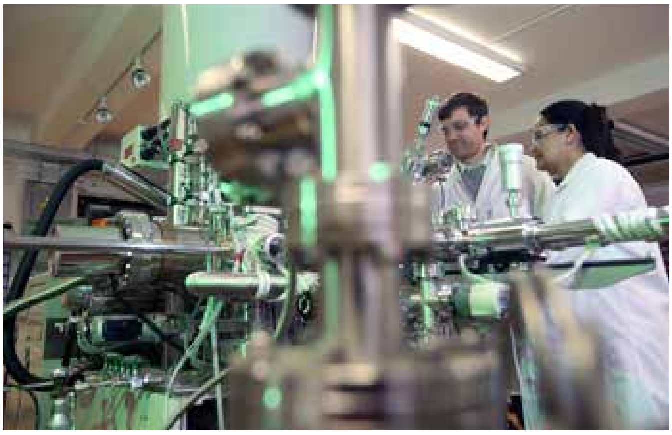
EPSRC
Investing in research for discovery and innovation

EPSRC National Research Facilities



FOREWORD

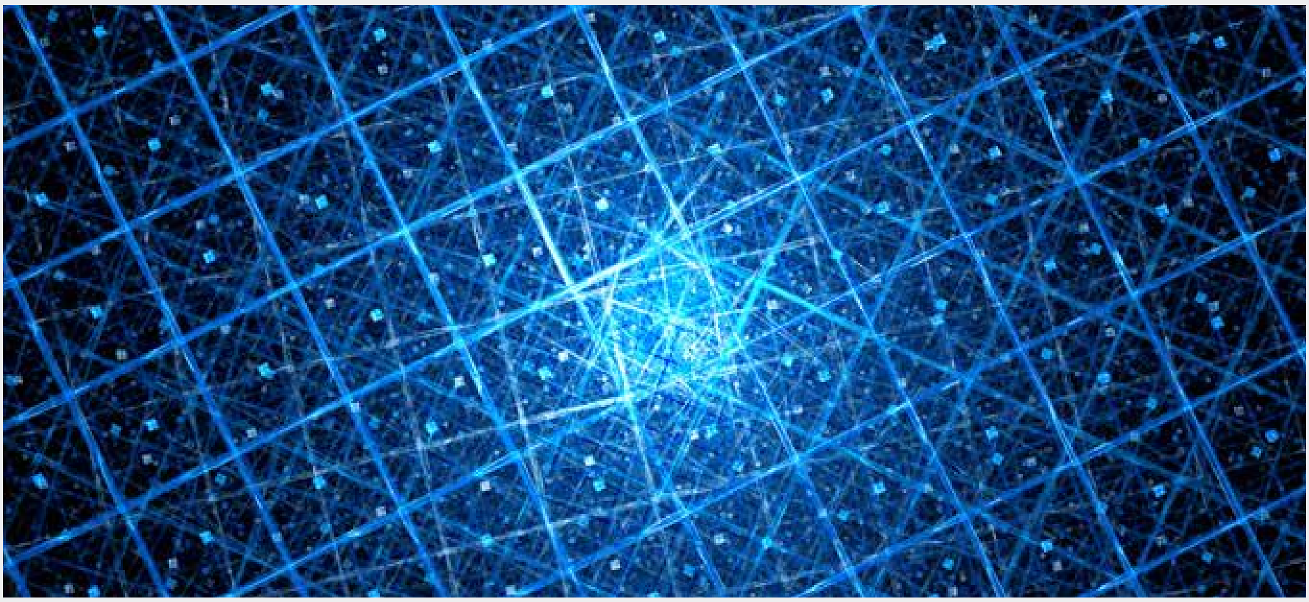
Andrew Wright
Head of Research Infrastructure

World Class laboratories are the combination of excellent people working in the right places to undertake cutting-edge research, using state-of-the–art fit-for-purpose equipment underpinned with well qualified technical support. This provides the driver for scientific productivity and excellence that leads to innovation and inspiration for the next generation.

As part of its world class laboratories portfolio EPSRC funds state of the art facilities for the engineering and physical sciences research communities to use. These facilities provide leading edge capabilities and technique development at a national level and/or access to European research facilities.

To reflect their importance in the world class laboratories landscape, and to the research community, we have rebranded these facilities as the EPSRC National Research Facilities (NRF). The EPSRC NRFs provide additional capability to a diverse user base and I would like to encourage more academic and industrial researchers to benefit from these strategic resources of national importance.

This brochure contains information about our twelve current facilities and the capabilities they offer to potential users as well as links to find out more information on each of them.



CDS National Chemical Database Service

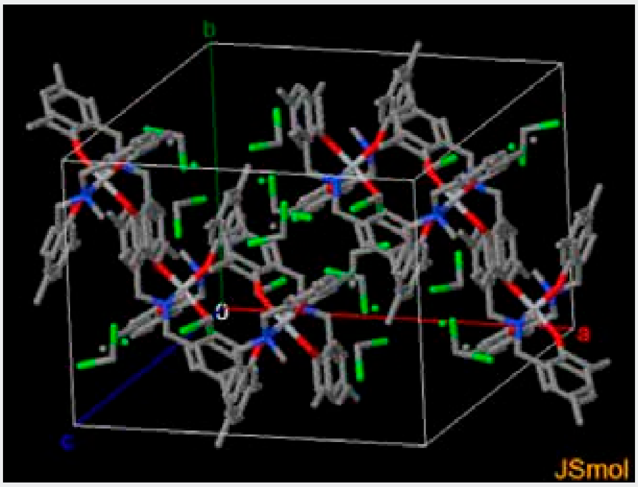
EPSRC National Chemical Database Service

Research at the University of Bath has led to the development of sustainable polymerisation catalysts which will replace highly toxic complexes of tin, antimony and mercury.

The research relied on access, via the Chemical Database Service, to the Cambridge Structural Database, which is fundamental to understanding structure in organometallic chemistry.

- The performance of plastic manufacturing has been improved through the introduction of new products and processes.
- The research has generated £4.6 million from sale of intellectual property.
- New technology will eliminate the use of heavy metals in industrial catalysts and enhance processes for manufacture of degradable materials from renewable resources.

The intellectual property and process developments have been implemented globally in the poly(ethylene terephthalate) (PET) and poly(urethane) (PU) plastics markets, worth US$23B and US$33 billion, respectively, in 2010. The technology has been patented by UK companies ICI Synetix and Johnson Matthey and multinational companies Dorf Ketal (India) and Corbion Purac (The Netherlands).



About the Facility
The National Chemical Database Service (NCDS) provides online access to a range of chemistry resources and databases. The service is free for all UK academics. Anyone working in a UK school or university can access the NCDS. Funded by the EPSRC and hosted by the Royal Society of Chemistry (RSC), the NCDS is designed to support UK researchers working in chemistry–related fields.

For more information on the NCDS, visit **www.youtube.com/watch?v=dU-NHeQL_mY**

European Magnetic Field Laboratory (EMFL)

Led by the National Graphene Institute at the University of Manchester and in collaboration with the University of Nottingham, an international team of physicists has provided fresh insights into the remarkable properties of electrons in graphene. These discoveries were made possible by the EMFL, which the UK joined as a member in 2015.

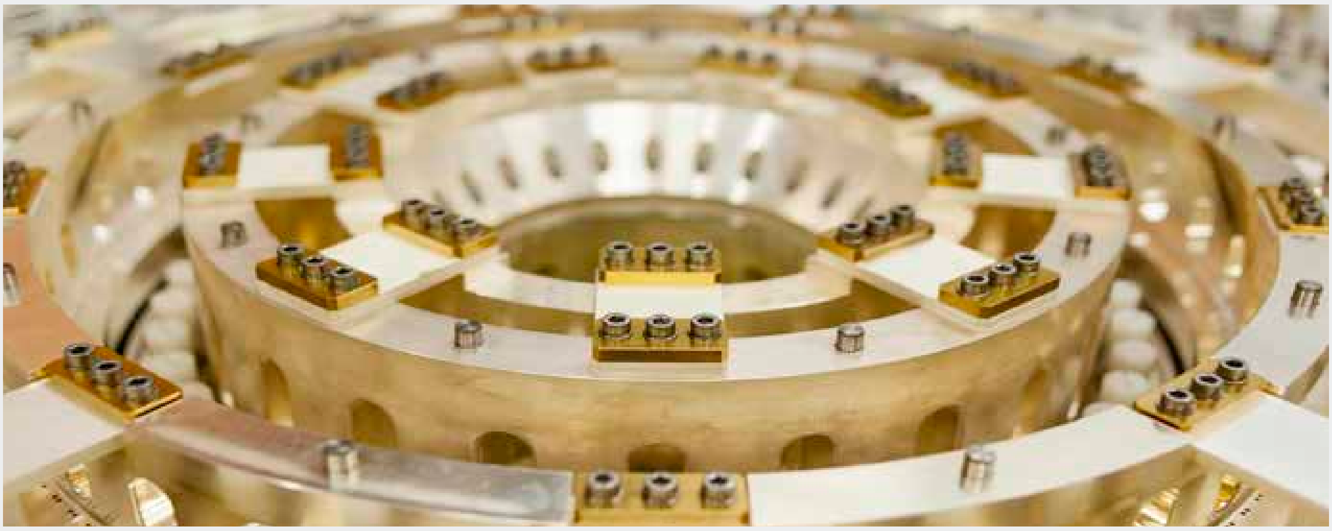
- EMFL facilities in France and the Netherlands can generate magnetic fields of up to 30 Tesla (not available at any UK-based facility), essential for performing these pioneering experiments.
- These powerful magnetic fields boost the momentum of electrons when they 'tunnel' through a boron nitride barrier sandwiched between two graphene layers.
- This manipulation of the electrical current has extended our understanding of graphene, enhancing its potential for future technologies.

Access to the EMFL is helping to keep the UK at the cutting edge of graphene science. This project is shedding new light on electron chirality, a property which determines if the electron spin is pointing in the same or the opposite direction to its momentum. The momentum boost provided by the magnetic field controls the chirality and hence the tunnel current.

About the Facility

Dedicated to generating the highest possible magnetic fields and providing the scientific research community with access to them, the EMFL brings together European large-scale high magnetic field research infrastructure in France, Germany and the Netherlands. The EPSRC funds the UK's membership. Calls for Proposals to access the EMFL are launched twice a year.

For more information on the EMFL, visit **www.emfl.eu/home.html**



Free Electron Laser for Infrared eXperiments (FELIX)

Researchers from UK universities are making important advances that will aid the development of solid-state quantum computing – a potentially game-changing technology harnessing atomic-level physics to perform computing tasks with unprecedented speed and sophistication.

The capabilities of FELIX have been instrumental in making these advances possible, with beam lines at the facility used to:

- Deliver short, intense pulses of light that have helped to generate new insights into transitions between shallow impurity 'donor' states in semiconductors.
- Build a platform of understanding on how to use light pulses to control 'superpositions' of donor states and exploit them for 'qubit' gates (a qubit is a unit of quantum information).
- Demonstrate electrical readout of donor qubits following light-pulse control – realising a crucial benefit of the solid-state architecture.

Through significant technical breakthroughs like these, the UK-FELIX collaboration is helping to pave the way for a new breed of quantum-level devices and expects to develop control and readout of single donor qubits in the near future.

About the Facility

A unique international facility located at Radboud University, Nijmegen, the Netherlands, FELIX provides very bright, short pulsed, coherent light beams all the way from the mid-infrared to the microwave region of the spectrum. The laboratory is available to external users, with calls for proposals issued every six months and projects selected by an international Programme Advisory Committee.

For more information on FELIX, visit **www.ru.nl/felix/**

Harwell XPS

Harwell X-ray Photoelectron Spectroscopy Facility (Harwell XPS)

Delivered since August 2017 by Cardiff University, University College London (UCL) and the University of Manchester, Harwell XPS helps researchers achieve insights into materials' surfaces that are essential to making crucial advances in fields ranging from biology to tribology.

Visi

Teams from across the UK benefiting from its unique combination of world-class equipment and expertise, and the extensive experience of Harwell XPS staff in acquiring and analysing data, include:

- Imperial College London: exploring how phosphate coatings with anti-wear additives could provide improved protection and performance for racing-cart engines, for example.
- Nottingham Trent University: studying the potential of silver-based antibacterial polymer coatings for use in catheters and other medical devices.
- University of East Anglia (UEA): assessing the potential use of graphene-based materials in energy-storage applications.

Bombarding samples with high-energy radiation and measuring the number and energy of electrons ejected is a crucial technique for these teams to harness as they seek new discoveries and breakthroughs. Harwell XPS enables researchers to do this while avoiding the need to invest in expensive in-house equipment or pay commercial rates to access facilities of the required calibre.

About the Facility

Harwell XPS provides academia and industry with access to leading-edge capabilities in X-ray and Ultraviolet Photoelectron Spectroscopy (XPS and UPS), Low Energy Ion-scattering Spectroscopy (LEIS) and other techniques. The service includes state-of-the-art facilities at the Research Complex at Harwell (RCaH), complemented by specialist expertise at the three consortium partners.

For more information on Harwell XP, visit **www.cardiff.ac.uk/harwell-xps**

NATIONAL EPITAXY FACILITY | EPSRC Engineering and Physical Sciences Research Council | Universities of Sheffield, Cambridge & University College London

National Epitaxy Facility

This facility is making a key contribution to the development of quantum cascade lasers (QCLs), which have the potential to deliver major benefits for the offshore oil industry and sensor manufacturers.

It is working with end-users to develop and demonstrate QCL technology, in order to stimulate the market and give the UK a competitive edge in an innovative type of laser that:

- Emits infra-red light at a wavelength of two-ten microns – the range where many chemicals absorb light most strongly.
- Therefore enables more accurate detection and monitoring of those chemicals (eg gaseous pollutants).
- Can be incorporated into leading-edge sensors designed for use in a range of air, land and marine environments.

The facility has been engaged in pioneering science in this field since 2003. As a key step in its drive to accelerate the evolution of this fledgling market, a spinout company, Stratium Ltd, has been formed to develop and manufacture QCLs.

About the Facility

The National Epitaxy Facility helps the UK stay at the forefront of semiconductor science and technology by providing universities and commercial customers with world-class materials, and with advice in the field of semiconductor epitaxy (the growth of crystal layers of one material on layers of another material). The facility is delivered by the University of Sheffield in partnership with the University of Cambridge and University College London (UCL).

For more information on the National Epitaxy Facility, visit **www.nationalepitaxyfacility.co.uk**

National EPR Research Facility & Service

National Electron Paramagnetic Resonance (EPR) Facility and Service

At the University of Bath, researchers have made a biological discovery that enabled them to identify a new, readily available catalyst for potential use in the chemicals, automotive and other sectors.

Utilising the National EPR Facility and Service's capabilities in both continuous wave and pulsed EPR spectroscopy, the team:

- Investigated, through biomimicry, the enzyme monoamine oxidase (MAO) which, by varying the strength of adrenalin and other neurotransmitters, regulates important biological processes in mammals.
- Showed that the biological pathway concerned involves a free radical (an unstable molecule with a free electron), and then identified the free radical in question.
- Used this work as the basis for Identifying an inexpensive, highly efficient catalyst for use in industrial oxidation reactions and oxidative cross-coupling of amines.

EPR spectroscopy is a powerful method for studying materials that contain unpaired electrons (so-called 'paramagnetic' materials) via their magnetic properties. The use of state-of-the-art EPR facilities enabled the Bath team to achieve its objectives significantly more quickly than would otherwise have been possible.

About the Facility
Based at the University of Manchester, the National EPR Facility and Service provides highly specialised equipment and tailored training that meet the needs of UK academia. Industrial access can also be arranged. The facility handles test samples in the form of crystals, powders, solutions or glasses.

For more information on the facility, visit **www.chemistry.manchester.ac.uk/our-research/facilities/epr/**

NDFIS
National Dark Fibre Infrastructure Service

National Dark Fibre Infrastructure Service (NDFIS)

A University of Southampton team has developed and demonstrated a versatile new way of boosting the quality of signals transmitted over optical communications networks.

NDFIS – the UK's only facility of its kind – provided a testbed for trialling and refining the team's ideas in a realistic network environment.

- The research showed that inverting the optical part of a signal at the midpoint of a transmission link significantly reduces 'noise' affecting signal quality.
- The NDFIS experiments proved the technique's ability to function on optical links not specifically designed with it in mind.
- With optical fibres now carrying 99 per cent of global data and internet demand rising rapidly, the technique has potential to increase transmission lengths and efficiency of bandwidth usage.

Access to 'dark' fibre – fibre that users can access at optical data level, rather than electrical data level as in conventional communications networks – was critical to the project's success. The Southampton team is now extending the study in collaboration with Sweden's Chalmers University of Technology.

About the Facility

Funded by EPSRC, NDFIS provides a key resource for researchers developing the novel wireless and optical networks that will underpin tomorrow's internet. It incorporates a 650km dark fibre network linking four universities – Bristol, Cambridge, Southampton and UCL – and interconnected with European research networks. NDFIS welcomes requests for direct or remote access from academic researchers, industrial partners, public bodies and overseas collaborators.

For more information on NDFIS, visit **www.ndfis.org**

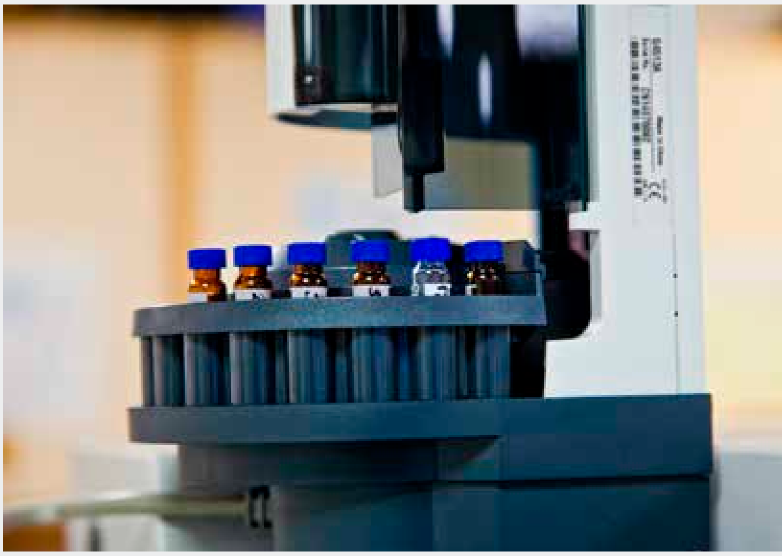
National Mass Spectrometry Facility (NMSF)

The drive to develop new medicines is just one potential beneficiary of a breakthrough achieved by the University of Cambridge with vital input from the NMSF.

Supported by EPSRC, the Cambridge team has devised a technique that could dramatically simplify the synthesis of complex molecules.

- The research demonstrated an innovative palladium-catalysed chemical reaction capable of selective transformation of aliphatic carbon-hydrogen bonds into more reactive bonds.
- Expert analysis at the NMSF – and the very precise, highly accurate instrumentation available there – generated evidence confirming that the expected transformations had occurred.
- The discovery has major implications for the synthesis of aliphatic secondary amines, a class of small molecules that are an important component of many pharmaceuticals.

In mass spectrometry, samples are ionised then accelerated in a vacuum system where the charged species are separated and measured. The process can be used to establish a molecule's mass, structure and chemical composition. At a single location, the NMSF provided the Cambridge team with the full range of mass spectrometry equipment and expertise they required to produce the evidence they needed.



About the Facility
Located at Swansea University Medical School, the NMSF provides comprehensive mass spectrometry services harnessing an extensive range of ionisation and chromatographic techniques. Capabilities include analysis of a very broad spectrum of known and unknown chemical compounds, from small molecules to large biomolecules and polymers. Enquiries are welcomed from academia and industry.

For more information on the NMSF, visit **https://nmsf.swan.ac.uk**

The UK 850 MHz Solid-State NMR Facility

Through new discoveries about the molecular architecture of plant cells, University of Cambridge-led research has potentially opened the way to wider, more efficient use of crop residues and other woody materials in the generation of green energy.

Detailed insights secured using the UK 850 MHz Solid-State NMR Facility enabled the team to demonstrate a new theory of how plant cell walls assemble.

- The research showed how two different carbohydrates in plant cell walls – xylan and cellulose – interact at molecular level.
- This discovery has improved understanding of cell characteristics that make plant biomass harder to digest and hinder its use to produce biofuels.
- The new knowledge could, within five to ten years, aid development of less expensive biofuel production processes requiring less energy and fewer enzyme additives.

The project focused on Arabidopsis, a flowering plant widely used in the study of plant biology. Nuclear magnetic resonance (NMR) spectroscopy – which exploits the magnetic properties of atomic nuclei – produced high-resolution data revealing the cell structure in ultra-fine detail.

About the Facility
Sited at the University of Warwick and operated by a consortium of seven UK universities, the UK 850 MHz Solid-State NMR facility is based around a 20 Tesla wide-bore NMR magnet. Calls for applications to use the facility are issued every six months, with at least 80 per cent of time allocated by an independent panel.

For more information on the facility, visit **www2.warwick.ac.uk/fac/sci/physics/research/condensedmatt/nmr/850/**

SuperSTEM

The SuperStem facility is helping research understand and improve existing catalysts in order to solve major energy and environmental challenges.

It has recently worked with Danish catalysis company Haldor Topsøe A/S to look at molybdenum disulphide, a catalyst used in oil refineries to remove harmful sulphur impurities from fossil fuels.

- Researchers were able to take images of the catalyst's constituent atoms one-by-one to gain a detailed understanding of its structure.

- This detailed insight allowed researchers to see how additives altered the structure of the catalyst and boost its properties.

About the Facility

SuperSTEM provides a world leading capability for the direct imaging of atomic structures as well as the analysis of elemental composition and chemical bonding in thin samples down to single atom levels. As such it supports the elucidation of structure-property relationships in advanced materials and devices for the benefit of the user community.

For more information on SuperSTEM, visit **www.superstem.org/instrumentation**

The images we obtained at SuperSTEM show exactly how the atoms are arranged, while the spectroscopy data provides invaluable information about the bonding of these atoms to their environment... Such data are hard to obtain as we are working right at the edge of what is physically possible. We did this work anyway because other experimental tools gave in the past only some hints to the structure and no one had ever seen this type of industrial catalyst, atom-by-atom.

Dr Stig Helveg, Fellow at Haldor Topsøe

EPSRC UK National Crystallography Service (NCS)

Data collected by the National Crystallography Service (NCS), at the University of Southampton, is enabling researchers at the University of Glasgow to explore the answers to some of the key challenges facing our world today such as the capture and storage of CO_2.

NCS data is enabling:

- the understanding of structural features required for the storage of alternative fuels such hydrogen and ammonia in porous materials.
- the development of porous materials that could be used for CO_2 capture.
- the understanding of magnetic behaviour in materials.
- the synthesis and characterisation of new molecular magnetic and nanomagnetic materials.

The NCS offers both data collection only and full structure analysis services for single crystal x-ray diffraction. The service also offers advanced technique work with charge density, high pressure, variable temperature and gas cell studies possible. Seamless access to DLS is provided for samples requiring synchrotron facilities. The service is free at the point of access for UK academics and is also available at competitive rates for commercial customers.

The NCS has been really useful for my research group because our crystals tend to be around 50 microns in size and they don't diffract well. The equipment that is available to us in Southampton is sufficiently powerful enough for us to be able to generate high quality data and enable us to publish our research.

Dr Ross Forgan, Early Career Researcher, Glasgow University

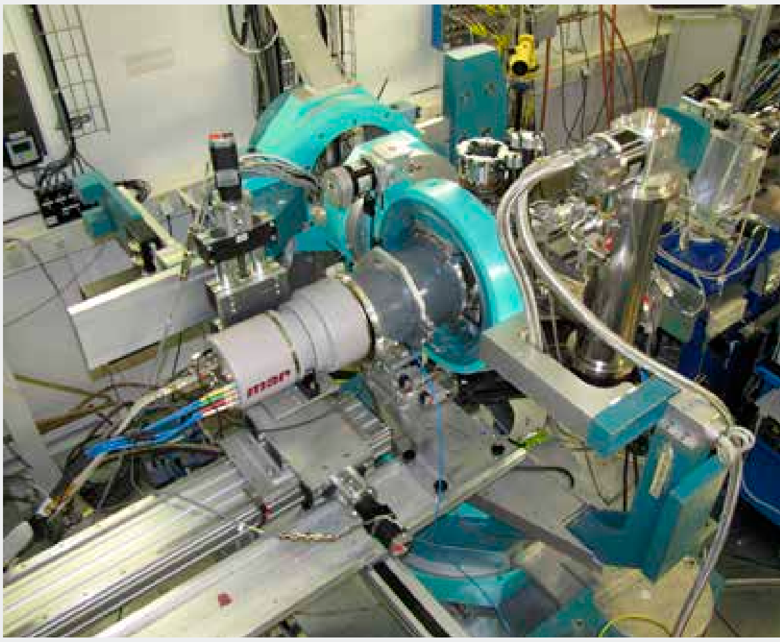
X-ray Materials Science Facility (XMaS)

The oil industry could achieve valuable savings in corrosion-related costs thanks to University of Manchester research harnessing the cutting-edge equipment and expertise available at XMaS.

With BP and EPSRC support, the Manchester team is exploring how scales form when carbon-steel pipelines corrode.

- The research is helping to clarify the extent to which these scales protect the metal – and whether oil companies could rely on them more to increase oilfield infrastructure lifetimes.
- The knowledge generated will strengthen computer models used by the industry to predict the rate and extent of pipeline corrosion.
- Improved models could be available within five years and help cut sector expenditure on corrosion and its control, which now totals around US$1.4 billion/year worldwide.

X-ray diffraction experiments at XMaS have gathered data from a sample of pipeline steel submerged under model oilfield water – enabling the research team to monitor the process of scale formation and, for example, generate new insights into chukanovite rust.



About the Facility
XMaS is located at the world-leading European Synchrotron Radiation Facility (ESRF), Grenoble, France. Synchrotrons produce bright X-ray light that can be used to explore the structure and behaviour of materials at the atomic and molecular level. There are six-monthly calls for UK-led materials science projects wishing to use the XMaS facility, with access awarded on a peer review basis. The XMaS facility is managed by the Universities of Liverpool and Warwick.

For more information on XMaS,
visit **www2.warwick.ac.uk/fac/cross_fac/xmas/**

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