Engagement



https://www.rgu.ac.uk/study/courses/6325 -hydrogen -energy -systems

18 March 2025 – National Subsea Centre (NSC), Aberdeen

Thank you