

The logo for Advanced Materials Research & Innovation, featuring a grid of dots above the text.

ADVANCED
MATERIALS
RESEARCH &
INNOVATION

The logo for the Henry Royce Institute, consisting of the text 'HENRY ROYCE INSTITUTE' with a grid of dots to the right.

HENRY ····
ROYCE ····
INSTITUTE

UK innovation for future semiconductor industries

Professor Edmund Linfield
Director, Bragg Centre for Materials Research at Leeds
Royce 'Atoms to Devices' Research Area Lead

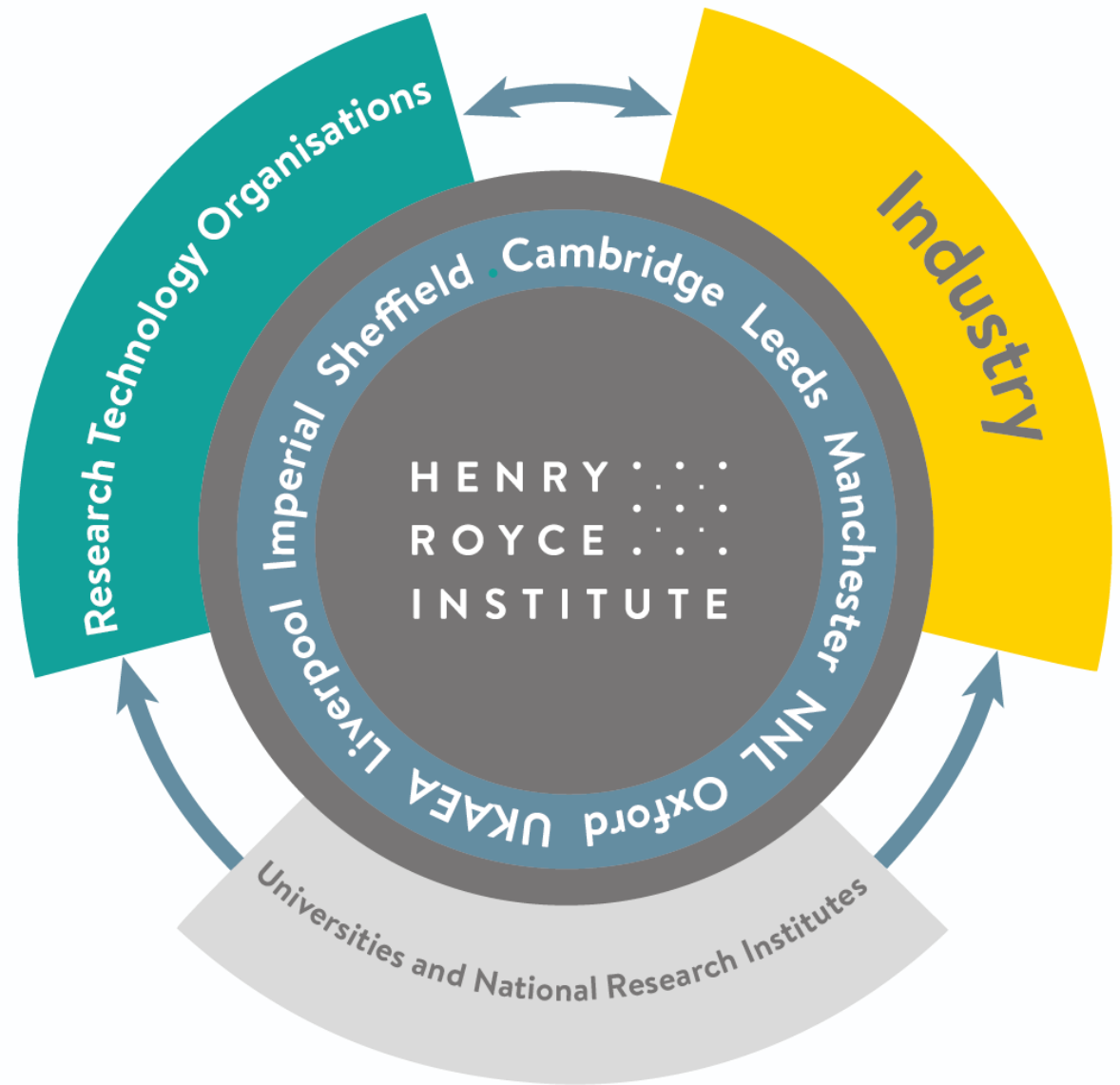
Large vertical text 'ROYCE' in white, set against a background of teal, grey, and yellow geometric shapes.

ROYCE

Purpose of the Royce

The Henry Royce Institute was established to develop and capitalise on the UK's world-leading excellence in advanced materials research:

- Transition to zero carbon
- Sustainable Manufacture
- Digital & Communications
- Circular Economy
- Health & Wellbeing



ROYCE

National institute with regional footprint

Advanced Forming Research Centre
University of Strathclyde (Associate Partner)

Central Laboratory
National Nuclear Laboratory

Materials Innovation Factory
University of Liverpool

Royce Hub Building
The University of Manchester

Centre for Energy Materials Research
University of Oxford



Bragg Centre for Materials Research,
University of Leeds



Translation & Discovery Centres,
University of Sheffield



National High Temperature Surface Engineering Centre,
Cranfield University (Associate Partner)



Maxwell Centre
University of Cambridge



Sir Michael Uren Hub
Imperial College London



Materials Research Facility
UKAEA

ROYCE

Research Areas

Research Area Leads (Atoms to Devices)

Neil Alford (Imperial)

Manish Chhowalla (Cambridge)

Richard Curry (Manchester)

Edmund Linfield (Leeds)

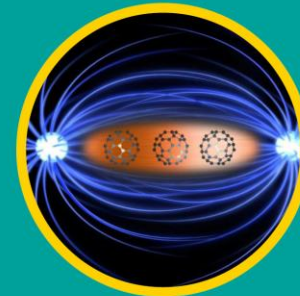
2D MATERIALS



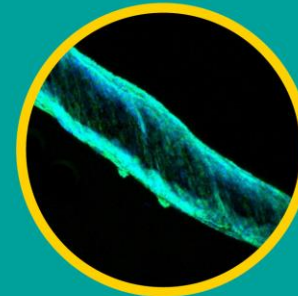
ADVANCED METALS
PROCESSING



ATOMS TO DEVICES



BIOMEDICAL
MATERIALS



CHEMICAL
MATERIALS DESIGN



ELECTROCHEMICAL
SYSTEMS



MATERIAL SYSTEMS
FOR DEMANDING
ENVIRONMENTS



NUCLEAR
MATERIALS

ROYCE

Royce's Mission

To support and grow world-recognised excellence in UK materials research, accelerating commercial exploitation, and delivering positive economic and societal impact for the UK.

Delivered through four key pillars of activity:

Enabling national materials research foresighting collaboration and strategy



Catalysing industrial collaboration and exploitation of materials research



Fostering materials science skills development, innovation training and outreach



Providing access to the latest facilities and capability

ROYCE



1.

Enabling national materials
research foresighting,
collaboration and strategy

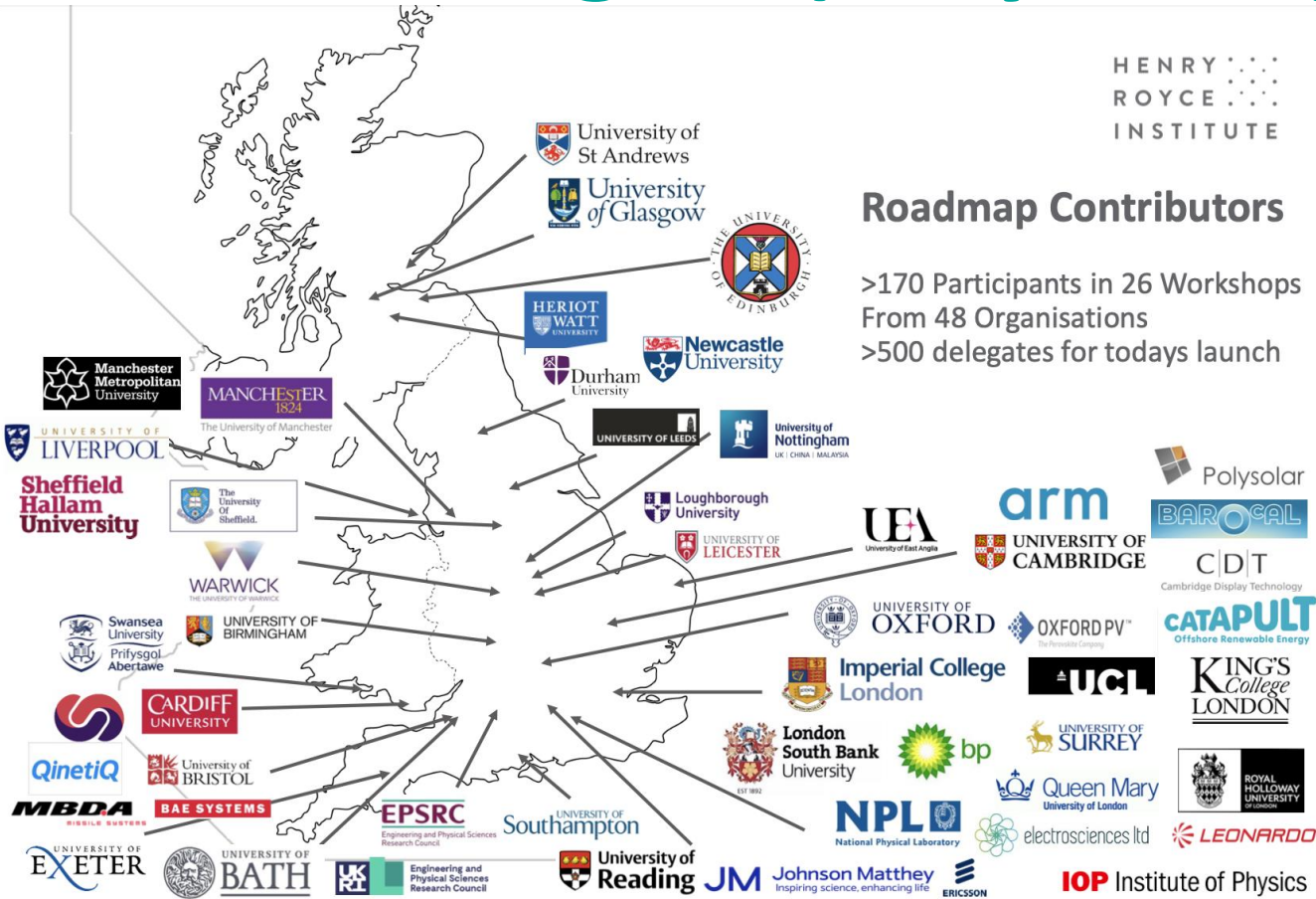
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'Net-zero' targets (May 2019)

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Roadmap Contributors

>170 Participants in 26 Workshops
From 48 Organisations
>500 delegates for today's launch



Roadmaps for 'Materials for the Energy Transition'

1. Materials for photovoltaic systems
2. Materials for low-carbon methods of hydrogen generation
3. Materials for decarbonisation of heating and cooling

I. Thermoelectric energy conversion materials

II. Caloric energy conversion materials

4. Materials for low-loss electronics

www.royce.ac.uk/materials-for-the-energy-transition/ (with the IOP/IfM)

(published September 2020)

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Key findings for all topics

- The need for infrastructure to transfer technology from lab to prototype devices
- National facilities for device metrology and degradation testing^[SEP]
- National coordination of industrial and academic research programmes^[SEP]
- Targeted investment from UKRI to unlock potential
- Legislate the uptake and implementation of low-carbon technology
- Researched materials should be resource abundant, scalable and recyclable
- People: training including facility operation, PhD programmes, postdoctoral researcher support

Consider Low-loss Electronics...

- Materials for Power Electronics
- Materials for CMOS
- Materials for 'beyond CMOS device architectures' (*'More than Moore'*)

www.royce.ac.uk/content/uploads/2020/10/M4ET-Low-Loss-Electronics-Roadmap.pdf



HENRY
ROYCE
INSTITUTE

IOP
INSTITUTE OF PHYSICS

IfM
MANAGEMENT
TECHNOLOGY
POLICY

DCMS launch Semiconductor Infrastructure Feasibility Study

December 2022

[Department for Digital Culture Media & Sport](#)

UK Semiconductor Infrastructure Initiative Feasibility Study

Source: [Find a Tender](#)

Published: Mon 05 Dec 2022

Closed: Mon 16 Jan 2023

DCMS is seeking to commission a study to understand the technical and economic feasibility and requirements of a UK Semiconductor Infrastructure Initiative, aiming to catalyse growth of the UK semiconductor sector and contribute to supply chain resilience.

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UK Semiconductor Strategy

Launched in May 2023:

'The UK will secure areas of world leading strength in the semiconductor technologies of the future by focusing on our strengths in R&D, design and IP, and compound semiconductors.'



www.gov.uk/government/publications/national-semiconductor-strategy/national-semiconductor-strategy

The Institute of Manufacturing (IfM) in Cambridge was awarded the contract:

- Royce Institutions (Leeds, Imperial College London, and Cambridge) all part of the successful consortium:



engage.ifm.eng.cam.ac.uk/uk-semiconductor-infrastructure-initiative-2023/

- Sets of roadshows presented findings to the community
- Final report submitted to DSIT in December 2023

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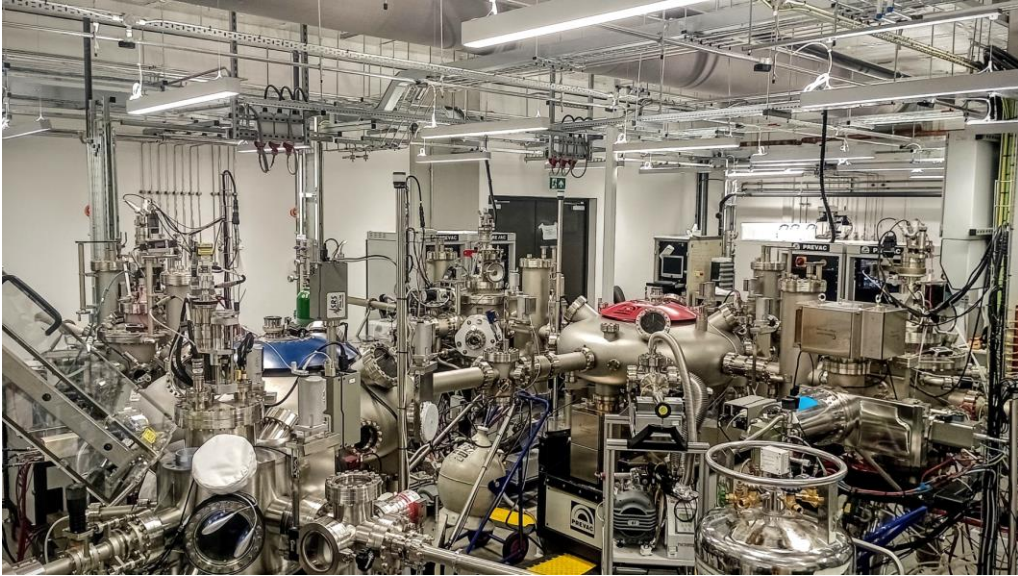
2.
Providing access
to the latest facilities
and capability

ROYCE

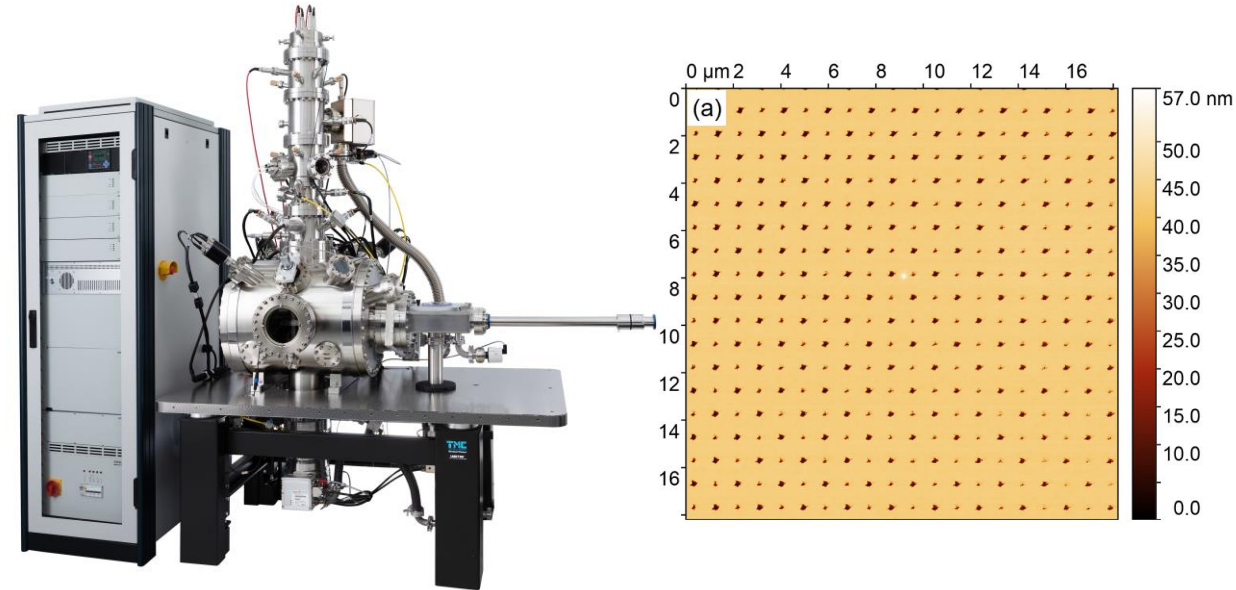
‘Generate breakthroughs and innovations that will drive next-generation semiconductors’



State-of-the-art open-access Royce facilities, e.g.



Royce deposition at Leeds – sputtered metal/oxide thin films, PLD of complex oxides, MBE of topological materials, and thermal evaporation of organics



Platform for Nanoscale Advanced Materials Engineering (P-NAME) at Manchester – deterministic single ion implantation, <20 nm spatial resolution (with Ionoptika Ltd)

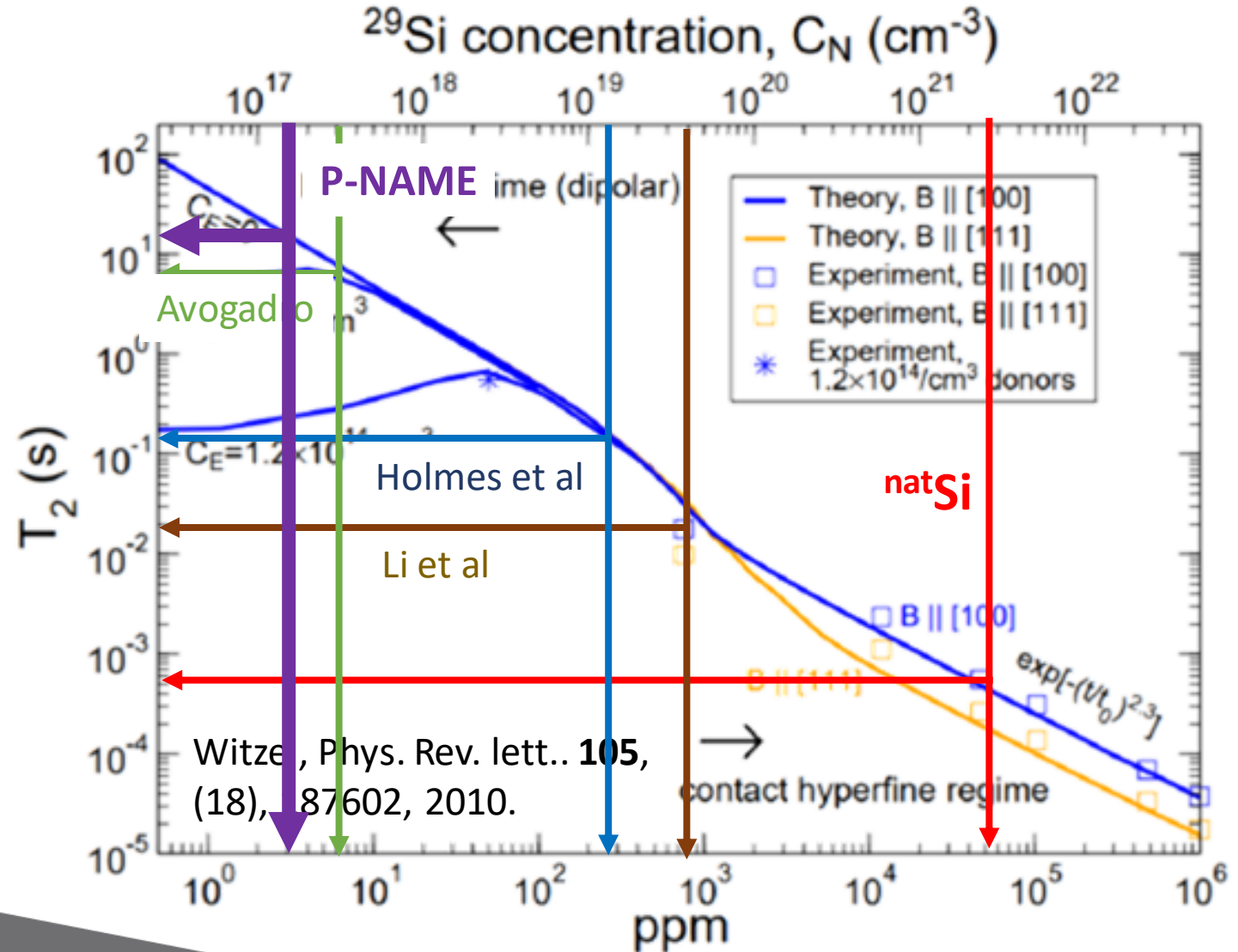
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Accessing Royce Facilities:



P-NAME Performance: Isotropic Enrichment

- Scalable ^{28}Si enrichment demonstrated to highest Si-purity reported to date:
doi.org/10.48550/arXiv.2308.12471
- Same process can dope single ions to form qubit arrays for quantum computing applications.



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3.
Catalysing industrial
collaboration and
exploitation of materials
research

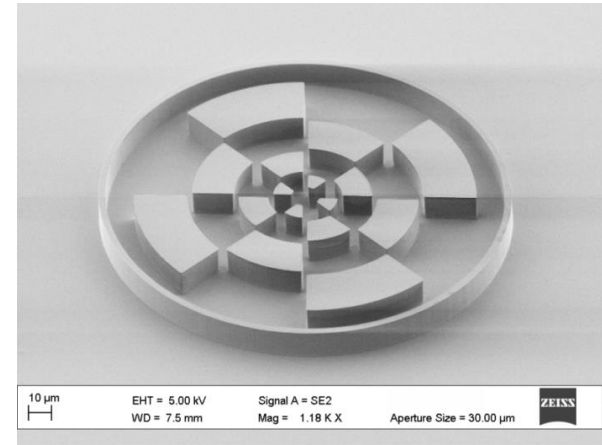
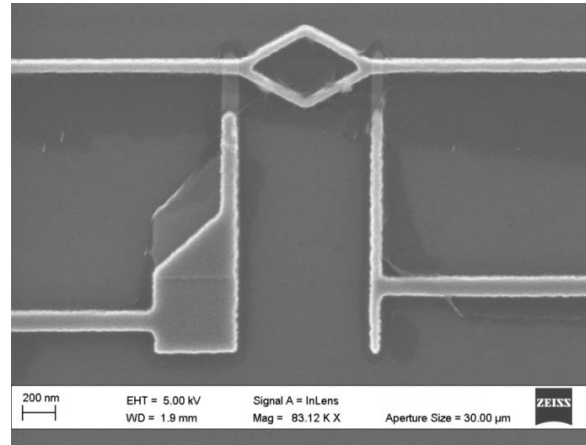
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*‘Support the sector through the
technology cycle, fostering a
new culture of enterprise’*



Providing industrial access to Cleanroom facilities

- e.g. the new Leeds Nanotechnology Cleanroom in the Bragg Centre, part of the Leeds Royce facilities
- Specialising in supporting diverse production needs, from short-loop process runs to full device flows, and in integrating non-standard materials
- Enabling industry to use university cleanrooms as a test-bed for prototyping new devices and processes
- Supported by highly skilled research technical professionals (RTPs)



Nanotechnology Cleanroom Facilities
at Leeds, available through Royce:



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A new semiconductor wafer analytical capability

- New facility (ASemi-WAC) being established at the 'Centre for Integrative Materials' (CISM) at Swansea University
- Partnership between the Wolfson Foundation, Welsh Government and Royce
- Electron microscopy with custom stages for 200 mm wafers, Ultimex 100 EDX, Cathodoluminescence...
- Delivery: late 2024



The Wolfson
Foundation



Llywodraeth Cymru
Welsh Government

ROYCE



4.
Fostering materials
science skills development,
innovation training
and outreach

ROYCE

*'Attract the skilled talent it
needs, and train tomorrow's
semiconductor innovators'*



Provision of Training

- National Training School in Practical Cleanroom Skills, making use of facilities at Leeds, CISM (Swansea) and Cav3 (Cambridge)
- Led by Research Technical Professionals
- ‘Fabricate and test a transistor in a week’
- 20 people per course, with representatives from academia and industry – technicians, experimentalists, theoreticians
- Additional outreach programmes for schools

(Also courses at Imperial/Leeds on thin film deposition)



Training and Outreach at Leeds,
including Practical Cleanroom Skills:



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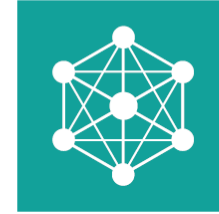
Conclusions

The Royce 'Atoms-to-Devices' theme is contributing to the UK Government's Semiconductor Strategy across its four key activity pillars:

- Providing advocacy for materials research
- Supporting the translation of discovery-led research through the technology pipeline
- Developing skills, and providing training and outreach

New collaborations are welcomed from both industry and academia

Enabling national materials research foresighting collaboration and strategy



Catalysing industrial collaboration and exploitation of materials research



Providing access to the latest facilities and capability



Fostering materials science skills development, innovation training and outreach

Find out more: royce.ac.uk

Contact: info@royce.ac.uk

University of Leeds: BraggCentre@leeds.ac.uk

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