



UK HyRES Research Excellence: Capabilities and Collaboration Opportunities

Across institutions | From fundamentals to deployment

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UK-HyRES

UK Hub for Research Challenges in
Hydrogen and Alternative Liquid Fuels

- UK Hub for Research Challenges in Hydrogen and Alternative Liquid Fuels (ref EP/X038963/1)
- Five-year, £10.7M EPSRC national research hub led by the University of Bath from 01/06/2023

The flagship UK-HyRES Hub will **identify, prioritise & deliver sustainable & practical solutions to fundamental research challenges** that must be addressed to ensure widespread adoption and deployment of hydrogen & alternative liquid fuels to meet Net Zero 2050.

UK-HyRES will provide an integrated **network & collaboration** platform for UK research & innovation communities & international partnering.



UK-HyRES Team at the Launch Meeting, September 2023



19

Universities



59

Staff & Students



40+

Partnerships



£27.1m

Funding

Hub Themes and Project map

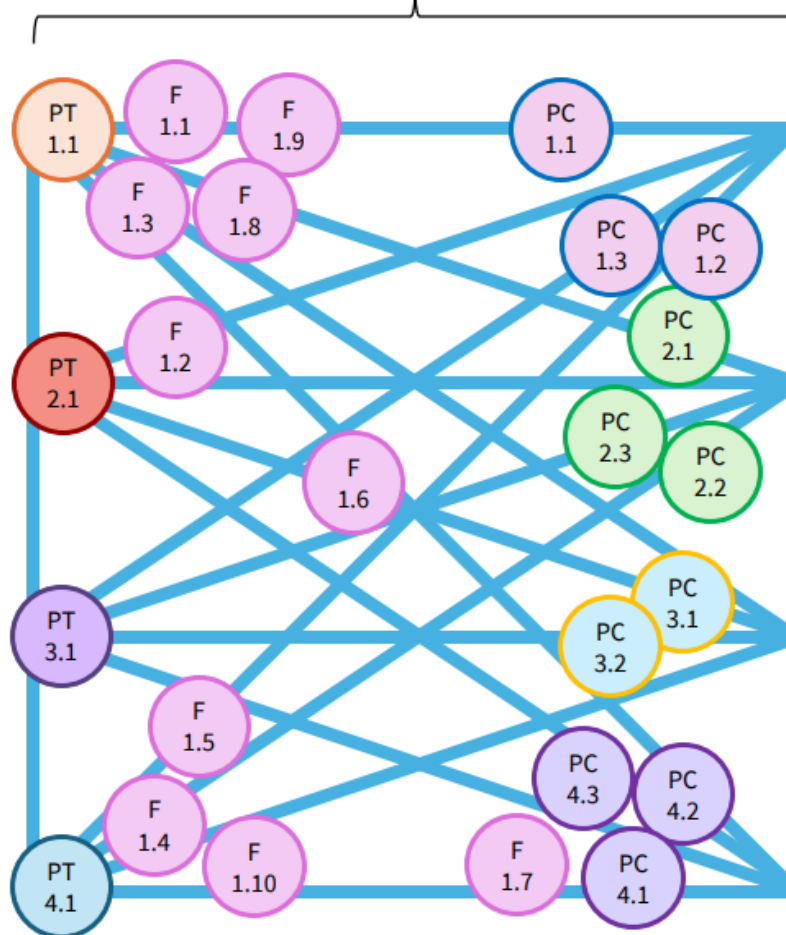
Co-I



Technical Themes

**TT1:
Production**
John Irvine

Projects



Cross-cutting Themes

**CT1:
Economic**
Paul Dodds

Co-I



Co-Director & Co-I



**TT2:
Storage &
Distribution**
Mi Tian

**CT2:
Environmental**
Rachael Rothman

Co-Director & Co-I



Co-I



**TT3:
End Use**
Qiong Cai

**CT3:
Social**
Chris Jones

Co-I



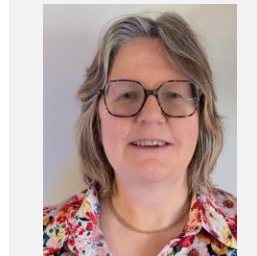
Co-Director & Co-I



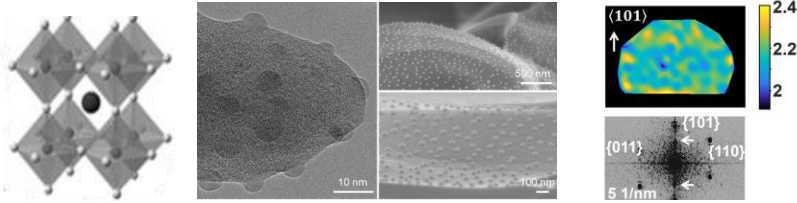
**TT4:
Alternative
Liquid Fuels**
Shanwen Tao

**CT4:
Safety**
Joan Cordiner

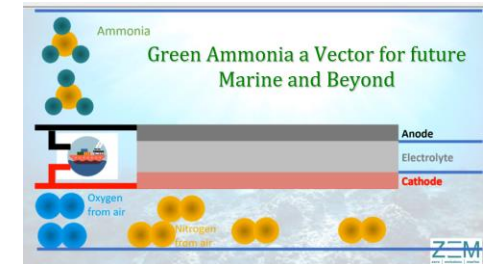
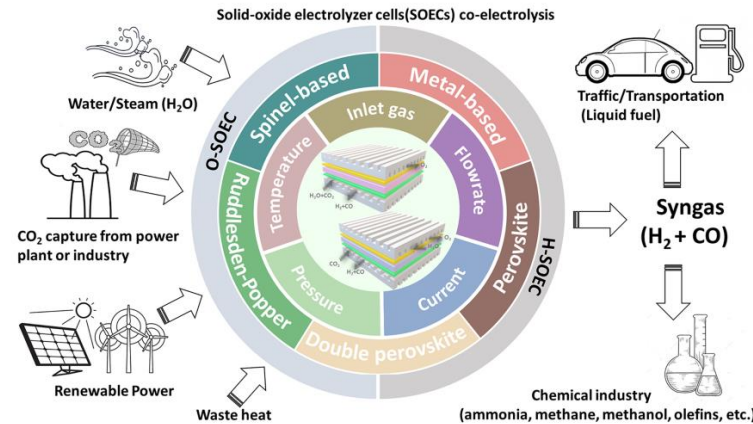
Co-I



JTSI Group - Energy and Materials in St Andrews



material development / engineering



material integration and testing

Key research areas

- ✓ Perovskites, double perovskites, spinel-based, metal-based, hydrides
- ✓ Solid oxide electrochemical systems (SOEC, SOFC)
- ✓ Low temperature electrolyzers & fuel cells (AWEC, PEMEC, PEMFC)
- ✓ Advanced battery materials (Na-, Li-ion, Solid-state and Thermal battery)

Electrochemical testing facilities

- SOEC/SOFC fabrication (tape casting, screen printing)
- Electrochemical test stations for SOEC/SOFC testing
- Battery assembly and testing systems
- Low temperature electrolyzers/fuel cell testing (PEM, AWE and RRDE)

Prof. John Irvine (jtsi@st-andrews.ac.uk)

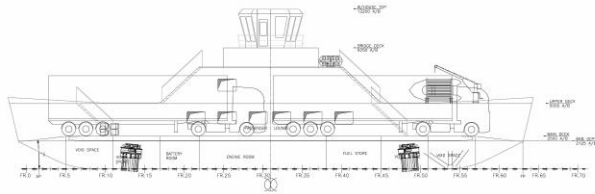
List of equipment

- ✓ FESEM / FEI Scios FIB-SEM/STEM
- ✓ Powder XRD/In-situ XRD/Single crystal XRD
- ✓ Raman/FTIR
- ✓ BET / TGA / Mass Spec.
- ✓ Particle size analyser / Dilatometry

Research activities and challenges

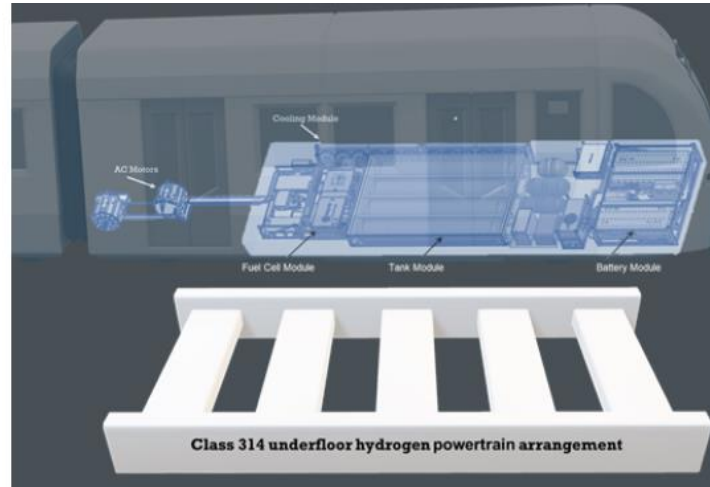
- Green hydrogen/green ammonia production
- Scale, manufacture, efficiency, durability
- Large vehicles (train, fleet)
- Marine (fuel cell drive, ammonia)

Hyseas III Hydrogen Ferry



- 6 x 100kW Hydrogen Fuel Cell modules
- 10+ tonnes of Li-battery
- Safety systems installed and tested
- Power – restricted to 600-700kW - maximum of 520W in duty use cycle trials

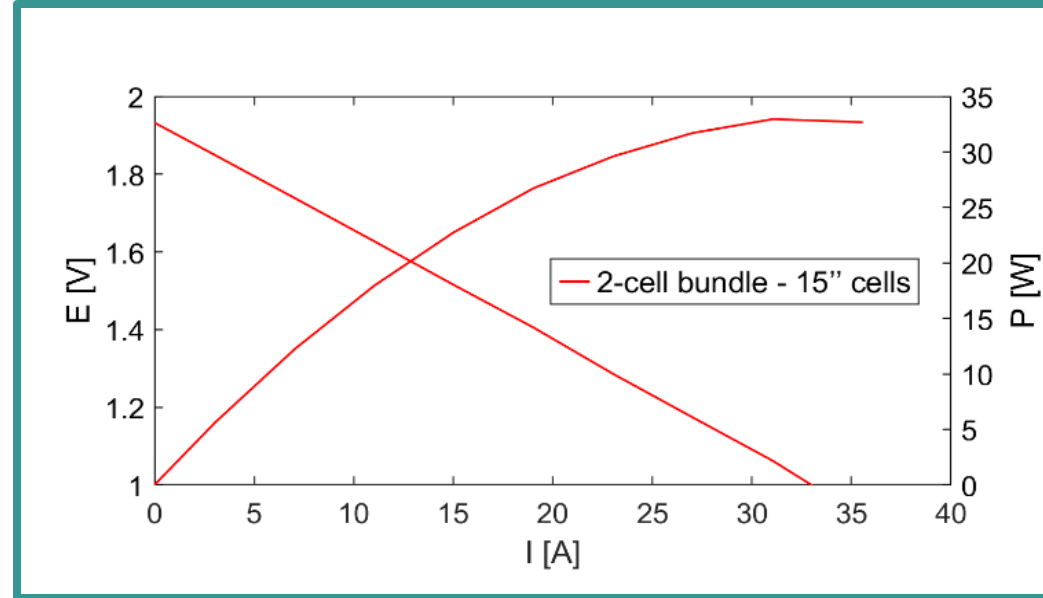
Zero Emission Train Project



Hydrogen Electrolyser



Green Ammonia a Vector for Future Marine and Beyond

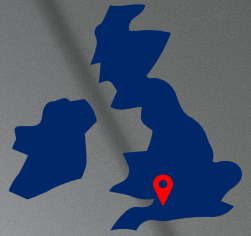


➤ *100W 3-cell bundle achieved*

ZEM
Zero | Emissions | Marine

Power to X Facility





Hydrogen Research and Innovation Lab

Department of Chemical Engineering,
Faculty of Engineering and Design,
University of Bath
Contact: Prof Mi Tian, mt747@bath.ac.uk



Research Strengths

- Gas sorption analysis and modelling
- Advanced characterisation: in situ neutron scattering
- Sustainable synthesis and mechanochemistry
- Solid-state hydrogen storage materials and composites

Facilities

- High pressure manometric (up to 20 MPa, 77-773 K)
- Gravimetric and dynamic mixed gas sorption analysis (up to 2 MPa, 77-1000 K)
- Low-pressure physisorption and chemisorption analysis
- High-pressure gas milling and hydrogenation reactors
- 100 % hydrogen thermogravimetric analysis (RT-2000 K)

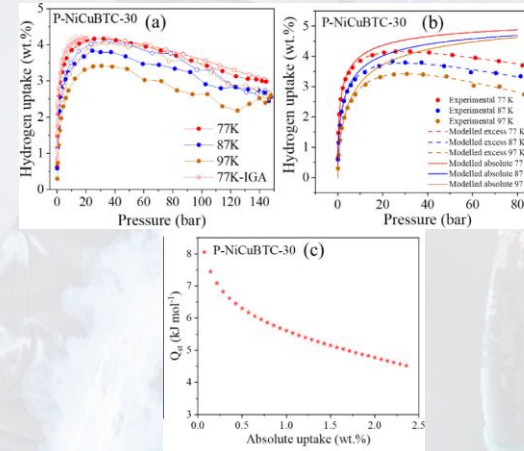
Research activities

- Advanced porous materials and metal hydride composites
- Hydrogen storage system design and scale-up
- Aerospace, mobility, and off-grid hydrogen applications
- In situ/operando characterisation and modelling
- Industrial testing, safety validation, and prototype development

Seeking Collaboration

- Hydrogen storage system integration
- Operando characterisation and modelling
- Industrial testing and prototype development

High pressure isotherm analysis

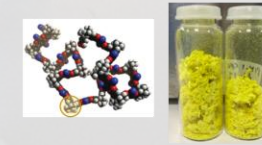


UNIVERSITY OF
BATH



PIM-1 (Budd & McKeown)

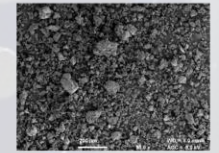
~ 800 (\pm 200) m² g⁻¹



- Processable (Composites)
- Mechanical & Thermal Properties

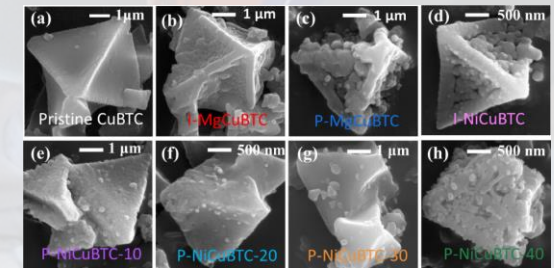
Activated Carbons

Up to 3440 (\pm 10) m² g⁻¹

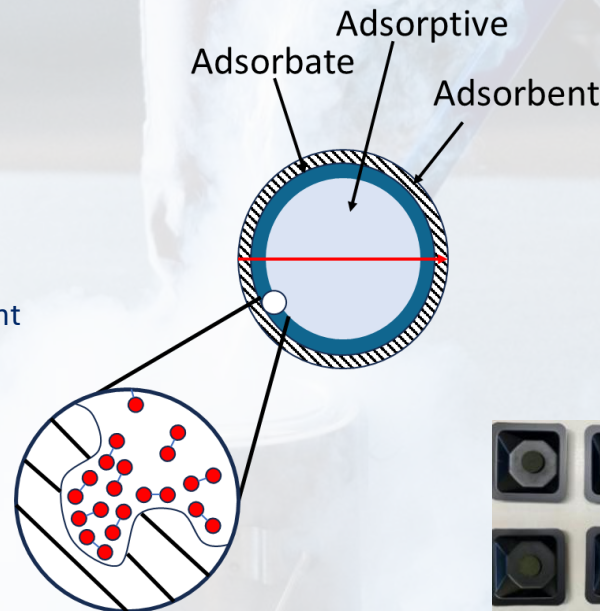


- Maxsorb™ (< 1 nm pore dia.)
- Filler (50% wt. +)

Modified metal organic frameworks



Consolidation and forming



Key areas of expertise / research strengths

Experiment:

- Synthesis of catalysts
- Testing anion exchange membrane electrolyzers
- Testing catalytic NH_3 cracking and NO_x conversion

Multiscale modelling:

- Density functional theory calculations
- Molecular dynamics simulations
- Mesoscale simulations of the electrode materials in electrolyzers and fuel cells

Specific areas where you are seeking collaboration

- Testing of solid oxide electrolyzers
- Manufacturing of porous electrode structures for electrolyzers

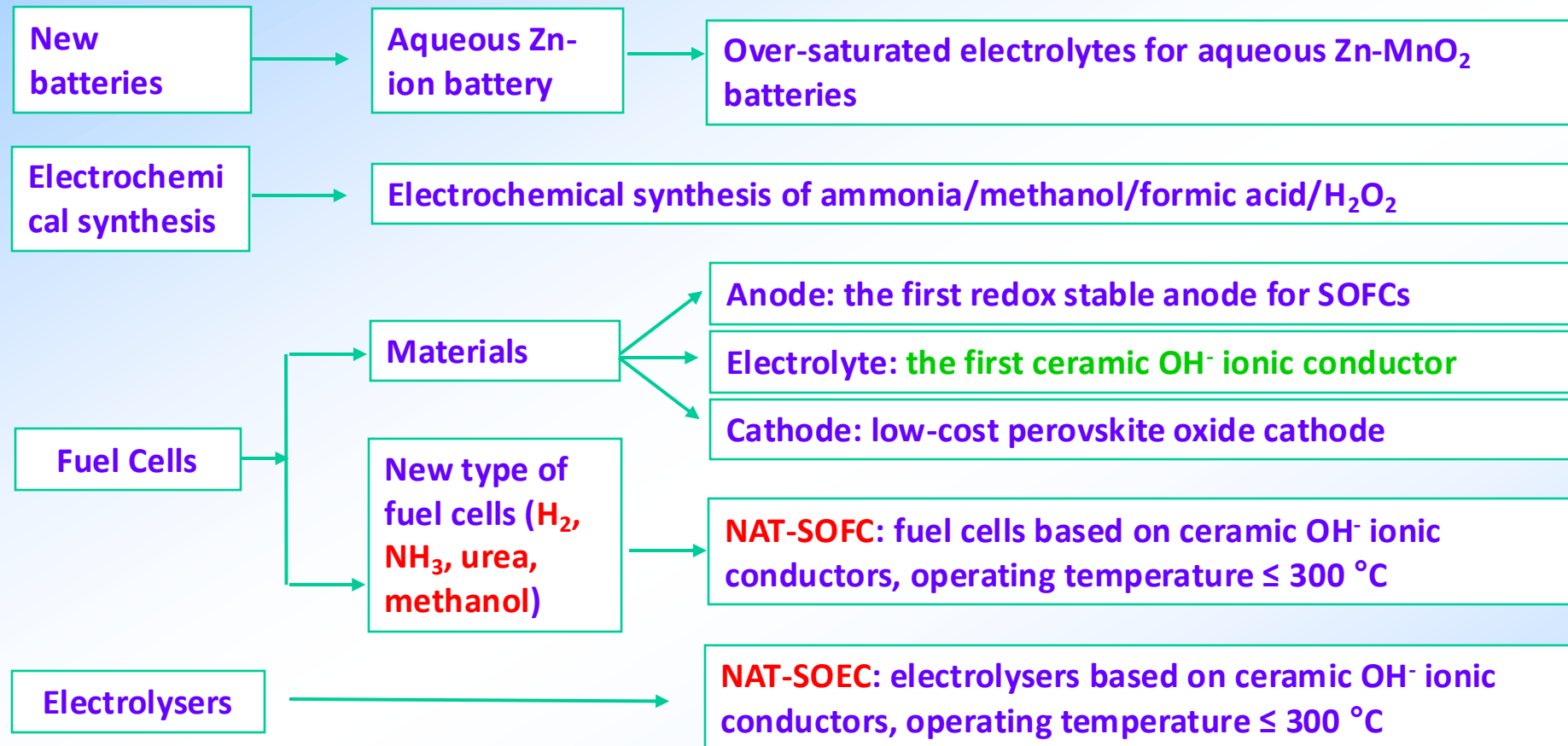
Facilities and equipment

- NH_3/NO_x conversion reactor
- Reactors and furnaces for materials synthesis
- AEM electrolyser
- Materials characterisation facilities

Current or upcoming research activities

- AEM electrolyzers
- Solid oxide electrolyzers
- Design of electrode microstructure and modelling of electrochemical performance and microstructure evolution
- Catalyst development
- Ammonia cracking
- NO_x removal

Key research areas at Tao's group



Collaboration areas: all the areas listed above

Research facilities: electrochemical interface; a.c. impedance; 1600°C muffle furnace

Contact: Prof. Shanwen Tao; Email: s.tao.1@warwick.ac.uk

Energy Transition Modelling Lab

UK-HyRES theme: Economics

Contact: Prof Paul Dodds
Email: p.dodds@ucl.ac.uk



Areas of expertise

- Energy and environmental system modelling
- Technoeconomic analysis (TEA)



Facilities

- Access to UK and global energy system cost-optimisation models and a UK electricity system model



Research activities in HyRES

- Business cases for various electrolysers
- TEA of green ammonia
- Hydrogen compression and purification technologies
- TEA of decoupled AEM electrolysers



Collaboration opportunities

A good technoeconomic analysis can reveal hidden opportunities, highlight risks, and strengthen your research. So, please feel free to reach out!



Prof Rachael
Rothman
University of
Sheffield



Josh Kassongo
University of
Sheffield



Alex Newman
University of
Sheffield

Key areas of expertise / research strengths:

- Expertise in **full value chain hydrogen life cycle assessment**, covering production (including **PEM, AEM, SOEC and fossil routes with CCS**), storage, distribution, and end use.
- Modelling of hydrogen utilization within **integrated energy and industrial systems** (e.g. power-to-X, synthetic fuels).
- Methodological **harmonization with techno-economic and social lifecycle assessments** and broader sustainability frameworks.

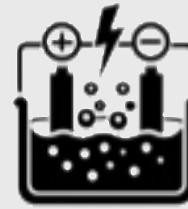
Key areas of expertise / research strengths:

- **SimaPro** –LCA platform with strong database integration, scenario management, and audit-ready modelling
- **Brightway** – flexible, code-based framework for large scale analysis
- **Ecoinvent** – high-resolution, peer-reviewed lifecycle inventory database covering global supply chains and industrial processes

Specific areas where you are seeking collaboration:

- Primary data collection for electrolyser stacks, large scale H₂ storage systems or fugitive emissions during distribution.

Current or upcoming research activities:



Electrolysis:

- Evaluation of the environmental impacts of hydrogen production pathways (aligned with PC1.1), with emphasis on GHG emissions and system integration (heat and energy coupling).
- Lifecycle assessment of electrolyzers accounting for stack configuration, technology maturity, operating conditions, and integration with industrial sectors.



Review paper [in draft]:

- Meta-review of hydrogen LCAs (~160 studies) to interrogate methodological choices (scope, functional unit, data, LCIA) and their effect on quality and comparability.



Hydrogen in aviation:

- Consequential LCA of hydrogen deployment in short-haul European aviation, inclusive of production, distribution, and airport infrastructure.
- Evaluating whether infrastructure burdens are non-trivial on a cradle-to-grave basis and associated trade-offs between upstream burdens and use-phase benefits.

Contact: chris.jones1@port.ac.uk
Website: targ-et.online



▶ Key areas of expertise

TARG:ET is an interdisciplinary group led by Prof. Chris Jones at the **University of Portsmouth**. We seek to better understanding the social acceptance of established and emerging energy technologies.

We advocate for the timely inclusion of societal perspectives into the research and development these technologies (and their related policies) through the application of rigorous social science.

▶ Specific facilities

We have access to software that can be used to create and analyse qualitative and quantitative social scientific studies. We can make use of online panels of participants to investigate opinion among different targeted groups of individuals.

▶ Research activities

Via UK-HyRES we have conducted questionnaire-based research into public perceptions of geological hydrogen storage and the use of hydrogen in aviation. We have also assessed stakeholder perceptions of the importance of social acceptance to hydrogen futures and are creating a network of social scientists with research interests in hydrogen and ALFs.

▶ Collaboration

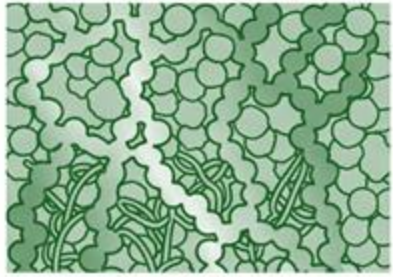
We are always open to collaboration with those in academia, business and beyond who are seeking to better understand the nature and predictors of acceptance of energy technologies among key social actors (publics, policy, stakeholders).

Skinner Group

IMPERIAL

Interfaces, Transport and Materials for Solid Oxide Energy Devices

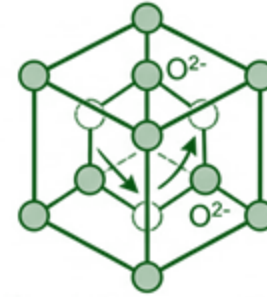
Contact: Prof Stephen J Skinner, s.skinner@imperial.ac.uk



Materials



Interfaces



Ion Transport



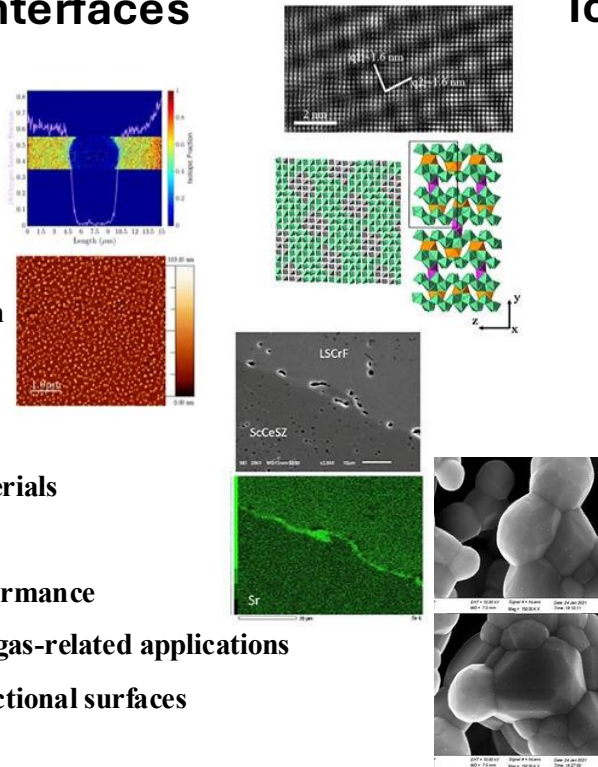
Device Performance

Research strengths

- Solid oxide fuel cells and electrolyzers (SOFC/SOEC)
- Ion transport in functional oxides
- Interfaces, thin films and heterostructures
- Surface exchange, degradation and performance optimisation
- Exsolution-enabled functional electrode surfaces

Current / upcoming activities

- ❖ Discovery and optimisation of SOC electrode/electrolyte materials
- ❖ Oxygen/proton transport studies in electrochemical ceramics
- ❖ Interface and grain-boundary control for improved cell performance
- ❖ Oxygen transport membranes for oxygen separation and syngas-related applications
- ❖ Heterointerface engineering and exsolution strategies for functional surfaces



Facilities / capabilities

- ❑ High-temperature electrochemical testing and impedance spectroscopy
- ❑ Labelled isotope studies for oxygen and hydrogen mobility
- ❑ Surface and interface analysis: XPS, LEIS, SIMS, APT
- ❑ Thin-film / heterointerface characterisation and structure–function studies
- ❑ Access to national large-scale facilities for operando / structural investigations

Seeking collaboration

- Operando / in-situ characterisation of SOC materials and interfaces
- Modelling of transport, surface exchange and degradation
- New electrode/electrolyte materials for electrolyzers and reversible cells
- Microstructure–performance–durability correlation across scales
- Joint projects linking materials chemistry with device-level validation

The Symes Group



University of Glasgow | School of Chemistry

Electrochemistry, Energy Conversion and Electrocatalysis

Key areas of expertise / research strengths: All aspects of electrochemistry and energy conversion in chemical systems:

- Electrochemical water splitting
- Decoupled electrolysis
- New routes to nitrogen fixation
- Electrosynthesis
- Electrochemistry for space applications
- The electrochemical and spectroscopic properties of coordination complexes, and chemistry in molecular cages

Current or upcoming research activities:

- EPSRC HyRES award (2025–2027, £300k FEC):
Decoupled electrolysis of seawater
- Novel methods to fix nitrogen

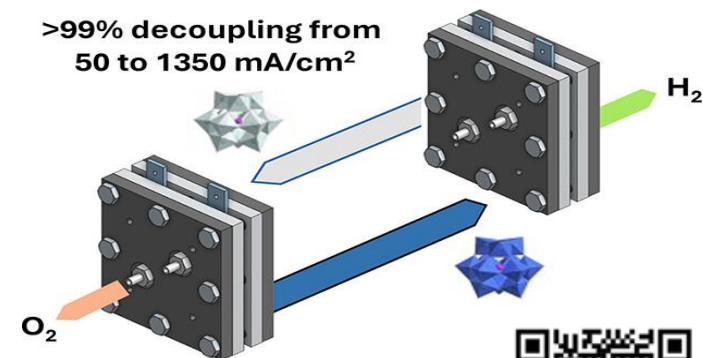
Facilities and equipment :

- Potentiostat/Galvanostat systems for all electrochemical measurements
- Gas chromatography (GC)
- UV–Vis spectrophotometer
- Ultrasonic processor / sonicator
- Access shared university analytical facilities

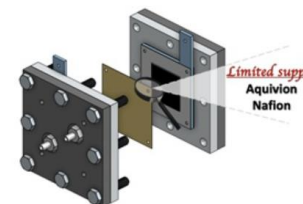
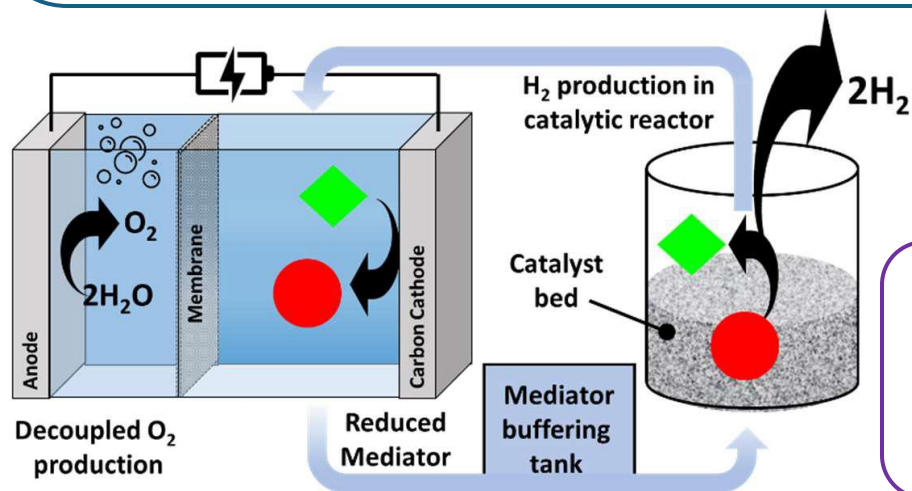
We are interested in collaboration on:

- Academic and industrial partnerships (sustainable energy conversion, electrocatalysis research, green hydrogen production, techno-economic & systems modelling)

>99% decoupling from
50 to 1350 mA/cm²



Symes Lab



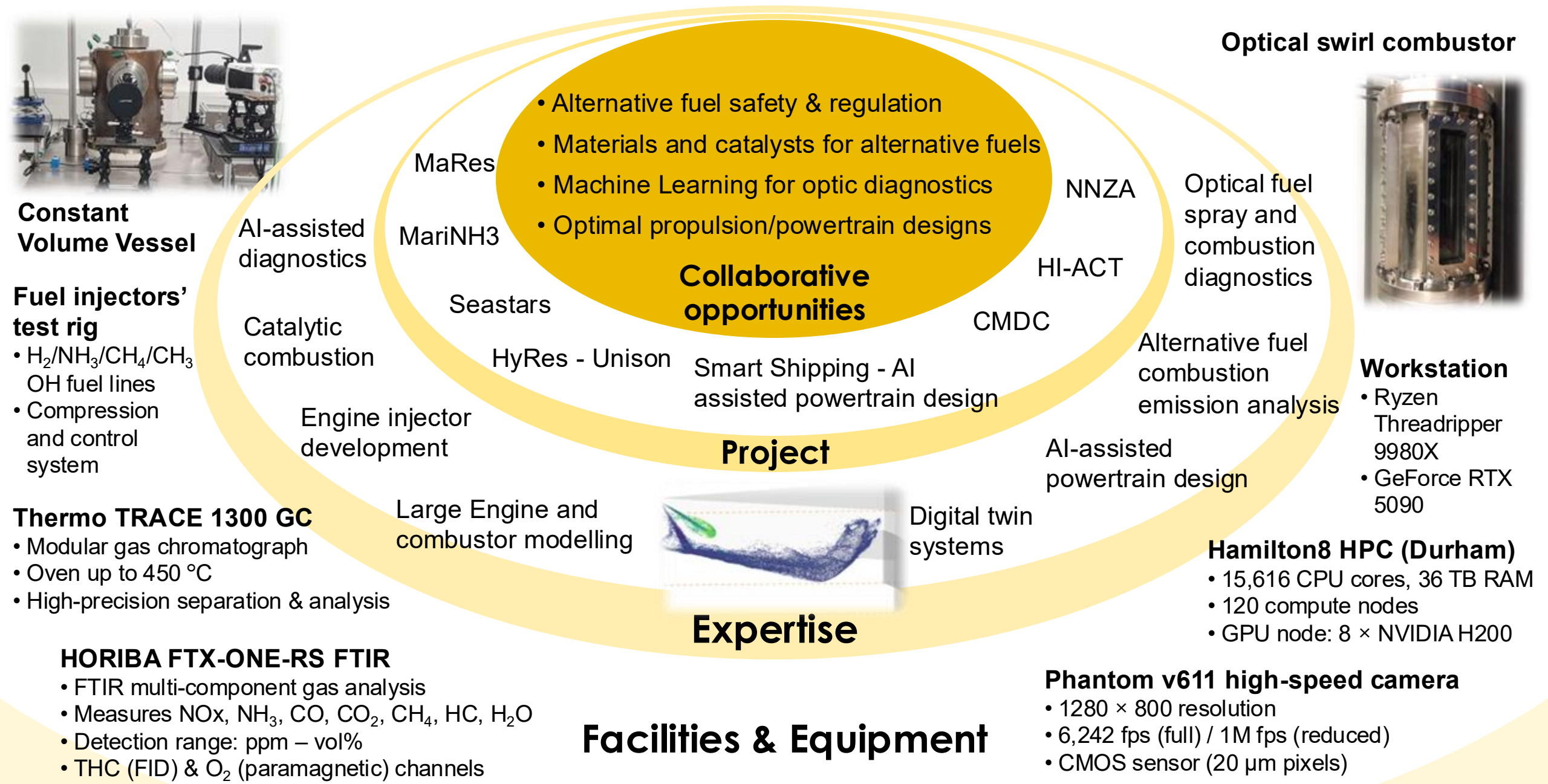
PFSA D170-U membrane

Engineering and Physical Sciences Research Council



Contact: Prof. Mark D. Symes: Mark.Symes@glasgow.ac.uk, Dr. Zeliha Ertekin: Zeliha.Ertekin@glasgow.ac.uk

Joseph Black Building, University of Glasgow, G12 8QQ, United Kingdom



➤ Research Areas

- **Optical fibre sensors** for monitoring strain, temperature, vibration, acoustic emission, chemical reactions, hydrogen and refractive index.
- **Integration of sensors** in/on bridges, concrete, composites, pressure vessels & analytical equipment.
- **Self-sensing composites** using reinforcing fibres and light guides.
- **Integration of sensors** into solid-state hydrogen storage systems for charge monitoring.
- **Fusion Fuel breeding and recovery** using inline sensing to detect the presence of hydrogen isotopes from breeding and ceramic membranes recovery.
- **Dense Membranes for purification** developing metal and ceramic membranes for hydrogen purification.
- **Recycling of functional Oxides** using hydrogen as a reducing agent for the recycling of Li-ion batteries.
- **Hydrogen Embrittlement** using gaseous conditions to simulated real world conditions under strain and unstrained.

➤ Current & Planned Research

- *Low-cost sensors for detecting hydrogen.*
- *Vision-based sensing for hydrogen.*
- *Sensor integration into a Sievert's rig.*
- *Alloys for sensing hydrogen.*
- *Alloy coating and characterisation methods.*
- *Kinetic studies of the sorption of isotopes of hydrogen in different alloys.*

➤ Collaboration

- *Integration of sensors in/on structures and equipment.*
- *Bio-based carbon nano-fibres.*
- *Composites & sensors for cryogenic H₂ storage.*
- *Composites & sensors for 700 bar compressed H₂ storage.*
- *Distributed sensors for hydrogen pipelines.*

Contacts: Professor Gerard Fernando. Professor David Book. Dr Dan Reed.

g.fernando@bham.ac.uk

d.book@bham.ac.uk

d.reed@bham.ac.uk

Stabilizing the AEM-Catalyst Interface (STACI)

Project team:



Alex
Cowan (PI)



Laurence
Hardwick (Co-I)



Alex
Neale



Bhavin
Siritanaratkul



Jacqui
Everitt

Expertise:

- ◆ Electrochemistry
- ◆ Electrocatalyst development
- ◆ Spectroscopy of interfaces
- ◆ Electrolyser testing and development

Facilities:

- ◆ Electrolyser stations (H₂O, CO₂)
- ◆ Raman microscopes, FTIR spectrometers
- ◆ Gas analysis (GC, DEMS)

Research activities:

- ◆ Catalyst-ionomer interface stabilisation by protective coatings
- ◆ Development of *in situ* Raman spectroscopy cell and methods to probe interface degradation.

Collaboration areas:

- ◆ Electrocatalysis
- ◆ Low temperature electrolysers
- ◆ *In situ* spectroscopy

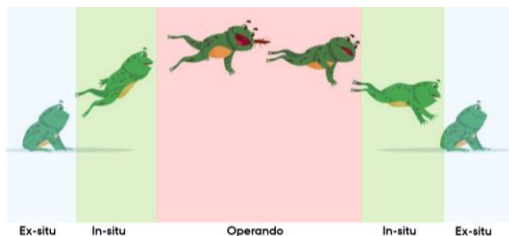
WALTON RESEARCH GROUP @ UNIVERSITY OF MANCHESTER

Research Areas:

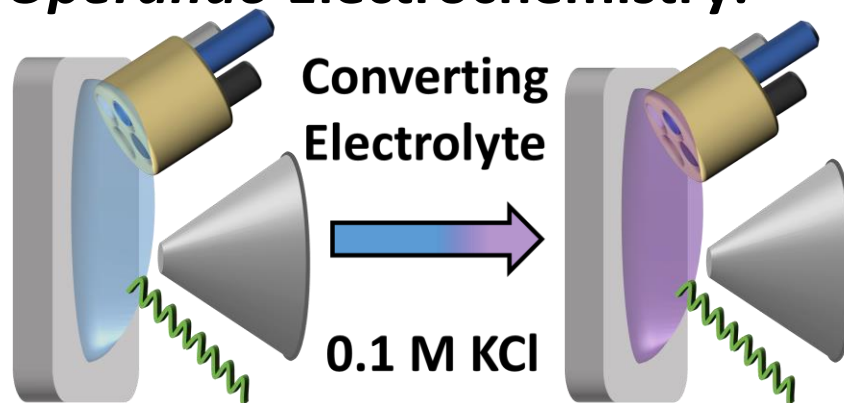
1. Probing the solid-liquid interface in-situ.
2. Operando studies of heterogeneous catalysts.
3. Surface science studies of model thin-film electrocatalysts

Collaborative areas include but are not limited to:

1. Operando studies of catalytic systems.
2. Probing surface chemistry of materials in-situ.

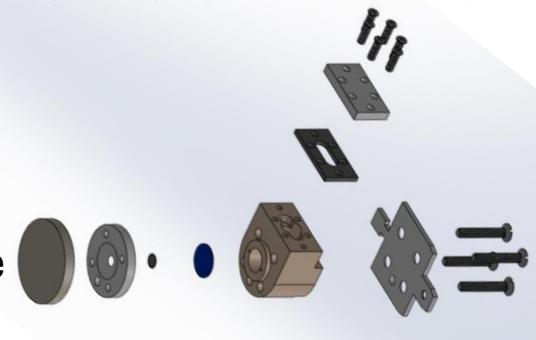


Operando Electrochemistry:



Operando Electrochemical cell:

For catalyst coated membranes, for use in a two-electrode system.



Facilities include 4 different X-ray Photoelectron Spectroscopy systems including: UV-light to Hard X-ray, depth profiling, inert transfer. A handheld X-ray fluorescence (XRF) device. An e-beam evaporator for physical vapor depositions.

The Near Ambient Pressure XPS has capabilities of:

- Up to *three* gases simultaneously up to a total pressure of (~10 mbar).
- Heating/cooling of the sample during analysis in gas mixtures- heating to ~500°C and cooling down to ~ -50°C.
- Electrical biasing during measurement possible.
- Simultaneous mass spectrometry. (correlation of gas composition to XPS measurements)
- Capillary for liquid injection. (bulk liquid XPS or solid/liquid interface)
- Surface science sample prep chamber. (sputter/annealing, ports for e-beam evaporators etc.)

~GAS MENU~

O₂
CO₂
CO
NH₃
NO
H₂
H₂O (vapour)
Others possible upon request

To collaborate, please contact:
Alex.Walton@manchester.ac.uk
For more information visit:
waltonresearchgroup.com

NanoSIMS 50L



- The NanoSIMS Lab applies the Cameca 50L NanoSIMS for characterisation in a range of different material science problems.

Research Areas:

- Investigating hydrogen localisation and correlated microstructures.
- Spatially resolving hydrogen and deuterium distributions.
- Temporal studies of materials using dynamic isotope labelling.

Collaborative areas include but are not limited to:

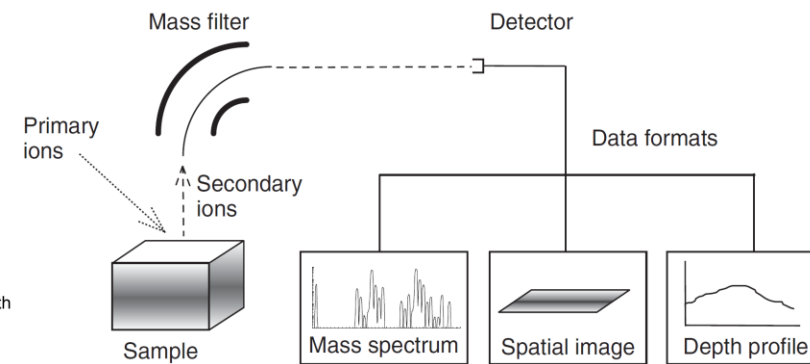
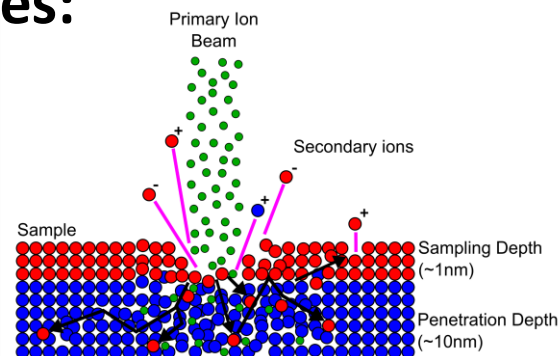
- Isotopically labelled catalytic materials.
- A wide range of projects in the analysis of metallic, polymeric, biological, geological and cosmological materials.

The NanoSIMS has capabilities of:

- Spatial resolution limit of 50 nm. (Better than SEM+EDX)
- Seven detectors for parallel acquisition of 7 masses.
- Detection limit of ppm to ppb. (Perfect for trace elements)
- Mass Range: Hydrogen to Uranium. (Able to detect light elements that are typically difficult)
- Mass resolution: $M/\Delta M$ up to 10,000.

Secondary Ion Mass Spectrometry (SIMS) operating principles:

To collaborate, please contact:
katie.moore@manchester.ac.uk
For more information visit:
sites.google.com/view/manchester-nanosims





www.ukhyres.ac.uk

Please use the contact details on the slides for more information about their individual research and projects, as well as for collaboration.

For general enquiries, please reach out to us at ukhyresadmin@bath.ac.uk.