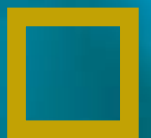


SCIENCE CITY RESEARCH ALLIANCE

UNIVERSITY OF
BIRMINGHAM

THE UNIVERSITY OF
WARWICK

Advanced Materials Facilities & Equipment



Introduction

The Science City Research Alliance (SCRA) brings together the West Midlands' two leading research led universities, the University of Birmingham and the University of Warwick, in collaborative projects across scientific themes in Advanced Materials, Energy and Translational Medicine as part of the Birmingham Science City* initiative.

The Advanced Materials programme consists of two projects:

AM1: Creating and Characterising Next Generation of Advanced Materials

AM2: Innovative Uses of Advanced Materials in the Modern World

Both projects are funded by Advantage West Midlands (AWM) and the European Regional Development Fund (ERDF) which have enabled the projects to invest over £17M in scientific equipment across Physics, Chemistry, Chemical Engineering, Metallurgy & Materials and Dentistry departments at both institutions. This investment has created world leading state-of-the-art research facilities for the region that are accessible not only to the Universities of Warwick and Birmingham but also to other HEIs and private businesses.

The projects have invested in the equipment to further enhance and develop research in areas such as nanotechnology, coatings and surfaces, multifunctional materials, biomaterials, fracture and fatigue analysis. However the application of the equipment is not restricted only to these areas so please speak to project staff regarding your interests.

This booklet is structured into 10 broad functional disciplines to help categorise the vast array of instrumentation available. In each section equipment items have short descriptions plus a 'features' box to highlight specifics of that particular instrument. The descriptions are brief and are intended to provide an overview of the capabilities only. Under each equipment item details of the location is provided in the grey box. As equipment across these projects varies from bespoke instruments to off the shelf analysis machines, it is strongly encouraged that you talk with the projects' Business Engagement Managers who can provide further equipment information and assist in suggesting the best match of facilities and expertise to individual research or measurement requirements.

The rates charged for equipment access and usage ensure that working with the projects is cost effective for businesses. Collaborative research projects, contract research work and analytical services to provide data generation and interpretation are all possible through the AM projects. Project Business Engagement Managers should be approached to gain further information on types of services and the access options available.

* Birmingham Science City is a region-wide partnership of the public sector, businesses and the research base, which is facilitating the use of science and technology to improve the quality of life and prosperity of the West Midlands. Funded by Advantage West Midlands, Birmingham Science City's aim is to create strategies to exploit centres of world-class scientific research, by developing relevant activities for sustainable economic and social benefit.

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04.07 Diffraction

Bruker D8 Advance Diffractometers



Routine measurement of powder X-ray diffraction patterns for identification of crystalline phases, purity estimation and/or determination of crystal structure, measurement of powder X-ray diffraction patterns up to 1100°C in air.

Features

High resolution powder X-ray Diffractometer operating in transmission and reflection mode with automatic sample changer, monochromatic Cu radiation, LynxEye position-sensitive detector.

Location: Birmingham 1.1 & 1.2

Bruker D5000 & D5005 Diffractometers



D5000

Routine measurement of powder X-ray diffraction patterns of samples in capillaries from 80 to 500K. This system will be of most interest to those looking at organic samples such as pharmaceuticals or air-sensitive species.

Features

High resolution powder X-ray Diffractometer operating in capillary mode with low temperature cryostream, monochromatic Cu radiation, Braun position-sensitive detector.



D5005

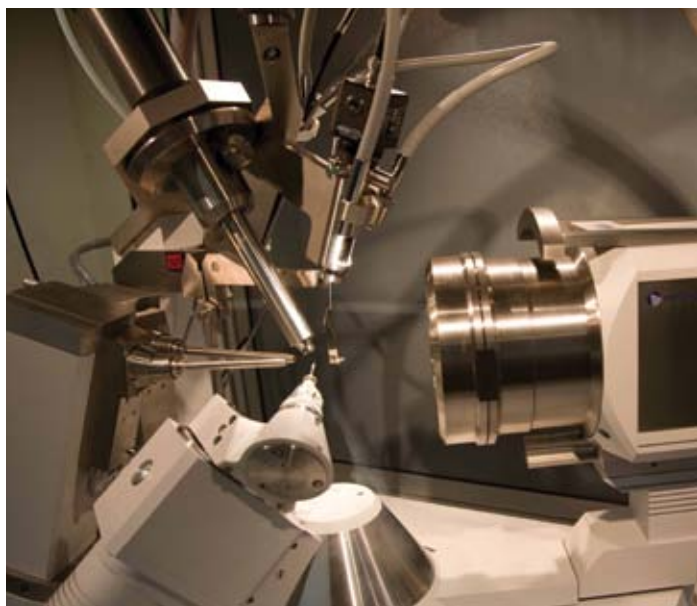
Routine measurement of medium resolution powder X-ray diffraction patterns using Cu or Mo radiation.

Features

Powder X-ray Diffractometer operating in reflection mode using Cu or Mo radiation.

Location: Birmingham 1.3 & 1.4

Oxford Diffraction Gemini R CCD Diffractometer



X-ray diffraction is an important tool for structural determination of single crystals, both organic and inorganic. Usage spans from routine structural work on organic and metal-organic small molecules to highly detailed investigations of heavy metal oxides that can include twins, modulated structures or diffuse scattering.

Features

The Oxford Diffraction Gemini R CCD X-ray Diffractometer is a powerful tool for the measurement of single crystals. The Gemini R is a Kappa geometry goniometer equipped with dual wavelength (Cu/Mo) fine focus X-ray sources, graphite monochromators and Enhance optics. The detector is a Ruby Charge Coupled Device area detector, which allows for extremely fast data collection of the entire Ewald sphere. The Oxford Diffraction CrysAlisPro software enables data collection, data integration and absorption corrections to be performed, and is used in conjunction with refinement software such as ShelX or Jana. For low temperature experiments (80K-400K) an Oxford Cryosystems Cobra is attached to the system. Additionally, an optical stereomicroscope is used for mounting and alignment of samples.

Location: Warwick 1.29

Bruker D8 Advance Powder X-Ray Diffractometer



X-ray powder diffraction is a powerful technique for phase identification and structural determination.

Applications of this environmental Diffractometer include:

- Catalysts under real reactive conditions - Oxidising or reducing gases
- Kinetic studies of solid state reactions - Thermal decompositions, gas solid reactions, phase changes
- Solid gas reactions at elevated pressure (10 bar) and temperature (900°C)
- Structural changes under redox reaction conditions
- High temperature material stability with fast data collection - phase separation and collapse
- Gas uptake by porous materials - H, CO₂.

Features

The Bruker D8 Advance Powder X-ray Diffractometer is optimised for high-throughput in-situ gas reaction measurements. For maximum intensity and throughput, the Bruker D8 is equipped with unmonochromated Cu radiation and a Ni filtered VANTEC-1 solid state detector with a maximum active length of 12° 2θ. This allows very quick static (~10s) measurements to be made, particularly useful for kinetic studies. The sample is held in an Anton Paar XRK 900 reaction chamber, a chemical reaction cell for studies in the presence of reactive gases (oxidising and reducing) at up to 10 bar.

Software available includes Bruker EVA for data analysis and Topas for structural refinement. The latest ICDD powder diffraction database is also available which includes over 100K patterns.

Location: Warwick 1.29

Panalytical X'Pert Pro MRD



High resolution X-ray diffraction is an important technique for studying individual Bragg peaks of single-crystal and thin-film materials.

This machine is suitable for the study of single crystals, thin films (including multilayers) and polycrystalline materials (e.g. ceramics). Typical materials include semiconductors (SiGe, GaAs etc), magnetic multilayers, ferroelectrics (PZT, LiNbO₃), photovoltaic thin films and metallic rods / sheets.

Techniques available include:

- Rocking curve analysis and reciprocal space mapping - Crystalline quality, accurate lattice parameters, strain & misorientation.
- Reflectometry and thin film phase analysis - Layer thickness & composition
- Residual stress and texture analysis
- Diffuse scatter measurements
- In-plane and grazing incidence diffraction
- Non-ambient diffraction - phase transitions, layer annealing studies.



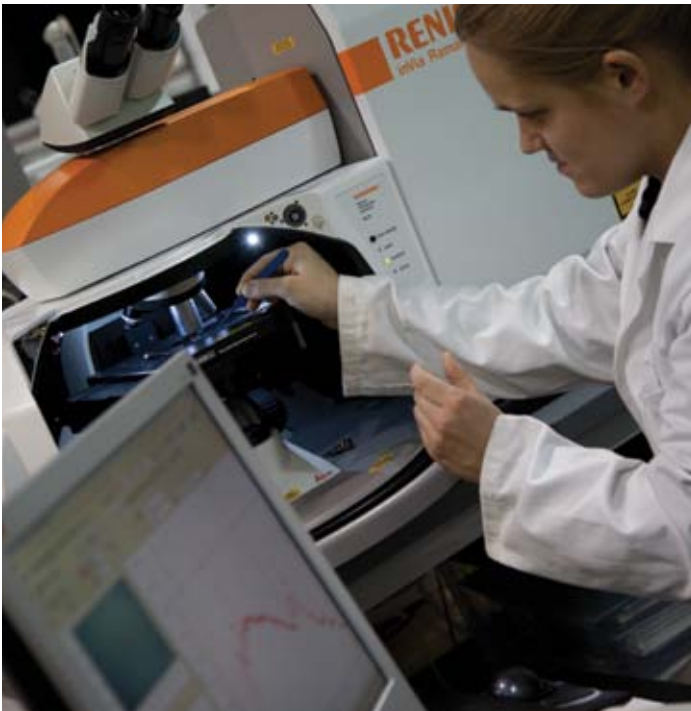
Features

- Can handle a large variety of sample shapes and sizes.
- PiXcel solid state detector enables better counting statistics, high linearity and eliminates the need for a beam attenuator.
- Interchangeable X-ray optics allows the equipment to be quickly tailored to the experiment.
- High-resolution monochromators give high-intensity pure Cu K α 1 radiation.
- Anton Paar DHS900 domed hot stage - non-ambient studies on thin-films, single crystals and ceramics at temperatures of up to 900°C.
- Software available for Phase ID and the analysis of rocking curves, reflectivity, stress and texture measurements.

Location: Warwick 1.28

Raman Microscope

Renishaw InVia Reflex and Witec Alpha 300R



Provides spatially resolved information on structure, bonding, constituents, and electronic structure of a wide variety of functional and structural materials.

Examples of applications of Raman microscopy include the differentiation of polymorphs, chemical mapping in the pharmaceutical industry, detection and monitoring of stress in silicon based microelectronics, and identification of high temperature and pressure treated diamonds.

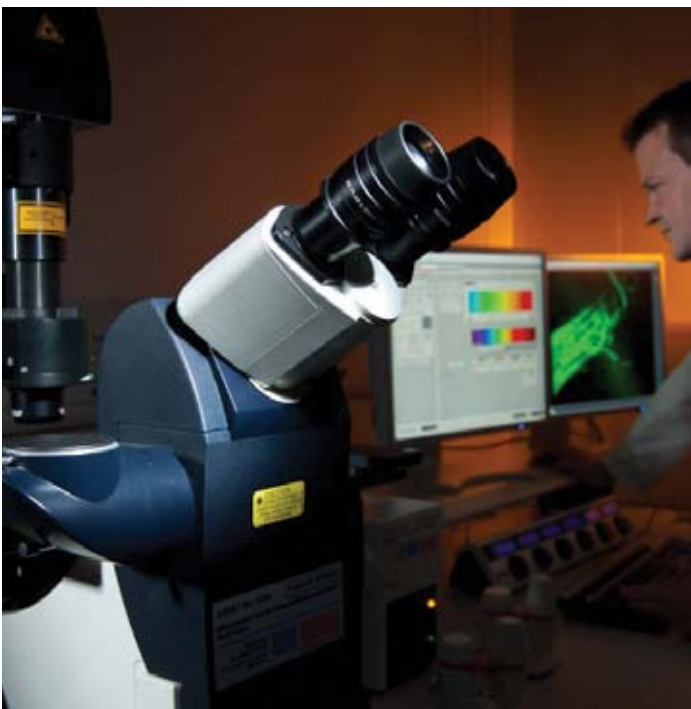
Features

- 325, 442, 514.5, 532, 633, 785nm lasers
- CCD detector for visible to near-IR plus InGaAs for IR
- Temperature: 77K - 873K
- Automatic sample stage
- Surface mapping 1 μ m spatial resolution
- 3D analysis of samples using confocal option.

Location: Warwick & Birmingham 2.5a, 1.5 & 2E20

Confocal Microscope

Leica TCS SP5 X & Leica TCS SPE



Confocal microscopy may be used to investigate soft matter surfaces and interfaces allowing observation of the interaction of a wide range of molecules including polymers, colloids, electrode (sensor) surfaces etc.

Allows ultra-fast imaging and the widest range of excitation wavelengths in the visible range via a continuously tuneable laser.

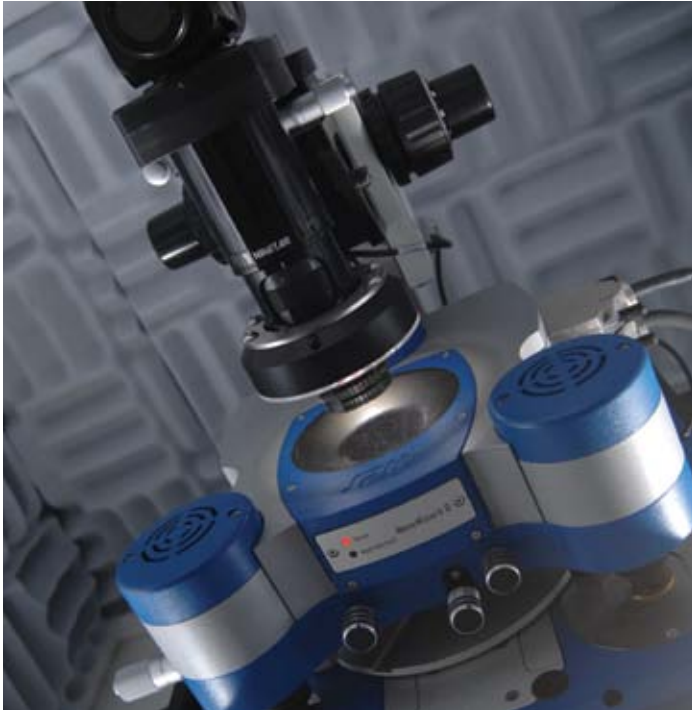
Features

- Tuneable super continuum laser source: 470 to 670nm in 1nm increments
- Laser argon source with 5 selectable wavelengths from 458 to 514nm, diode laser 405nm
- Up to 8 simultaneous excitation wavelengths
- 5 detection channels
- Configurable in upright and inverted configurations
- Ultra fast bidirectional scan (max 16KHz).

Location: Warwick & Birmingham 2.6a & 2E33

Atomic Force Microscope (AFM)

NanoWizard & Veeco diMultimode V



Atomic force microscope capable of imaging in air and fluid as well as making electrical measurements. Large scale samples may be studied such as nanoparticles, electrode surfaces, thin films and biological samples.

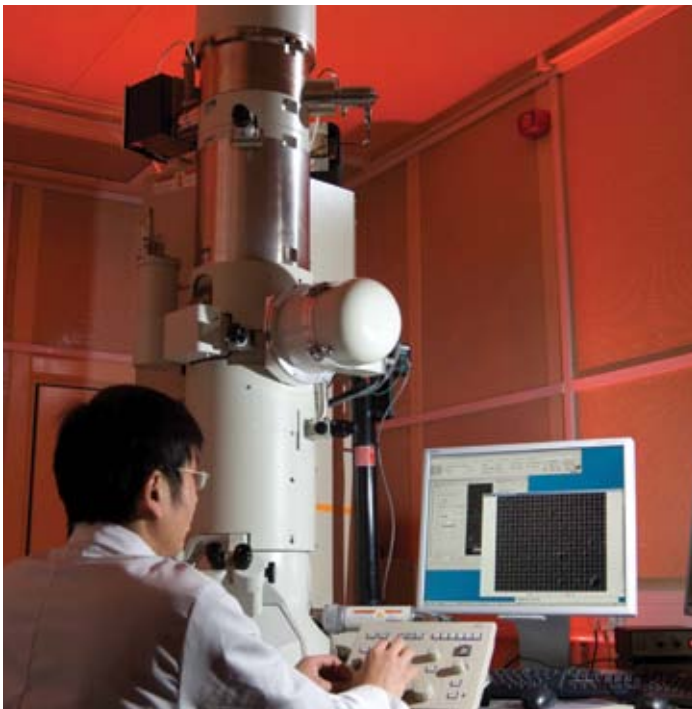
Measurements at variable temperatures with perfusion possibilities. Applications include 3D surface topography and adhesion force mapping.

Features

- Large scan field of $100 \times 100 \times 15 \mu\text{m}^3$
- Range (x, y, z): $100 \mu\text{m}$, $100 \mu\text{m}$, $100 \mu\text{m}$
- Sub Ångstrom resolution
- Dedicated conducting module
- Comprehensive range of accessories:
 - Cellhesion controller
 - Biocell controller
 - Petri-dish heater
 - Electrochemical cell
 - Biopotentiostat.

Location: Warwick & Birmingham 2E29 & 2.8

JEOL Aberration-Corrected Transmission Electron Microscope (JEM-2100F)



High resolution imaging, Materials qualification, Chemical analysis, Particles detection/characterisation, Defects analysis, Microstructural characterisation.

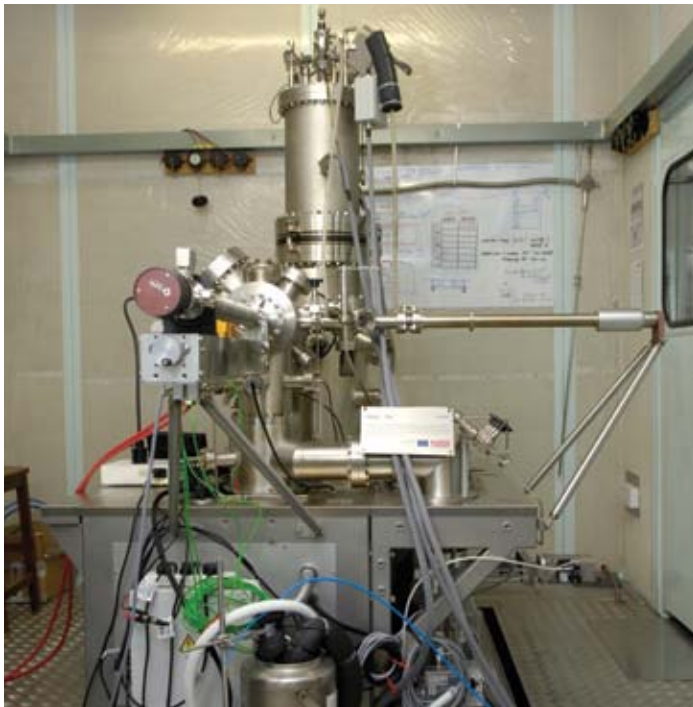
Features

The JEM-2100F is a JEOL field emission gun transmission electron microscope:

- Ultra-high-resolution pole piece
- Operates at 200kV
- It can work in TEM mode with a point resolution of 0.19 Ångstrom and STEM mode with a corrected probe size of 1 Ångstrom.
- EELS energy resolution can get to 0.95 eV for standard beam emission.

Location: Birmingham 1.2

Low Temperature Scanning Tunnelling Microscope (STM)



The key to STM is that it can image and probe individual atoms. This allows electronic and vibrational spectroscopy with atomic-scale spatial resolution. They can also image larger areas of surfaces ($\sim 2 \text{ mm}^2$) still with high spatial resolution.

Possible applications range from probing the fundamentals of surface induced catalysis to arranging individual atoms in pre-designed structures, e.g., writing words and letters using individual atoms.

Features

- Operational temperature range: from 4.6K to 300K (measured with Si-diode)
- Conducting sample: metal, graphite and semiconductor
- Sample size: 10mm x10mm (standard sample plates)
- Scan range: $1.8 \times 1.8 \mu\text{m}^2$ @4.6K - $5.6 \times 5.6 \mu\text{m}^2$ @ 300K
- Gap voltage: $\pm 1 \text{ V}$ and $\pm 10 \text{ V}$ (smallest increment $30 \mu\text{V}$ and $300 \mu\text{V}$)
- Tunnelling current: 1pA to 300nA with feedback loop active
- Z-stability: $< 0.05 \text{ \AA}$ (rms)
- Temperature range of manipulator: up to 1170K on heater stage; down to $< 100\text{K}$ on cooling stage
- Base pressure in ultra-high vacuum: 10-12~10-10 mbar
- Measurement control software: NANONIS SPM Control System.

Location: Birmingham 1.13

Ultra High Vacuum Scanning Tunnelling Microscope

Scanwel



Ultra high vacuum scanning tunnelling microscopy can be used for the study of conductive samples with nano-scale roughness.

Samples can be prepared in-situ by noble gas ion sputtering and annealing and direct heating (i.e. for semiconductor wafers). Gas, organic and electron beam metal molecular beam epitaxy (MBE) sources are available.

STM can be used for structure determination of surfaces with molecular and atomic resolution and local electronic structure determination.

Location: Warwick 2.25

Features

- Base pressure 1×10^{-10} mbar
- Measurement temperatures liquid N_2 and liquid He including cooled sample manipulator
- Maximum scan area 400 nm^2

White Light Laser Source and Near Field Optical Microscope

Park high resolution AFM, Park Near Field Optical Microscope (NSOM), SC400 Fianium white laser source, Hammamatsu PMT, Andor CCD spectrometer, Tsunami laser.



The AFM permits to achieve morphological analysis of the samples with a resolution less than 1 \AA . Confocal system permits to achieve 3D optical images of the samples and to analyse their fluorescence properties. White laser source provide broadband excitation of the samples.

Location: Birmingham 1.16

Features

- SC400 from Fianium: 2W femtosecond white-light laser source (80MHz repetition rate, 400fs pulses, available wavelengths: 400-1500nm)
- XE-NSOM from Park Systems: Cantilever-based near-field optical scanning microscope both in transmission & reflection modes (can be used as well as a contact, tapping or non-contact AFM)
- Nikon NE-2000 inverted microscope, used in conjunction with the NSOM for transmission mode
- Andor water-cooled CCD spectrometer.

Zeiss Axioimager and Stemi2000 Stereo Microscopes



Axio Imager from Carl Zeiss, designed for quality control, quality assurance, materials analysis, and for the development of new materials. Ideal for routine applications and research. Darkfield illumination reveals unevenness in the surface (such as phase boundaries between graphite and matrix or break-outs). C-DIC (color contrast): The matrix is contrasted because of the relief. Hard and soft grain components as well as polishing inconsistencies (exclusively mechanically polished) are visible.

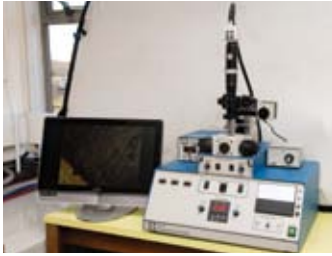
Location: Warwick 1.32

Features

Microscope can offer:

- 50 - 1000 times magnification
- Reflective/Transmitted light source
- Bright field imaging
- Dark field imaging
- Differential Interference Contrast imaging
- 3.2 megapixel camera.

GATAN PIPS™ Ion Miller



For the thinning of samples such as silicon, ceramics, glass ceramics etc for viewing in the Transmission Electron Microscope.

Location: Warwick 1.33

Features

The PIPS is a user-friendly precision ion polisher designed to produce high quality, TEM specimens with minimal effort. The miller has a liquid N₂ cooled specimen stage and CCD zoom camera to view milling progress.

Cathodoluminescence System

Gatan MonoCL3 with Digiscan

The Cathodoluminescence system is attached to a scanning electron microscope (SEM) and may be used to investigate chemical composition including trace elements, electronic structure, and studying stress information in semiconductors and insulators. The system may also be used for mineral analysis.

Location: Warwick 2.5b

Features

- Spectra can be measured in parallel with scanning electron microscopy
- Monochromatic and panchromatic imaging modes
- Wavelength range 185 - 850nm.

High Speed Camera with Microscope

Leica DM 2500M with Vision Research Phantom Monochrome v.7.3

High speed camera system may be used to study microscale dynamic processes.

Location: Warwick 2.6b

Features

- Up to 6688 frames per second at 800 x 600 resolution
- 8, 10, 12 or 14 bit image depth
- Continuously adjustable shutter speeds down to 1 μs.

GATAN ORIUS® CCD Camera

GATAN ORIUS® CCD camera - large format (11 Megapixel) retractable and fiber-optical coupled CCD

Viewing and recording images and electron diffraction patterns. The high speed viewing mode also allows the user to replace the traditional TEM viewing screen. Operations such as microscope alignments, stigmation, and focus can be performed with high precision using the camera display instead of the TEM viewing screen.

Location: Warwick 1.31

Features

The SC1000 offers a high speed (>14 fps - frames per second) image viewing mode. This allows the user to search areas within the sample quickly and efficiently. Another benefit of the high frame rate of the SC1000 is the capability of TEM in-situ observations. The SC1000 can output high quality (dark and gain corrected) LIVE images via a digital video stream.



Scanning Probe Energy Loss Spectrometer (SPELS)



The SPELS instrument delivers spatially resolved spectroscopic information about surfaces with sub-50 nm resolution.

A scanning tunnelling microscope tip is used to produce a narrow beam of field-emitted electrons in close proximity ($< 1 \text{ fm}$) to the sample surface. These electrons are used to probe surface excitations such as plasmons and excitons. SPELS is extremely surface sensitive and can be used to map the chemical composition of a surface or plasmon modes in nanostructured media. It combines these features with the atomic resolution capability of a scanning tunnelling microscope.

Features

- Sample size: 10mm x 10mm x 1mm
- Maximum scan range: $3\mu\text{m} \times 3\mu\text{m} \times 1.5\mu\text{m}$ (height)
- Primary beam energy range: 0-250eV
- Energy resolution: 300meV
- Spatial resolution: sub 50 nm
- Criteria for use: Room temperature, Conducting samples, Ultra high vacuum.

Location: Birmingham 1.1

High Resolution Hybrid Mass Spectrometer Coupled with UHPLC

Bruker MaXis with Proxeon Easy-nLC and Dionex RS3000 HPLC & Bruker HCT-Ultra, ETD Discovery with Agilent 1200 UHPLC



Ultra high resolution - time of flight mass spectrometer (TOF-MS) for use in applications such as: identification of small molecules, metabolomics, quantitative proteomics, biomarker discovery, characterisation of (bio)polymers and supramolecular assemblies.

Features

Ion trap MS:

- CID/ETD
- MSⁿ
- LC-MS/MSⁿ

MaXis MS:

- Resolution $> 40,000$ FWHM
- MS and MS/MS mass accuracy typically between 600 - 800 ppb
- Acquisition rate up to 20Hz

Location: Warwick 2.4

Mass Spectrometry System for Surface Analysis

KORE Surface Seer



The 'Surface Seer' is a time-of-flight SIMS instrument dedicated to investigating the surface chemistry of materials. A focused caesium ion beam scans an area typically $500 \times 500 \mu\text{m}$ on the surface of a sample. This results in mass spectra characteristic of the very top-most atom layers of the sample, which is of increasing importance in materials engineering, biomaterials, drug delivery, etc.

The instrument detects all elements of the periodic table from hydrogen to uranium down to ppm levels, but its real strength is the ability to provide unique information about organic compounds on surfaces, even coatings or structures just a few atom layers thick. Various surface phenomena, such as self-assembled monolayers, can be characterised.

Features

- Reflectron energy analyser
- Positive and negative ion modes
- Analysis of both insulating and conducting samples
- Mass range $> 1000 \text{ m/z}$
- Mass accuracy of $\pm 10 \text{ mamu}$
- Samples must be vacuum-compatible.

Location: Birmingham 2E5

MALDI Mass Spectrometer

Waters Micro MX



High-performance, matrix-assisted laser desorption/ionisation time-of-flight mass spectrometer featuring parallel position sensitive detection (PSD) technology for confirming protein identification and determining post-translational modifications.

Negative ion capability allows applications in genotyping and polysaccharide analysis.

Features

- Enables analysis of sub-femtomole quantities of biological and synthetic molecules
- Molecular weight range 200 Da - $> 500 \text{ KDa}$
- In reflection mode with $\text{m/z} < 4\text{kDa}$ high resolution spectra obtained.

Location: Birmingham 2E2

Gas Chromatography Mass Spectrometer (GCMS)

Waters GCT Premier



An orthogonal acceleration time-of-flight mass spectrometer with high resolution for the selectivity needed to separate analyte spectra from isobaric interferences and background chemical noise. Identifies the elemental compositions of small molecules.

Features

- Sub-5 ppm RMS
- EI, CI and FI ionisation.

Location: Birmingham 2E3

High Resolution Electron Energy Loss Spectrometer (HREELS)

LK ELS500MCA



The HREELS technique allows one to resolve finely spaced energy features, necessary for analysing molecular vibrations. The advantage of HREELS over other energy loss spectroscopy is that momentum can be transferred by the electrons to the features being measured, this gives the experimentalist extra information regarding the energy-dispersion relations of surface features and the ability to excite indirect transitions (where spectroscopy with photons as the probe is limited to direct transitions).

Features

- Energy Resolution (Direct Beam) = 0.5meV
Beam Energy = 1eV to 70eV
- Sample size = up to 2cm square attached to omicron plate
- Temperature range = 77K to 800K (potentially from 4K with He)
- Energy range = 0 to 2eV window, with 40eV movement range
- Pressure = 10E-10torr (UHV), Prep = Ar Ion sputtering, E-beam annealing, LEED analysis.

Location: Birmingham 1.18

Bruker S8 Tiger X-Ray Fluorescence (XRF) Spectrometer



This system is capable of determining the elemental composition of samples, including solids, powders and liquids. It is able to detect elements from oxygen through to uranium.

The system is not optimised for elements lighter than oxygen and therefore not suitable for purely hydrocarbons or organics. Sample sizes can range from powders below 1g, to solids with diameters of up to 3cm (flat surface required).

The measurement is non-destructive in most cases.

Features

- Wavelength Dispersive XRF system
- Elemental analysis of materials, predominately inorganic solids and powders
- Optimised for detecting and quantifying elemental components ranging from oxygen through to uranium at major, minor and trace (ppm) levels
- Capable of handling small sample sizes (< 1g)
- Qualitative, fully quantitative and standardless analyses.

Location: Birmingham 1.9

Multi Frequency FT Electron Paramagnetic Resonance (EPR) Spectrometer



A large number of materials have unpaired electrons. These include free radicals, many transition metal ions, and defects in materials. Free electrons are often short-lived, but still play crucial roles in many processes such as photosynthesis, oxidation, catalysis, and polymerisation reactions. Hence EPR applications span a wide range of areas from quality control to molecular research in fields such as material research, structural biology, and quantum physics.

For example EPR is able to provide information on long-range interactions (1 to 8nm) between paramagnetic centres and extract conformational information which are difficult to obtain by other technologies (such as NMR, X-ray crystallography).

Features

This is a highly versatile multi-frequency (9.5 and 34 GHz) Fourier Transform Electron Paramagnetic Resonance (EPR) spectrometer equipped for all FT-EPR and Electron Spin Echo techniques including ESEEM and 2D-HYSCORE to measure spin density distribution and distances through the hyperfine interaction between electron and nuclear spins, SECSY and EXSY to measure correlations and exchange rates, Pulse-ELDOR and DEER to measure long range distances by electron-electron spin dipolar coupling, pulse-ENDOR to measure hyperfine interactions and nuclear spin relaxation, and laser triggered experiments to investigate chemical reactions and triplet states.

Location: Warwick 1.35

Solid State NMR suite



Millburn House has thirteen superconducting magnets for performing NMR, ranging from 850 MHz (proton Larmor frequency) to 100 MHz for solid-state NMR, 700 and 600 MHz for solution-state NMR and a three magnet solid-state DNP system.

Over sixty probes enable NMR to be performed over a wide temperature range from 90 K to 1000 K, with air or nitrogen gas, and MAS rotors ranging from 1.3 mm (65 kHz spinning) - 1.8 mm (45 kHz spinning) - 2.5 mm (35 kHz spinning) - 3.2 mm - 4 mm - 7 mm - 9 mm - 14 mm (4 kHz spinning). There are also two Double-Rotation (DOR) probes.

Spectrometers

- 600 MHz Bruker Avance II+
- 500 MHz Bruker Avance III
- 400 MHz Bruker Avance 400
- 300 MHz Varian InfinityPlus
- 300 MHz Field-Sweep Chemagnetics Infinity
- 200 MHz Chemagnetics Infinity
- 100 MHz Chemagnetics Infinity
- DNP: 143 MHz Super Widebore Chemagnetics Infinity
- DNP: 600 MHz Sweepable Varian

Rotors

- Bruker 2.5 mm
- Bruker 3.2 mm
- Bruker 4 mm
- Bruker 7 mm
- Chemagnetics/Varian 3.2 mm
- Chemagnetics/Varian 4 mm
- Chemagnetics/Varian 6 mm
- Chemagnetics/Varian 9.5 mm
- Chemagnetics/Varian 14 mm
- Doty 4 mm
- Doty 7 mm
- Samoson 1.8 mm
- Samoson DOR

Location: Warwick 1.36

850MHz Solid State NMR

Bruker 4 channel HFX with 11 MAS and static probes



The 850 MHz system is a world-leading UK facility delivering advances in materials science, chemistry, biology, earth science and physics, jointly funded through EPSRC, BBSRC and the Advanced Materials projects.

Solid-state NMR provides information about the structure of solids and is especially suitable for studying disordered materials which lack long range order.

Solid-state NMR uses nuclear spin as a "local probe" to investigate short range arrangements in materials in contrast to techniques such as X-ray diffraction. It can be used to study the structure and conformations of organic molecules and inorganic compounds, the interactions between different molecules or ions, as well as local dynamics, kinetics and dynamics at atomic resolution. The systems of interest can range from small and moderately sized organic molecules, e.g., pharmaceuticals, and peptides and inorganic compounds to large structures such as proteins or polymers.

Features

- UltraShield cryomagnet: bore size 89mm and persistent magnetic field of 20 Tesla
- Avance III ultrafast console (4 channels)
- Temperature control down to 150 K
- A range of 1.3, 2.5, 3.2, 4 and 7 mm MAS and DOR probes.

Location: Warwick 1.38 & 2.27

X-ray and UV Photoelectron Spectroscopy (XPS & UPS)

Omicron GmbH & VG Scienta



This instrument combines several electron spectroscopy techniques that can be applied to investigate the chemical composition and electronic structure of surfaces and interfaces. The instrument includes a monochromated twin-anode X-ray source (Al & Mg K_{α}) and a multi-channel concentric hemispherical analyser for high resolution X-ray photoelectron spectroscopy (XPS - supplied by Omicron GmbH).

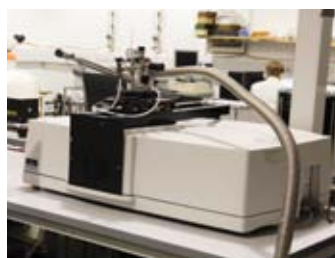
In addition there is a high intensity un-monochromated X-ray source, a low energy electron flood gun (for non-conducting samples), low energy electron diffraction (LEED) for surface crystallography, an ion sputter gun for elemental depth profiling, and a preparation chamber for deposition and in-situ sample pre-treatment. Samples are transferred through the system on sample plates and can be moved to an adjoining chamber with high resolution UV photoelectron spectroscopy (UPS - supplied by VG-Scienta) consisting of a monochromated high intensity helium discharge lamp and a Scienta R4000 high resolution electron analyser. This combination allows valance band electronic structure of materials and deposited overlayers to be investigated, with samples mounted on a 5-axis manipulator with a temperature range of 30 -1000K.

Features

- High resolution XPS for surface and interface chemical analysis
- Facilities for electron spectroscopy of non-conducting samples
- Electronic structure determination, valance band and Fermi surface mapping
- Elemental depth profiling
- Vacuum suitcase transfer from other growth/vacuum chambers under UHV conditions.

Location: Warwick 1.22

LAMBDA 1050 Spectrophotometer for Optical Absorption



Architectural and Specialty Glass: Energy conservation is more important now than ever before. Analysis of coated glass provides important information on thermal efficiency and other key design considerations.

Solar Energy Research: The LAMBDA 1050's capability in the NIR region allows full characterisation of not only the active solar cell materials but also the reflective protective covering.

Location: Warwick 1.34

Features

The LAMBDA 1050 is a high sensitivity and high resolution spectrophotometer for a wide range of demanding applications, such as high absorbing glass, optical coatings or thin film filters over the wavelength range 190 - 3300nm. It also features two large sampling compartments and polarizing optics.

It is equipped with an Oxford Instruments Optistat cryostat enabling measurements in the range 3.7 to 300K.

Steady State and Time Correlated Single Photon Counting (TCSPC) Fluorescence Spectrometer

Edinburgh Instruments



Modular instrument for measuring fluorescence and phosphorescence decays on molecular nanomaterials.

Location: Birmingham 2E10

Features

- Time range 100ps - 10s
- Xe flashlamp, pulsed diode laser and LED
- Detection in visible and near IR.

300 and 400 MHz Solution NMR Spectrometers

Bruker BioSpin Avance III 300 & 400

300 and 400 MHz NMR Spectrometers refurbished and equipped with automation and new Avance III controllers for routine solution NMR analysis. High performance digital NMR for characterisation of molecular materials and nanoparticles.

Location: Birmingham 2E1

Features

- ¹H, ¹³C, ¹⁹F, ³¹P as well as more demanding multi-pulse experiments
- Temperature range -95°C to +110°C
- Capacity to study traditional inorganic nuclei.

Near IR Spectrometer

Varian Cary 5000 Near IR Spectrometer with Harrick Praying Mantis Diffuse Reflection Accessory

Near Infra-Red Spectrometer with cryogenic unit for liquid nitrogen temperature measurements. Praying mantis accessory allows reliable diffuse reflectance studies of powders and other rough surface solid samples.

Location: Birmingham 2E9

Features

- Wavelength: 175 – 3300 nm
- Cryogenic temperatures
- Solutions, solid samples and thin films.

Varian 660 IR FTIR Spectrometer with Pike MIRacle diamond ATR

Records vibrational spectra. Capable of providing information on the chemical constitution of samples and the nature of bonds present.

Location: Birmingham 1.7

Features

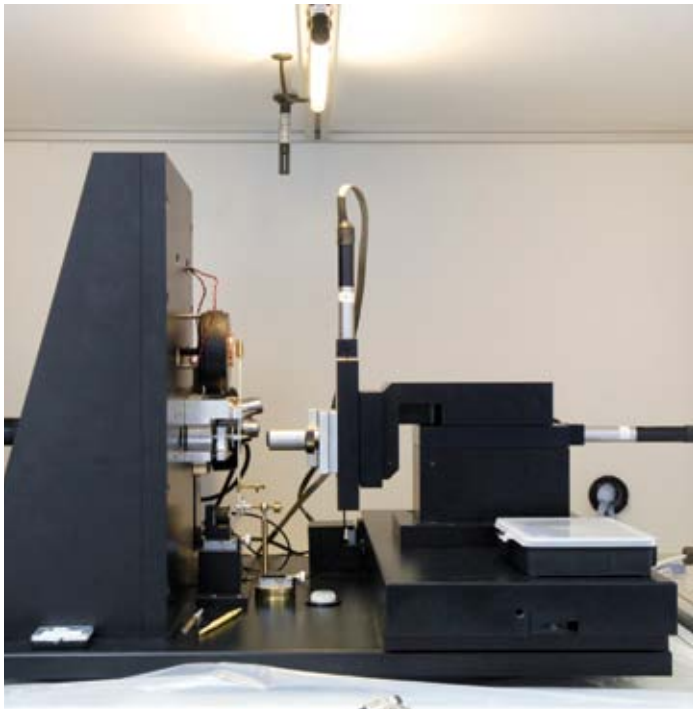
- Records infrared spectra
- Optimised for powder samples
- Environmental chamber for the measurement of air sensitive samples.



22 · 27
Physical &
Mechanical
Properties

Nanoindenter

Micromaterials NanoTest



Nanoindentation measures mechanical properties and scratch characteristics including fatigue and wear.

Hardness and modulus may be assessed on the nanoscale using diamond-coated indenters.

Features

- Force range 0.1 – 500mN
- Liquid immersion and humidity control 20 - 90%RH
- Range of indenter geometries
- Frequency dependent mechanical properties
- Target location identified to $\pm 1\mu\text{m}$

Location: Birmingham 2E31

Thermal Analysis Suite

Mettler Toledo DSC1-400, DSC1-Star and DSC1-1600



Differential Scanning Calorimetry (DSC) is the quantitative measurement of phase transitions used to determine transition temperatures and phase composition of materials e.g. glass transition in polymers, glass/crystal fractions, purity determination in pharmaceuticals.

The technique is used for monitoring of phase changes in high temperature materials such as metals and ceramics.

Thermogravimetric Analysis (TGA) can be used to determine the thermodynamics and kinetics of processes involving weight loss such as corrosion and oxidation.

Features

High sensitivity DSC:

- Temperature range -150 to 700°C $\pm 0.1^\circ\text{C}$
- 0.04 μW resolution

TGA/DSC:

- Temperature range: 20 to 1600°C, $\pm 0.3^\circ\text{C}$
- Controlled atmosphere
- 0.1 μg resolution TGA
- 0.1mW resolution DSC

Autosamplers on all three instruments.

Location: Warwick 2.15, 2.16 & 2.17

MUARC (Midlands Ultracold Atom Research Centre)



MUARC exploits the unique properties of ultracold atom gases to drive the advancement of knowledge in fundamental quantum phenomena. The research has a particular focus on optical lattice systems, which provide new interdisciplinary insights into important condensed matter phenomena like superconductivity and quantum phase transitions.

MUARC provides a suitable laboratory environment to enable cold atom experiments aiming at the creation of artificial materials. The facility will enable the creation and study of artificial 2D materials with many degrees of freedom in parameters, e.g. tunnelling, interaction, lattice geometry. An applied theme will be the development of quantum sensors for measurements of highest precision.

Features

- Quantum simulation of condensed matter phenomena
- Quantum measurement and quantum information
- Atom-surface interactions
- Atom-photon interfaces.

Location: Birmingham 1.20

Netzsch STA 449 F1 Jupiter Thermal Analyser



The thermal analyser can provide a variety information including:

- Temperature and composition of evolved gases
- Mass change for analysis, eg of oxygen content in materials
- Information on phases changes (DSC) even when no mass change occurs.

Features

The Netzsch analyser allows thermal analysis of materials up to temperatures of 1400°C in controlled atmospheres. Mass change and calorimetric effects can be monitored simultaneously. The equipment is linked to a mass spectrometer which allows immediate analysis of evolved gases.

Location: Birmingham 1.6

Rheometer

TA Instruments AR G2



Rheological analysis of liquids and soft solids for use in implants and delivery systems.

Assessment of the material properties using cone and plate, concentric cylinder and vane geometries is possible.

Features

- Ultra-low nano torque control down to 3nN m in controlled stress and direct strain controlled modes
- Frequency range 10⁻⁶ - 100Hz
- Temperature control up to 200°C
- Measurement of Newtonian and non-Newtonian materials.

Location: Birmingham 2E34

Calorimeter

TA Instruments TAM III



Calorimetry can be used for ultra-sensitive heat flow measurement. The equipment can monitor chemical stability, physical degradation and polymorphic transformations.

Example applications include polymer and pharmaceutical development, cement formulation and accelerated corrosion testing.

Location: Warwick 2.18

Features

- Up to four independent calorimeters can be used simultaneously
- 2 x microcalorimeters, 1 x multicalorimeter, 1 x solution calorimeter
- Isothermal, step-isothermal or temperature scanning modes
- 15 - 150°C temperature range
- Isothermal and slow scanning (2°C h⁻¹)
- Temperature stability < 0.01mK / 24h.

Dynamic Vapour Sorption (DVS) Moisture Adsorption Apparatus

Surface Measurement Systems DVSA-STD



The sorption apparatus characterises the behaviour of materials in different humidity and temperature environments.

Vapour sorption isotherms can be measured and compound stability evaluated. Additionally, surface adsorption effects can be examined.

Location: Birmingham 2E19

Features

- Gravimetric measurements using 0.05µg resolution microbalance
- Organic solute and water reservoirs
- Temperature range 5 to 60°C
- Analysis of solid and powder samples.

Dissolution Apparatus

Varian 705-DS



Monitors the degradation of resorbable biomaterials in addition to release from pharmaceutical materials and devices. Applications include formulations, materials, soluble dosage forms and release in vivo.

Location: Birmingham 2E21

Features

- 8-vessel / 8-spindle configuration
- Standard 1L vessels
- US Pharmacopeia (USP) compliance.

Helium Pycnometer

Micro-meritics Accupyc II 1340



High-speed, high-precision volume measurements and density calculations on a wide variety of powders, solids, and slurries as well as bulk objects and porous scaffolds. Uses gas displacement to measure volume.

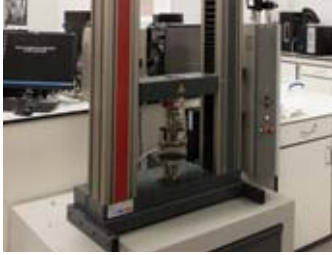
Location: Birmingham 2E22

Features

- Measures the absolute density of solids and slurries with volumes 0.01 to 1.0cm³.

Universal Mechanical Tester

Zwick/Roell Z030



Testing system for compressive and tensile strength of materials.

Example applications include tensile testing of polymers and compressive testing of bioceramics. Powder compaction studies may also be undertaken.

Location: Birmingham 2E24

Features

- Force range 10 mN to 30 kN
- Liquid immersion facilities to work under physiological conditions
- Compressive, tensile and flexural testing.

Environmental Mechanical Analyser

Instron MicroTest 5848



Enables measurement of mechanical properties, such as tensile and compressive strengths, as a function of humidity and temperature.

Fatigue studies may be conducted over extended time periods (weeks).

Location: Birmingham 2E25

Features

- Force range 10 mN to 2 kN
- Electromechanical position control ~ 5µm
- Custom waveforms and strain patterns
- Humidity range 10 - 80%RH
- Temperature up to 40°C.

Quantum Design Physical Properties Measurement System (PPMS)



The Quantum Design PPMS is an open architecture, variable temperature-field system, designed to perform a variety of automated measurements. It offers a wide range of magnetic, thermal and electrical measurements.

Location: Warwick 1.25

Features

Heat capacity: T range, 0.4K - 400K in magnetic fields of up to 9T. Sample mass 5-500 mg with a resolution of 10nJ/K @ 2.0K.

Transport Measurements: AC Resistivity, Hall Effect, I-V Curve Tracing, and Critical Current measurements, 1 nV sensitivity, nΩ resolution at 2 A, drive amplitude 10µA to 2 A. Thermal conductivity, dynamic range 0.1 to 250 W/mK, Seebeck coefficient, range 1µV/K to 1V/K. For all the transport measurements T range 1.8K - 400K in magnetic fields of up to 9T.

Magnetic Property Measurement System (MPMS) SQUID Magnetometer



Magnetic Property Measurement System (MPMS) magnetometer utilises Superconducting Quantum Interference Device (SQUID) technology. The MPMS provides solutions for a unique class of sensitive magnetic measurements in key areas such as high-temperature superconductivity, biochemistry, and magnetic recording media.

Location: Birmingham 1.26

Features

Magnetisation Measurements: T range, 0.5K - 800K in magnetic fields of up to 7 T. Maximum sample size ~9 mm diameter by ~20mm long. DC magnetisation, sensitivity 1 x 10⁻⁸ emu @ 0.25T.

AC susceptibility measurements: 0.1Hz to 1KHz, sensitivity 2 x 10⁻⁸ emu at 0T.

Tribometry Suite

Tribometer and Nanotribometer

Tribological measurements of friction, lubrication and wear. Nanotribometry may be carried out under controlled humidity and temperature.

Location: Birmingham 2E26 & 2E27

Features

- Reciprocating motion and rotating motion.
- Tribometer loads > 1N and Nanotribometer loads 1mN - 1N
- Variable environmental conditions.

Micro-Manipulation System

Custom-built

Mechanical characterisation of single micro-particles, single cells, soft solids, MEMS devices, particle-particle interactions and particle-surface interactions.

Location: Birmingham 2E30

Features

Measures:

- Compression behaviour
- Stress relaxation behaviour
- Frequency-dependent behaviour
- Variable environmental conditions can be employed.

Dental Wear Simulators

Proto-Tech Fatigue Cycler, Thermal Cycler and Shrinkage Stress Analyser

A: Thermal Cycler - reproduces the temperature cycling which occurs in the mouth to evaluate dental materials.

B: Polymerisation Stress Tester - measures stress and shrinkage in polymerisation of dental composites.

Location: Birmingham 2E37

Features

- Thermal cycling: 0 – 80°C
- Fatigue testing:
 - Loading up to 400 N
 - Up to 4 parallel samples.

Micropore Analyser

Micromeritics ASAP2000 and Autopore IV



Determines the pore size distribution and pore volume of materials, including dental and medical materials, porous scaffolds and catalysts. Example materials include: catalysts and bio-scaffolds and gas storage materials such as carbons, zeolites and metal organic frameworks.

Chemisorption can be used to investigate active metal dispersions or surface acidity of catalysts. Materials with low surface areas such as powdered metals, glass fibers, and natural organic materials can also be analysed.

Location: Warwick 2.24 & 2E23

Features

- Measures surface areas from 0.001 to 3000m² g⁻¹
- Pore diameters from 0.003 to 360µm
- Resolution > 0.1µL pore size.

Deposition Growth & 28 ▶ 31

Size Selected Cluster Beam



Exploring size-dependent physical and chemical properties of nanoparticles are inspired by the expectation that due to their reduced dimensionality novel properties can arise that are not present in the bulk counterparts.

The state-of-the-art high vacuum system consists of a magnetron sputtering gas condensation cluster beam source and a unique lateral time-of-flight mass filter. This system allows synthesis of size-selected nanoparticles up to 75000 atoms with a mass resolution of $M/\Delta M \approx 130$. The size-selected cluster beam can be deposited onto many support materials at various impact (kinetic) energies and pinned by surface defects.

Features

- Source type: Magnetron sputtering
- Target material: Metals and semiconductors
- Dimension: diameter of 50mm; thickness of 4 (6) mm for indirect (direct) cooling
- Beam potential: -1.0 to +1.0kV
- Mass range: ~30 to 20,000,000amu
- Mass resolution: ~130
- Transmission: ~44%
- Substrate voltage: -1.5 to +1.5kV
- Beam current: Up to 3nA

Location: Birmingham 1.10

Pulsed Laser Deposition (PLD)



This instrument consists of an ultra-high vacuum (UHV) pulsed laser deposition (PLD) system with a series of in-situ surface structural and chemical probes.

The PLD system (supplied by TSST B.V. Holland) allows target materials placed in the chamber to be ablated using a pulsed ultra-violet laser for the growth of thin films of materials - some only a few atoms thick - in a controlled manner. This is achieved by in-situ monitoring of the growth process using reflected high energy electron diffraction (RHEED) to ensure high crystalline perfection in a range of different materials. This PLD system allows different combinations of materials and interfaces to be fabricated from complex oxides to semiconductor materials. The use of UHV and high purity materials ensures that stoichiometric thin films of the highest structural quality can be grown. The system incorporates a number of in-situ surface diagnostic techniques such as X-ray photoelectron spectroscopy (XPS) for determining the surface composition, and scanning probe microscopy, (both STM and AFM - supplied by Omicron GmbH) for topographic and atomic resolution studies of surface and interface structure in the epitaxially grown materials.

Features

- Controlled growth of high quality epitaxial thin films of complex oxides
- Layer by layer, controlled deposition of the thin films of various materials
- Deposition and growth of interfaces, multilayer and superlattice structures
- Optimisation of the growth conditions by in-situ diagnosis of the as grown thin films by RHEED and XPS
- Surface structure analysis in-situ using combined STM and AFM.

Location: Warwick 1.21

Single Crystal Growth Machine

(Cyberstar)



This equipment will be used to melt binary and ternary intermetallic compounds in polycrystalline form. Rods of these compounds can also be made using this method in preparation for crystal growth by the floating zone technique.

Features

- This system will be used as a crystal growth system using 4 arcs (tetra arc) to melt materials on a copper hearth
- This system can be used to produce crystals of intermetallic materials - alloys and compounds.
- Includes a radio frequency power generator, capable of delivering 40kW has been acquired to be used in conjunction with an existing cold boat system.

Location: Warwick 1.23 & 1.24

Photolithography Clean Room Suite



Moorfields electron beam evaporator, Recently upgraded Moorfields MiniBox thermal evaporator and sputtering system and Suss Microtec MJB4 Mask Aligner.

The suite consists of purpose built clean room facility housing a variety of equipment to facilitate photolithographic processing of device structures.

Features

- Moorfields electron beam evaporator - controlled thin film deposition of metals such as Pt, Ni etc
- Thermal evaporator and sputtering system - controlled thin film deposition of both metals and insulators including Pt, Au, Ti, Cr, Al, SiO_x etc
- Suss Microtec MJB4 Mask Aligner - high resolution printing down to 0.5µm.

Location: Warwick 1.27

Organic Thin Film Deposition and Solar Simulator System

mBraun 200B Glovebox with Solar Simulator

The system may be used for the formation of thin organic films via evaporation and deposition with controlled rate and thickness. Solar simulation allows the testing of the response of films to 1sun simulated solar irradiance.

Location: Warwick 2.4

Features

- Glovebox with two anti-chambers and evaporator
- Solar Simulator with Xe Arc lamp (550W)
- Quartz Crystal Microbalance for measurement of film formation.

Metal Evaporator

Edwards E306 Coater

Evaporator for gold, aluminium, silver, chromium, copper and germanium to prepare coated surfaces. Equipped with the ability to select sources during processing enabling in situ multilayer formation.

Location: Birmingham 2E13

Features

- Deposition is monitored by quartz crystal microbalance
- Deposition rates 0.01 or 0.001nm s⁻¹



Quartz Crystal Microbalance (QCM)

Qsense QCM-D E1 & E4 System



The Quartz Crystal Microbalance provides mass and structural information on molecular layers that form on the surface of a sensor. Molecular adsorption and interactions can be monitored in real time under a variety of conditions. Sensors can be chemically modified to produce a range of surfaces for study.

QCM can be used in a range of applications, for example to investigate the hydration of polymer films, monitor protein interactions with a variety of surfaces, or study the effectiveness of surfactants in removing lipid films.

Features

- Multiple sensor unit for up to four flow cells in series or parallel configuration
- Electrochemical cell
- Temperature range from 15 - 45°C
- Dissipation monitoring gives information on rigidity of films
- Sensitivity of the order of 2ng cm⁻²
- Resolution of 200 data points per second.

Location: Warwick 2.3

Ellipsometer

Nanofilm EP3-SE



Ellipsometry may be used for the determination of film thickness, morphology, microtribology, electric and optical properties of multilayer metal/metaloxides; self assembled molecules and thin film polymeric materials; next generation energy-efficient glazings. Surface plasmon resonance package is available for molecular surface interaction investigations.

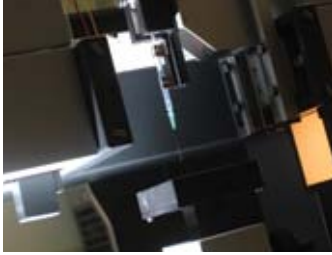
Features

- Spectroscopic ellipsometer with 46 wavelengths between 365 nm to 1000 nm
- Wavelength and angle of incidence scanning
- Mapping function
- Lateral resolution 1µm
- Surface plasmon resonance (SPR) cell.

Location: Warwick 2.10

Drop Shape Analyser

Kruss DSA-100



Static and dynamic contact angles of liquids on surfaces, interfacial and surface tensions of liquids and surface energies of solids can be measured. Applications include wetting properties of plastics, glasses or metals, effectiveness of surfactant solutions and investigating adhesion properties.

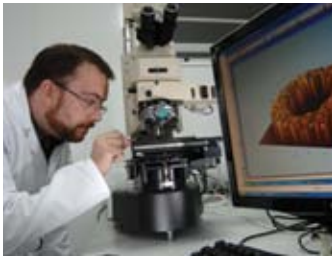
Features

- Contact angle (sessile drop)
- Surface tension (pendant drop)
- Tilting table
- EDM/ODM module (Expanding Drop Method/Oscillating Drop Method)
- Humidity chamber
- High speed camera available.

Location: Warwick 2.19

Interferometer

KLA Tencor MicroXAM2



Interferometry measures surface topography and wear volume through three-dimensional surface profiling.

Equipment may be used to measure coating film thickness up to 60µm.

Features

- Vertical range up to 50mm
- 100mm x 100mm sample positioning stage
- Phase mode for nanoscale resolution
- Surface roughness may be quantified
- Dissimilar materials analysis

Location: Birmingham 2E28

Ti:Sapphire Femtosecond Laser System - Optical Measurements and Characterisation



Measurements of materials reflectivity and absorption properties, determination of excitation decay dynamics, determination of real and imaginary parts of dielectric constants by means of static and time resolved ellipsometry, design and implementation of advanced optical set-ups, optical measurements automation and optimisation.

Features

- Micro 'seed' laser: 400mW pulses at 80MHz, Lambda = 800nm, Pulse Duration 40fs, Bandwidth 100nm.
- Legend Amplifier: 4W pulses at 1kHz repetition, Lambda = 800nm, Pulse Duration 30fs, Bandwidth 40nm.
- OPA for wavelength tuning between 250-20000nm.
- CEP for < 1mrad stability in phase of pulses.

Location: Birmingham 1.17



FEI Quanta 3D Focussed Ion Beam - Scanning Electron Microscope (FIB-SEM)



There are two important applications:

1. 3D SEM. Produces 3D images from 100x100x100µm. Images can be secondary electrons or X-rays (chemical images)
2. TEM (transmission) specimen production from any selection or combination of materials (e.g. polymers, ceramic etc).

Features

The Quanta 3D FEG is a versatile high-resolution, low vacuum SEM/FIB for 2D and 3D material characterisation and analysis. The Quanta 3D FEG's field-emission electron source delivers clear and sharp electron imaging. Increased electron beam current enhances EDS and EBSP analysis. Featuring three imaging modes - high-vacuum, low-vacuum and ESEM. Quanta 3D FEG's high-current FIB enables fast material removal. Automated FIB sectioning recipes enable accurate cross-sectioning.

Electron beam resolution

- High-vacuum (0.8nm at 30kV (STEM); 1.2nm at 30kV (SE); 2.5nm at 30kV (BSE); 2.9nm at 1kV (SE))
- Low-vacuum (1.5nm at 30kV (SE); 2.5nm at 30kV (BSE); 2.9nm at 3kV (SE))
- Extended low-vacuum mode (ESEM) (1.5nm at 30kV (SE))

Ion beam resolution

- 7nm at 30kV at beam coincident point (5nm achievable at optimal working distance)

Electron optics

- High-resolution field emission - SEM column optimised for high brightness/ high-current * optional
- 60 degree objective lens geometry with through-the-lens differential pumping and heated objective apertures

- Accelerating voltage: 200V - 30kV (optional down to 100V)

- Probe current: up to 200nA - continuously adjustable

- Magnification 30 x - 1280kx in "quad" mode

Ion optics

- High-current ion column with Ga liquid-metal ion source
- Source lifetime: 1000 hours guaranteed
- Acceleration voltage: 2 - 30kV
- Probe current: 1pA - 65nA in 15 steps
- Beam blaster standard, external control possible
- 15-position aperture strip
- Magnification 40 x - 1280kx in "quad" mode at 10kV
- Charge neutralisation mode for milling of non-conductive samples

Location: Birmingham 1.19

Microfabrication Facility

The Microfabrication Facility hosts the necessary equipment for small scale microfabrication prototyping, including silicon cleaning and resist preparation facilities, an Electron Beam Lithography tool with 10 nm resolution, thin film sputter coating, thermal processing and metrology.

With this suite of facilities we can create arbitrary patterns on a wafer, we can then coat the unpatterned areas with thin films of metal or insulator, or etch the unprotected material away. Typical applications include MEMS devices such as microfabricated cantilevers, patterned surfaces for biological applications, electrical contacting of nanowires, optical surfaces such as gratings, and other microdevices. We have developed a resist material in house that is particularly suited for high resolution, high speed, high aspect ratio patterning.



Location: Birmingham 1.14

Features

PlasmaPro NGP80 Inductively Coupled Plasma etching machine:

- Maximum sample size: up to 200 mm wafer
- Plasma sources: RF and ICP with maximum power of 600 W
- Maximum total gas flow: 200 sccm
- Maximum pressure: 60 mTorr
- Process gases: SF₆, C₄ F₈, CF₄, CHF₃, O₂, Ar
- Applications: RIE, ICP, Bosch or sputter etch processes for Si, SiO₂, polymer film and thin metal film
- Accessories: Automatic matching units, He backside cooling, temperature control 0-90 degree C.

Disco Automatic Dicing Saw DAD321 Wafer Dicer:

- Model: 6"-compatible automatic dicing
- Max workpiece size: 160 x160 mm²
- X-axis cutting range/max cutting speed: 192(mm)/0.1-300(mm/s)
- Y-axis cutting range/positioning accuracy: 162(mm)/0.005(mm)
- Z-axis moving resolution/max blade size: 0.0001(mm)/ø76.2(mm)
- Spindle rated torque/revolution speed range: 0.48(N.m)/3,000 - 40,000(min-1)
- Machine dimensions (W x D x H): 500 x 1050 x 1455 (mm³)

38 ▶ 39

Chroma- tography

Gel Permeation Chromatography (GPC) Polymer Analysis Suite

Varian (Polymer Labs) 4 x 390-LC Systems & PL-GPC 220 Varian (Polymer Labs) PL-PMC-003



GPC may be used to measure relative molecular weight and polydispersity of polymeric samples.

Examples of applications include: commercial plastics, polymer-bioconjugates, personal care products, lubricants, agrochemicals, packaging materials etc.

The PL-PMC-003 monitors reaction kinetics through continuous sampling with automated acquisition and analysis in real time with concentration monitoring via UV and DRI detection and molecular weight measurements using light scattering.

Features

- Full range of commercial columns and solvent capability
 - DMF, THF, Aqueous & Chloroform etc
- Multi Detector Systems
 - Viscometry, Differential Refractive Index (DRI), Light Scattering, UV, Fluorescence, Photodiode Array (PDA)
- High temperature (30-220°C).

Location: Warwick 2.1 & 2.2

High Performance Liquid and Gas Chromatography (HPLC and GC) Systems

Shimadzu 2 x LC20 & 2 x GC2010



Two HPLC and two GC systems for analysis of molecular materials and nanomaterials.

Features

- 2 x HPLC systems with multiple detectors:
 - variable wavelength UV
 - photo diode-array (scan through 190nm - 800nm for eluted compounds)
 - evaporative light scattering (for use when no chromophore is present)
 - fluorescent detection (for use with markers)
- 2 x GC systems supporting high speed analysis
 - cooling from 450 to 50°C in 6 minutes
 - 970kPa and 1200mL/min.

Location: Birmingham 2E4

Fast Protein Liquid Chromatography (FPLC) Equipment

GE Healthcare 2 x AKTA-Purifier 900/950

FPLC is used for purification and characterisation of proteins and peptides and their conjugates with polymers. Applications include hybrid biosensors and macromolecular devices.

Location: Warwick 2.12

Features

2 x FPLC systems:

- Flow rate up to 20 mL/min
- Monitors analytes by UV, conductivity and pH.

Particle Size and Shape Analyser

QICPIC and HELOS/BF Sympatec



Equipment for the characterisation of particulate systems including both dry and wet samples including suspensions, powders and emulsions.

High speed analysis of particle size distribution is possible. Shape analysis yields aspect ratio and sphericity.

Location: Birmingham 2E18

Features

- Particle size 1µm to 6µm
- Aerodispersions, sprays
- High-speed camera: up to 500Hz
- Study of agglomerated fine and cohesive powders: 1µm to 6µm
- Laser diffraction sensor 0.1µm - 875µm for wet and dry samples.

Dark Field Particle Tracker

Nanosight LM10

Particle sizing using Brownian motion tracking for a variety of applications, including ceramics, viruses, colloidal suspensions, polymer nanoparticles, and wear debris in lubricants.

Location: Warwick & Birmingham 2.20 & 2E6

Features

- Particles illuminated by 40mW 640nm laser tracked and quantified by software
- Size range typically 10 - 1000nm
- Sample volume 0.3ml
- Polydisperse and multimodal systems identifiable.

Dynamic Light Scattering Zetapotential Apparatus

Malvern Instruments Nano-ZS

Measures size and zeta potential of colloids to give information on stability, polydispersity of nanoparticles, and presence of aggregates (e.g. of proteins). Can be used in analysing size of colloids and nanoparticles, pigments and inks, protein size, proteomics, melting point, colloid stability, water treatment, isoelectric point determination.

Location: Warwick 2.21

Features

- Measures hydrodynamic size and zeta potential
- Particle size (0.6nm - 6µm diameter) over the molecular weight range (1000 - 2x10⁷ Da)
- Temperature control 0 - 90°C
- 4mW HeNe laser 632.8nm.

High RPM Disc Centrifuge

CPS Instruments AS200 and Analytik DC24000

Measures particle size via sedimentation behaviour. Applications include polymer latexes and emulsions, silica dispersions, micro-encapsulated drugs, pigments, and starch particles.

Location: Warwick & Birmingham 2.22 & 2E39

Features

- Size range approximately 5nm - 50µm depending on density
- Dynamic range (ratio of largest to smallest sizes) ~ 70 with constant centrifuge speed
- Maximum speed 24,000rpm
- High resolution (can separate 2% size difference).

Powder Particle Sizer

Malvern Instruments 2000 System

Measures particle radius of a variety of wet or dry powders, dispersions or emulsions by laser diffraction.

Location: Warwick 2.23

Features

- Size range 0.2µm - 2000µm
- Sizing on emulsions, suspensions and dry powders
- Dual wavelength; HeNe (red) and solid state (blue) lasers.

Zeta Potentiometer and Molecular Weight Characteriser

Beckman Coulter Delta Nano C

Instrument for analysing charge and size of nanoparticles.

Location: Birmingham 2E7

Features

- Particle size: 0.6nm - 7µm
- Zetapotential: -100mV - +100mV
- Concentration 0.001 - 40%
- pH 1 - 13
- Temperature: 10 - 90°C.

Surface Plasmon Resonance (SPR) Equipment

Reichert SR7000DC



Surface Plasmon Resonance (SPR) measures biomolecular interactions providing high quality, real time kinetic data requiring no tags or labelling of compounds or proteins. Example application include the study of proteins, antibodies, peptides, DNA or lipids as well as investigating drug binding or antibody-antigen interactions.

Location: Birmingham 2E32

Features

- Real-time simultaneous dual-channel SPR
- Temperature range: 10 - 90°C
- Sample loop: 10µL - 2mL
- Flow rate: 1µL/hr - 10mL/min.

Gel Electrophoresis Kit

Genetic Research Instrumentation (GRI)Alpha-Imager HP System

High resolution fluorescent and visible imaging for culture plate & microplate based arrays.

Location: Birmingham 2E11

Features

- Motorised lens
- Incident white light for focussing and positioning
- Dual wavelength transilluminator
- White light table
- Five-position filter wheel.

Bioanalyser

Agilent 2100

A microfluidics-based platform for sizing, quantification and quality control of DNA, RNA, proteins and cells. Example applications: characterisation of protein sensors – lab on a chip technology

Location: Warwick 2.13

Features

- 10-12 samples in parallel
- 30-40 min analysis time.

Microwave Reaction Station

CEM Discoverer S-Class

The reaction station allows up to 48 microwave reactions to take place simultaneously for chemical syntheses, including polymers and peptides.

Location: Birmingham 2E17

Features

- 10, 35, 80ml capacity at 21 bar, or 125ml at atmospheric pressure
- Manual peptide solid phase synthesis accessory
- Gas (H₂,CO) addition accessory.

Laser Vibrometer

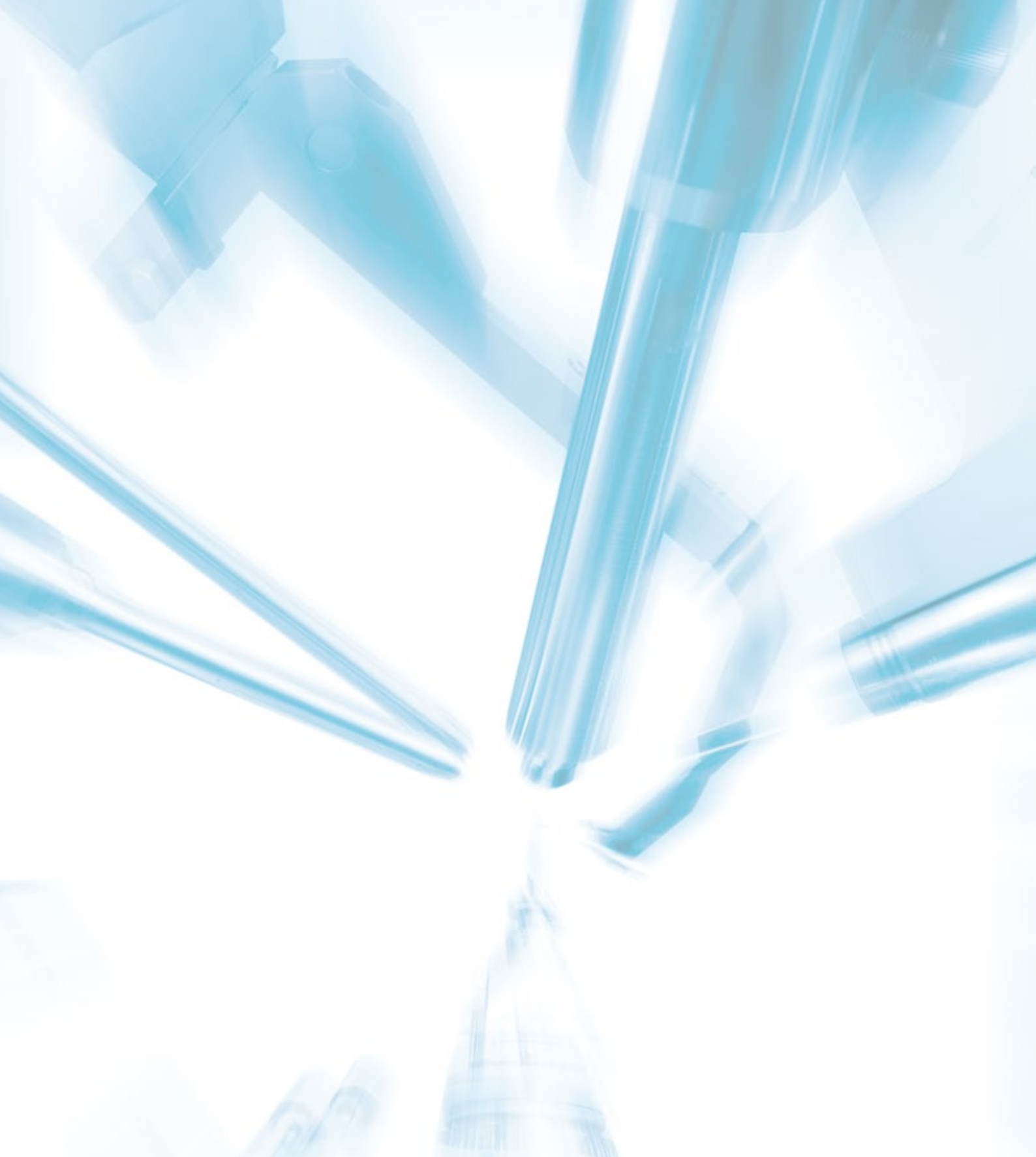
Polytec OFV-5000

Measures vibration amplitude, frequency and spatial location to give full vibration mapping of an object under test. The integral video camera can be used to monitor the area and provide a captured image for superimposition of the vibration data. Used for the evaluation of the design of dental instrumentation such as ultrasonic scalers and dental drills.

Location: Birmingham 2E35

Features

- Frequency range from near DC to 24MHz
- Velocities to ± 10m/s
- Displacements from the sub-nanometer to meter range.



For further information and enquiries, including access to the facilities, research consultancy or collaboration:

advanced.materials@warwick.ac.uk

T: 024 7652 4760

businessteam@bham.ac.uk

T: 0121 414 3898

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