University of Nottingham
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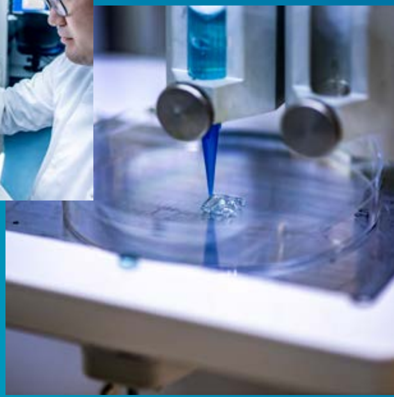
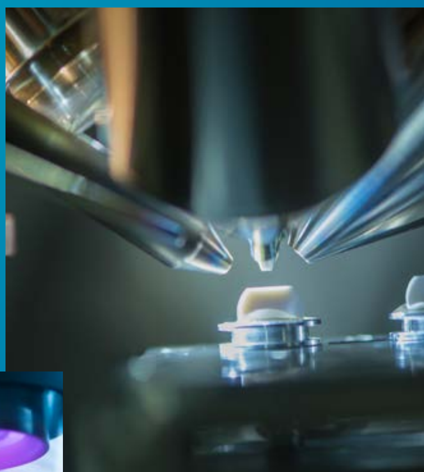
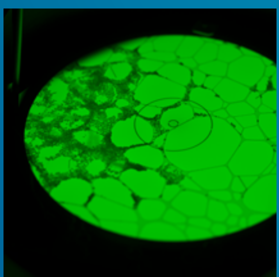


Advanced Materials









Introduction

Advanced Materials research is thriving at the University of Nottingham, with many world-leading research groups working in this area in the Schools of Chemistry, Pharmacy, Physics & Astronomy, Biosciences, Medicine, Veterinary Medicine and Science, Life Sciences and in the Faculty of Engineering. With such a strong research presence in this field already, the University of Nottingham is the perfect place to expand the work done in this priority area. With first-class equipment and research facilities, world-leading researcher teams and close ties to industry, the NHS and other academic communities, we are poised to transform our research output in this area.

Contents

Peter Beton

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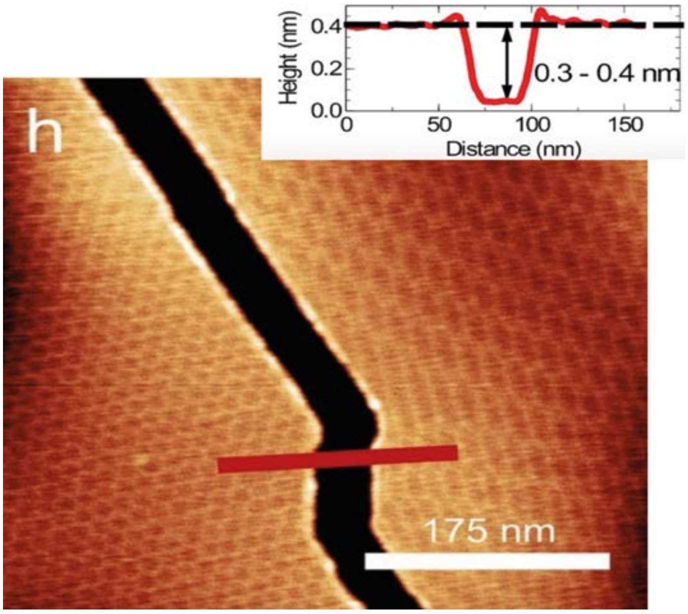
Materials investigated: We study the growth of strained graphene and boron nitride, molecular and polymer organisation on insulating and metallic surfaces, two-dimensional materials including metal chalcogenide semiconductors, the fabrication of van der Waals heterostructures by mechanical micromanipulation and epitaxial growth.

Methods used: We use scanning tunnelling microscopy and high resolution atomic force microscopy under liquid, ambient conditions and in an ultra-high vacuum environment. We also use high sensitivity electrical measurements and photoluminescence to investigate optoelectronic properties of materials.

Applications: We explore and develop novel materials for photo conductive and photovoltaic devices, electroluminescent structures, van der Waals devices for electronic applications.



Matthew Cliffe

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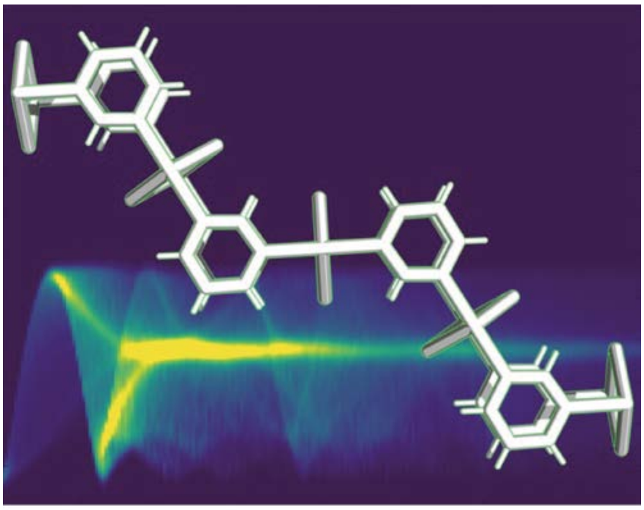

Materials investigated: We make, process or study (experimentally or theoretically): metal-organic frameworks; coordination polymers, magnetic and electronically conducting materials

Methods used: We use (experimental or theoretical): synthesis of new framework materials, X-ray and neutron diffraction, inelastic neutron scattering, magnetic property measurements, electrical transport.

Applications: We explore and develop: magnetic and electronic devices, sensing, catalysis.

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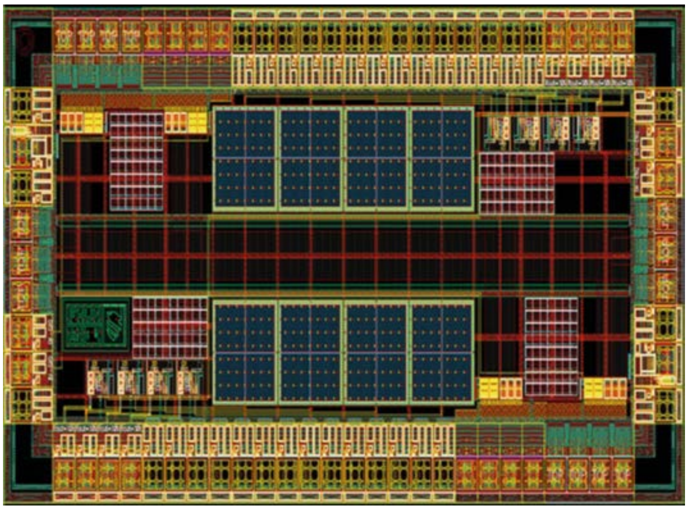

Materials investigated: Graphene and other 2D materials; van der Waals heterostructures; 3D printed multi-material optoelectronic devices; CMOS and graphene-based atom chips (image above); III-V materials.

Methods used: Green's function analysis of atom-surface interactions, Johnson noise and electromagnetic systems; Monte-Carlo and Galerkin methods; transfer-Hamiltonian calculations of quantum tunnelling.

Applications: Quantum sensors, high-frequency electronics, magnetic shielding, opto-electronic devices.

Mohamed Henini

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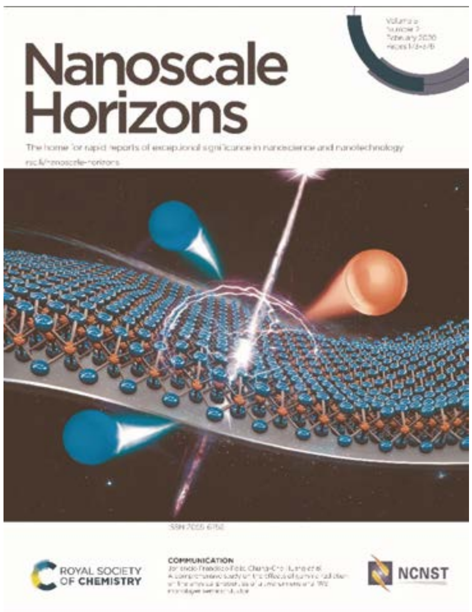
Materials investigated: Low dimensional semiconductor structures and devices including III-V, IV, and II-VI semiconductors; Oxides (e.g. TiO2 and Ga2O3); Two-Dimensional WS2 Semiconductors; Conducting Polymers (e.g. Sulfonated Polyaniline (SPAN) and Polyaniline (PANI).

Methods used: Current – Voltage, Capacitance – Voltage – Frequency, Deep Level Transient Spectroscopy (DLTS), Laplace DLTS and Photoluminescence.

Applications: Electronic, optoelectronic, and photovoltaic devices.



Tony Kent

Professor of Physics, School of Physics and Astronomy

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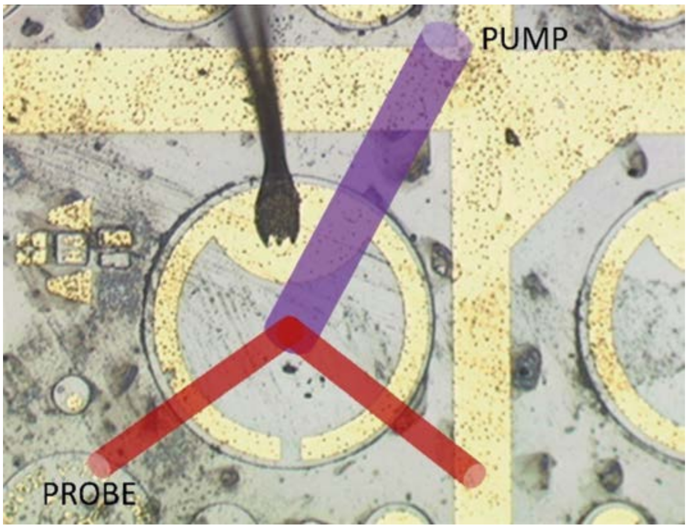
nottingham.ac.uk/physics/research/experimental-condensed-matter-and-nanoscience

Materials investigated: Inorganic semiconductor (e.g. AlGaAs and AlGaN) heterostructures; two-dimensional van der Waals materials inc. graphene, hBN, InSe etc., and magnetic materials like GaFe and YIG.

Methods used: We use THz acoustics, pump-probe experiments; microwave frequency electronic transport measurements; phonon spectroscopy; optical spectroscopy (time-resolved photoluminescence).

Applications: We explore and develop: novel acoustoelectric devices for applications at THz frequencies; new improved devices and methods for nanoacoustic measurement; phonon engineered materials with improved thermal and electronic properties.



Melissa Mather

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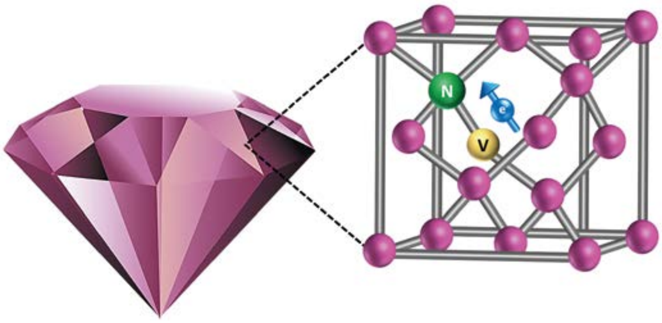

Materials investigated: fullerenes, photomagnetic nanomaterials, free radicals, electrospun polymers, biofluids, mitochondrial extracts, mammalian cells.

Methods used: are based on bespoke imaging and sensing systems combining optics and diamond based quantum sensors. We are developing a new form of microscopy that will integrate quantum microscopy based on diamond sensors within experimental platforms used in electron microscopy providing unique contrast to correlate nanoscale structure and chemical composition with magnetic, oxidation and electronic states of matter with unprecedented detail. We also design and engineer single molecule localisation microscopy techniques using nanosized diamonds enriched with Nitrogen Vacancies.

Applications: of our sensing and imaging technologies lie in the elucidation of structure-property relationships in molecular and nanoscale materials, the discovery of the inner workings of metal-containing biological molecules critical to life and characterisation of the emergent properties of complex materials.

Christopher **Mellor**

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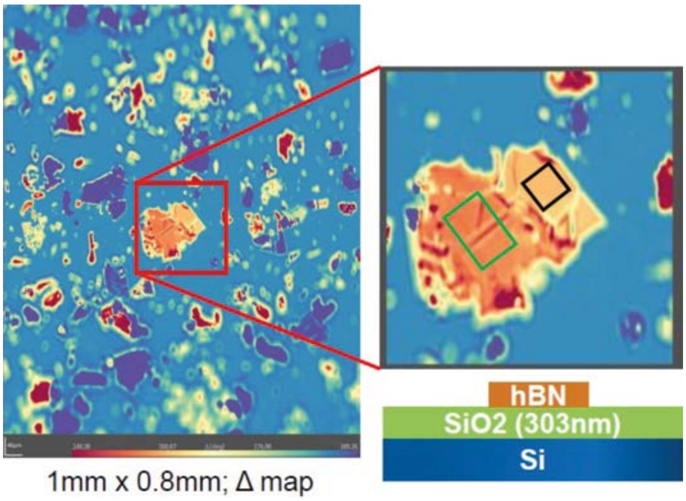

Imaging ellipsometry image of exfoliated 22nm thick boron nitride flake.

Materials investigated: 2D materials such as hexagonal boron nitride, graphene and indium selenide. III-V semiconductors such as GaAs/AlGaAs heterostructures. Silicon substrates with PECVD SiO2 and SiNx. Diamond NV- centres.

Methods used: UV and electron beam lithography, thermal and electron beam evaporation, PECVD, plasma etching, variable angle spectroscopic ellipsometry – both standard and imaging. Optical and scanning electron microscopy. Confocal and atomic force microscopy. Fluorescence microscopy.

Applications: Electronic, photonic and plasmonic devices. Characterisation of new 2D materials. Atom chips for quantum sensing. NV- centre scanning magnetometry. Optical switches for quantum technology applications.

Sergei **Novikov**

Professor of Physics, School of Physics and Astronomy

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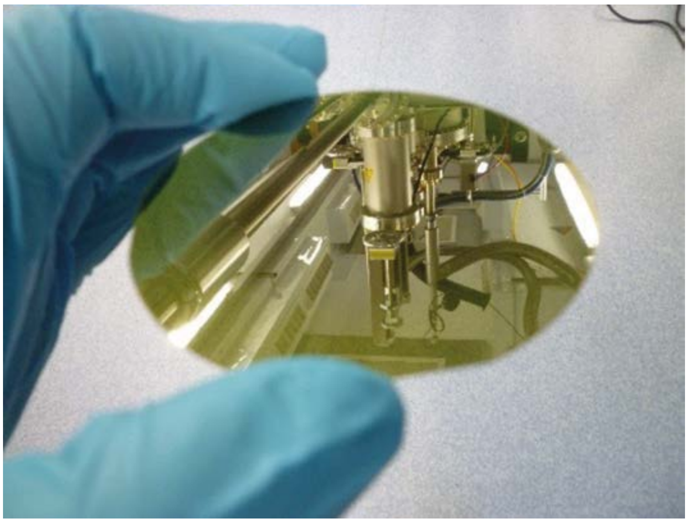
Materials investigated: We study epitaxial growth of semiconductor layers of group III-nitrides (GaAlInN) of wurtzite and zinc-blende polytypes and two-dimensional (2D) epitaxial layers of graphene and hexagonal boron nitride (hBN).

Methods used: We explore: molecular beam epitaxy (MBE), including plasma-assisted (PA-MBE) and high-temperature (HT-MBE).

Applications: We develop: photonics, optoelectronics, light-emitting devices, solar cells, water splitting, power electronics and other electronic devices.



James O'Shea

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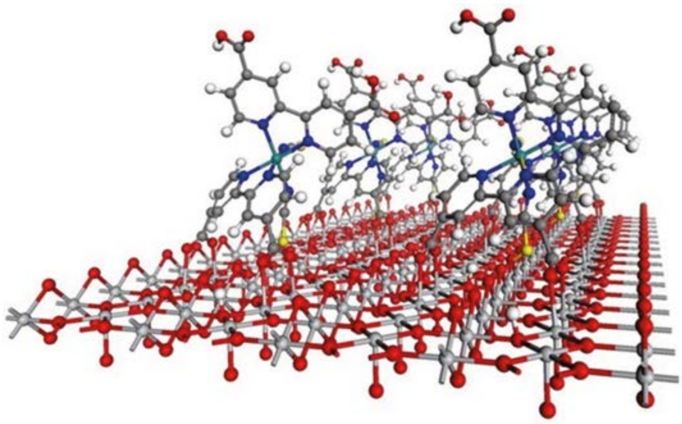
Associate Professor and Reader in Physics, School of Physics and Astronomy

Materials investigated: Oxide and metal surfaces functionalised with complex molecules such as dyes, fullerenes, polymers and nanoparticles.

Methods used: Electrospray deposition (ESD) in ultra-high vacuum (UHV), near-ambient pressure x-ray photoelectron spectroscopy (NAP-XPS), synchrotron radiation, x-ray absorption spectroscopy (XAS).

Applications: Solar cells, water splitting, molecular electronics, transparent conducting oxides.



Amalia Patanè

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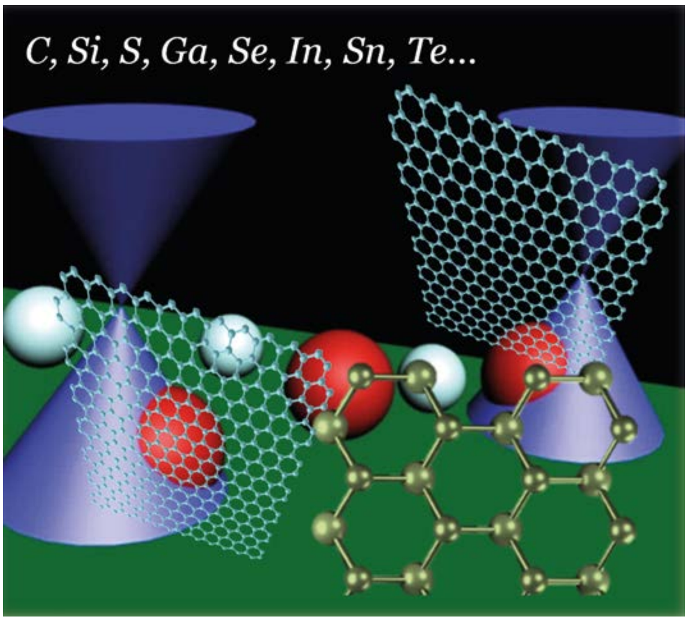

Materials investigated: Semiconductors, 2-dimensional materials, nanocrystals, heterostructures.

Methods used: EPI2SEM [EPItaxial growth and in-situ microscopy (scanning probe microscopy and electron spectroscopy) of 2-dimensional SEMiconductors]; Raman and photoluminescence microscopy; low-temperature electrical transport; high magnetic fields; device fabrication.

Applications: Quantum technologies for low-power electronics, sensing and communication.

Andrew Rushforth

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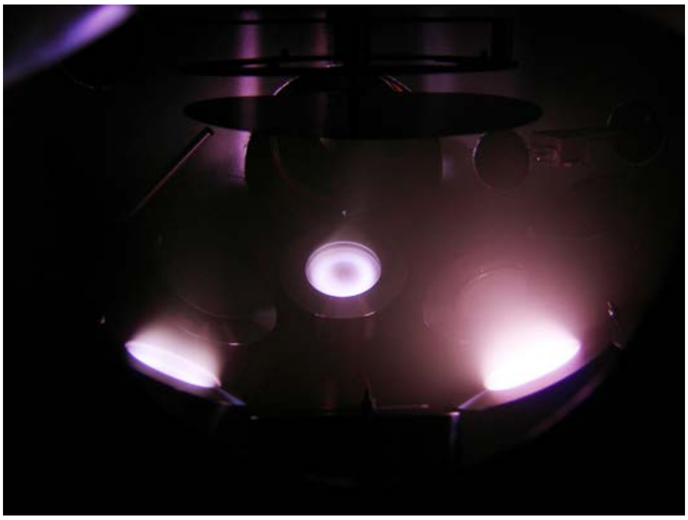

Materials investigated: Magnetic and non-magnetic thin films and devices, ferromagnetic, antiferromagnetic, magnetostrictive, metallic, oxides.

Methods used: Magnetron sputtering, SQUID magnetometry, magneto-transport, x-ray diffraction, photo- and electron- beam lithography, ion-milling.

Applications: Spintronic devices for information storage and processing, hybrid magnon-photon/magnon-phonon devices for quantum technology.

Darren Walsh

Associate Professor of Physical Chemistry, School of Chemistry

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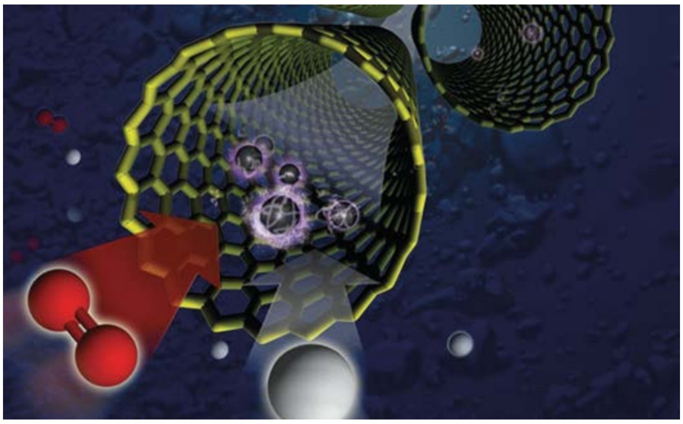
Materials investigated: Electrodes and electrolytes for electrochemical applications; ionic liquids; metallic nanoparticles; carbon nanomaterials.

Methods used: Electroanalytical chemistry; scanning electrochemical microscopy; scanning electron microscopy; cyclic voltammetry; rotating-disk electrode voltammetry; transmission electron microscopy; X-ray photoelectron spectroscopy; Raman spectroscopy.

Applications: We explore and develop: next generation batteries, electrocatalysis for fuel cells and electrolysers; supercapacitors; electrochemical microscopy; nano- and micro-electrode electrochemistry.



Michael Weir

Nottingham Research Fellow, School of Physics and Astronomy

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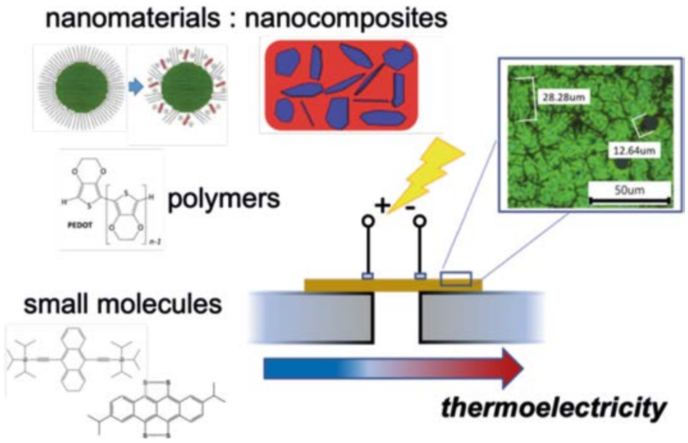
Materials investigated: Energy materials, with particular focus on the micro- and nano-scale structure arising from self-assembly and crystallisation, and its relation to function: this includes organic materials, hybrid organic-inorganic composites, and van der Waals materials.

Methods used: Thin-film thermal and electrical conductivity, custom Seebeck effect measurements, optical microscopy, atomic force microscopy, and small- and wide-angle X-ray and neutron scattering in which we have a strong research program at external, large-scale, international facilities.

Applications: We explore and develop materials and devices for organic electronics, solar energy conversion, and thermoelectrics.



Cameron **Alexander**

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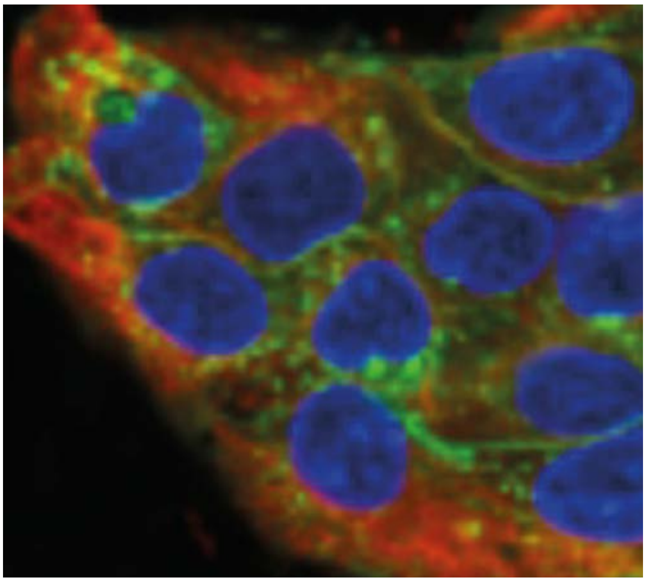

Materials investigated: We make, characterise and study: synthetic polymers and conjugates or complexes with small molecule drugs, proteins nucleic acids and cells.

Methods used: We use a range of controlled synthesis and polymerisation techniques to make functional materials, polymer-biopolymer hybrids and engineered living materials.

Applications: We explore and develop materials which can detect, prevent and treat disease. This includes applications in oncology, viral and bacterial infectious diseases, regenerative medicine and have significant programs in nucleic acid-based vaccines.

Morgan **Alexander**

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Materials investigated: Materials are identified through high throughput screening, including licensed bio-instructive polymers which control microbial cell and host tissue response when coated on to medical devices.

Methods used: Methods we use to understand the mechanism of bio-instruction are surface characterisation focussed, including time of flight and Orbitrap secondary ion mass spectrometry (SIMS) for material and biological molecular identification, X-ray photo electron spectroscopy (XPS) for quantification and many more.

Applications: Application in the clinic has been achieved for catheters coated in one of our patented anti-biofilm polymers, with those moving into the field including; antifungal coatings, coatings for paediatric devices, wound care, surgical mesh implants and viral surface inactivation.

Georgios **Dimitrakis**

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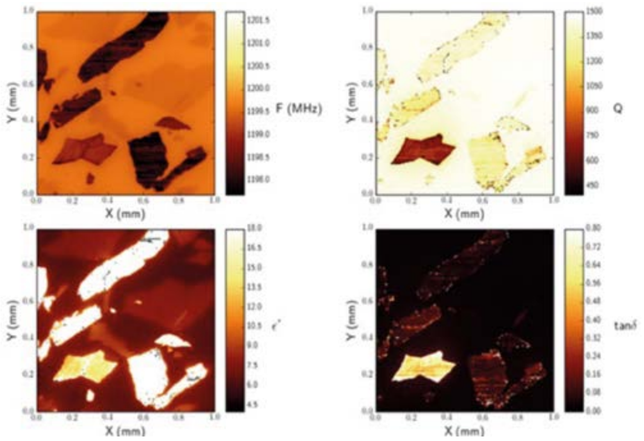
Associate Professor of Chemical and Environmental Engineering, Faculty of Engineering

Materials investigated: Metal oxides, solid state electrolytes, high temperature ceramics, ionic liquids and ionic liquid polymers, composites of carbon nanomaterials, metamaterials at microwave frequencies, chemicals and polymers, biofilms and biological systems/tissues.

Methods used: Dielectric spectroscopy across a wide frequency, temperature and pressure range; dual split ring resonators for microfluidic systems; Near Field Scanning Microwave Microscopy.

Applications: Real time monitoring of chemical synthesis/polymerisations in bulk and in microfluidic reactors; real time monitoring for the food industry; microwave sintering of electrolytes for fuel cells; microwave curing of composites; materials for aerospace applications, development of materials with antimicrobial resistance properties.



Steve **Howdle**

Head of School of Chemistry

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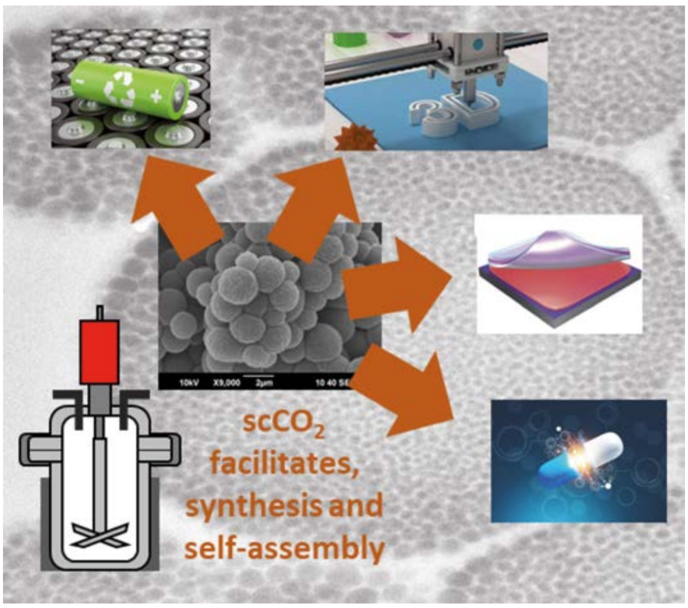

Materials investigated: A major part of the group's research is directed towards multidisciplinary collaborations on clean synthesis of new polymers, polymers from bio-renewable resources and new polymeric structures using supercritical fluids.
We are currently working closely with the Stockman group to synthesise new renewably sourced monomers and to create novel polymers.

Methods used: Our interests lie in the use of supercritical carbon dioxide (scCO2) as a clean and versatile solvent for polymer synthesis and materials processing. Dispersion polymerisation is used by the group to produce polymer particles formed from block copolymers with highly controlled morphologies and unique properties.

Applications: We explore and develop novel sustainable and responsive polymers for surfactants, coatings, 3D-printing, battery applications, chromatography, drug and gene delivery and tissue-engineering.

Clive Roberts

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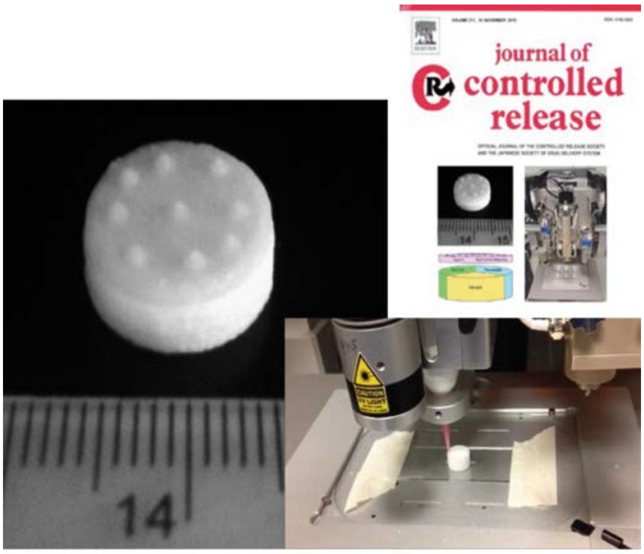

Research: Focused on the application of novel analytical and formulation strategies to develop new medicines and biomedical devices primarily via 3D printing, and in particular with colleagues in Additive Manufacturing in the School of Engineering (https://www.nottingham.ac.uk/research/groups/cfam/) and a number of industrial collaborators.

Methods used: Nanoscale analysis explores chemical and material properties at multi-material interfaces. Orbi-Secondary Ion Mass Spectroscopy, Confocal Raman and (Cryo) Electron Microscopy unique complementary insights linking structure, composition and function

Applications: Sustainable and personalised Pharmaceuticals and Medical Devices.

David Scurr

Principal Research Fellow, School of Pharmacy

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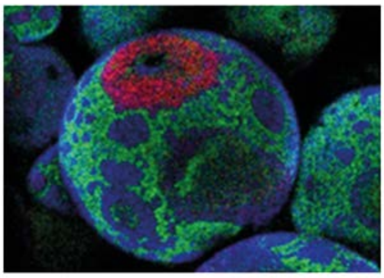
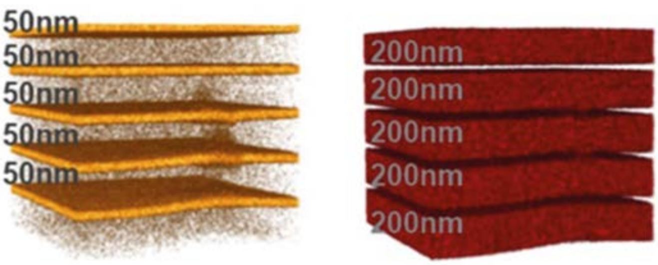
nottingham.ac.uk/pharmacy/people/david.scurr

Materials investigated: Human & porcine skin, topical skin formulations, pharmaceutical devices, drug delivery nano- & microparticles and diesel Injector deposits.

Methods used: Surface and sub-surface chemical analysis, ToF-SIMS & 3D OrbiSIMS, optical profilometry, Franz cells, HPLC and Raman spectroscopy.

Applications: Topical drug / antibacterial / cosmetic delivery, nano- & micro particle drug delivery and diesel injector contamination.





Mischa **Zelzer**

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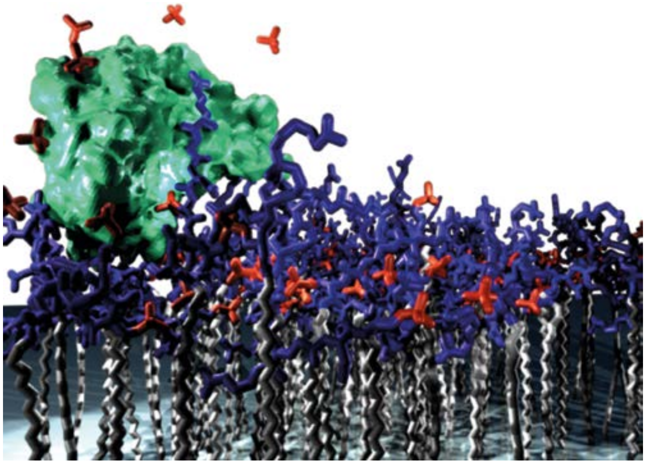
nottingham.ac.uk/research/groups/functional-biointerfaces

Associate Professor in Biointerface and Materials Engineering, School of Pharmacy

Materials investigated: we make, process or study (experimentally or theoretically): supramolecular and polymer hydrogels; peptide materials; polypeptides; stimuli responsive materials; surfaces and interfaces; particles.

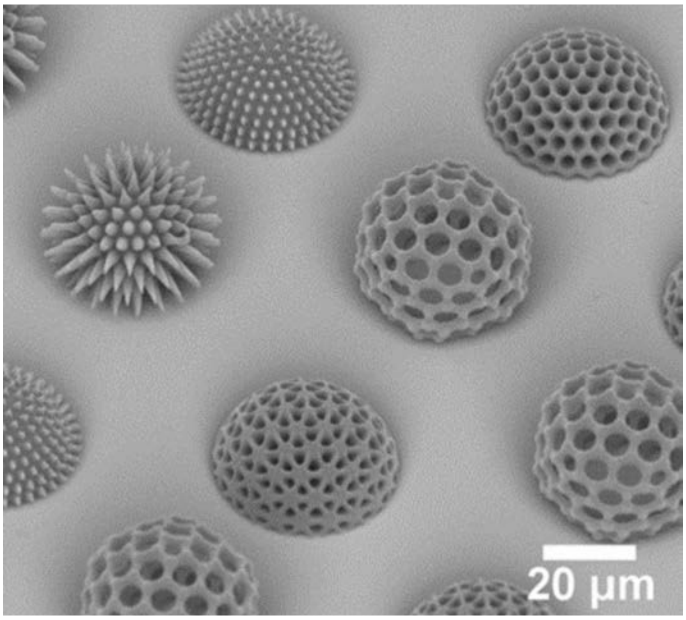


Methods used: we use (experimental or theoretical): surface chemical analysis; spectroscopy; electron microscopy; X-ray and neutron scattering; atomic force microscopy; mechanical characterisation of gels; rapid analysis; computational modelling; particle analysis; polymer analysis; peptide synthesis; NCA polymerisation; grafting to / grafting from; surface coating and modification.

Applications: We explore and develop: biomaterials; biointerfaces; cell-material interactions; materials for drug delivery; surface modification procedures; mechanistic understanding and models.

Centre for **Additive Manufacturing**

nottingham.ac.uk/research/groups/cfam



Materials investigated: Polymer-metal nanocomposites with in-situ generated Au, Ag or Cu nanoparticles, photo-initiators, polymer with bacteria anti-attachment properties, various polymeric biomaterials, graphene oxide.

Methods used: Using two-photon lithography based 3D printing technique to fabricate complex 3D micro/nano structures without a mask in a fast and co-efficient way with great design freedom, achieving a resolution close to 100 nm.

Applications: Nano-sensors, electronic devices, medical devices, drug delivery and regenerative medicine.

Andrei **Khlobystov**

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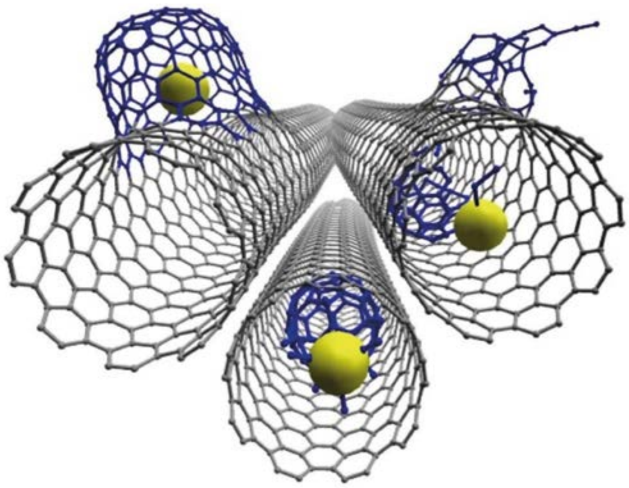

Materials investigated: We make, process or study (experimentally or theoretically): carbon nanotubes; hollow carbon nanofibers; fullerenes; composites of carbon nanomaterials with metals, metal oxides and chalcogenides, or organic compounds.

Methods used: TWe use (experimental or theoretical): synthesis of 1D nanostructures, electron microscopy imaging and analysis, surface chemical analysis, electrochemistry of nanomaterials, Raman spectroscopy.

Applications: We explore and develop: nanoreactors, nanocatalysts, nano-electrocatalysts, electronic devices.

Andrea **Laybourn**

Assistant Professor, Faculty of Engineering

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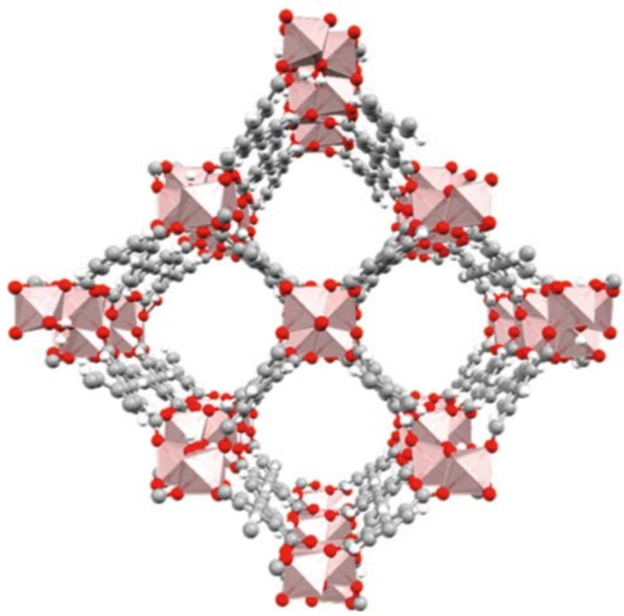
Materials investigated: Porous materials including metal-organic frameworks (MOFs). We prepare and study MOF bulk powders, films, hybrids, composites, and conduct post-synthetic modification of MOFs.

Methods used: Selective microwave heating to control the structure and properties of new and existing MOFs through kinetically driven reactions, batch systems and continuous flow technology; (analytical techniques for structure and properties) dielectric spectroscopy, X-ray diffraction, thermogravimetric analysis, differential scanning calorimetry, solid-state nuclear magnetic resonance, scanning electron microscopy, X-ray photoelectron spectroscopy, LC-MS.

Applications: Gas and hydrocarbon storage and separation, catalysis, sensors, pollutant recovery from water and air, and scaling-up MOF synthesis beyond the laboratory.



Robert Mokaya

Professor of Materials Chemistry, School of Chemistry

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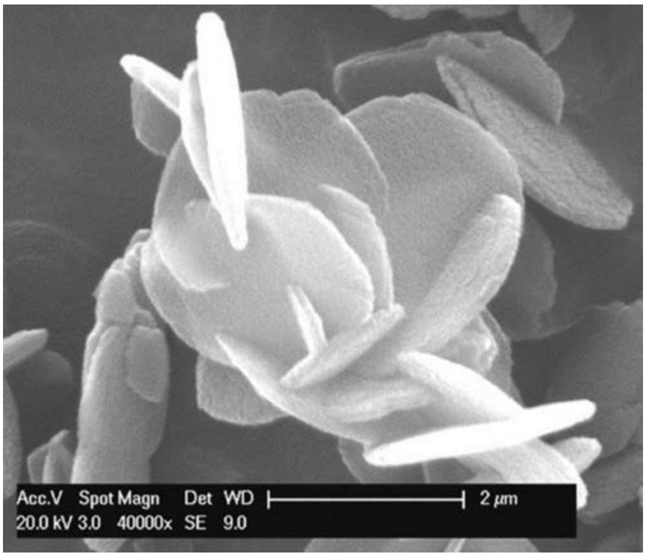
Materials investigated: porous metal oxides (silica, titania, zirconia, etc), porous carbons (activated or templated), carbon nanotubes, hollow carbon spheres, oxynitrides, catalysis and electrochemistry.

Methods used: Synthesis of carbon nanostructures, porosity analysis, electron microscopy, surface analysis.

Applications: Hydrogen and CO2 storage, molecularsieves/adsorbents, templates and hosts foradvanced composite materials, catalyst/catalyst supports.



Begum Tokay

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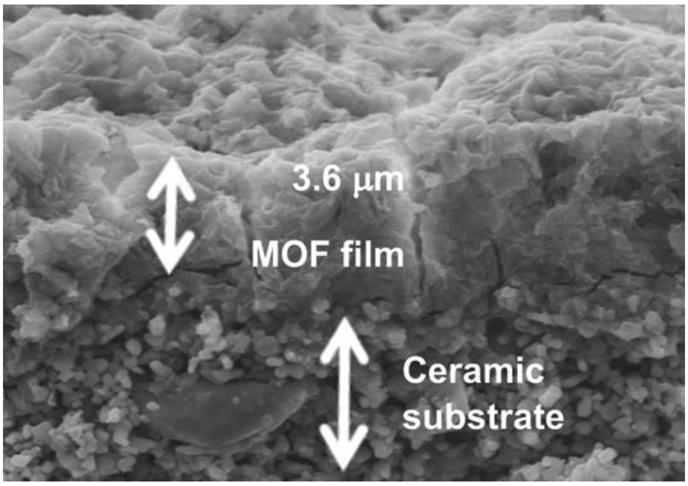

Materials investigated: We make, process or study (experimentally or theoretically): 2D zeolites, metal organic frameworks (MOFs), inorganic-polymer composite films, zeolite and MOF membranes, biopolymer films, TiO2 nanotube arrays.

Methods used: we use (experimental or theoretical): Synthesis of films, electrochemical atomic layer deposition, electron microscopy imaging and analysis, x-ray photoelectron spectroscopy.

Applications: we explore and develop: membrane-based separations and purifications, heterogeneous catalytic reactions, gas sensors, foldable devices, H2 production.

Stephen Argent

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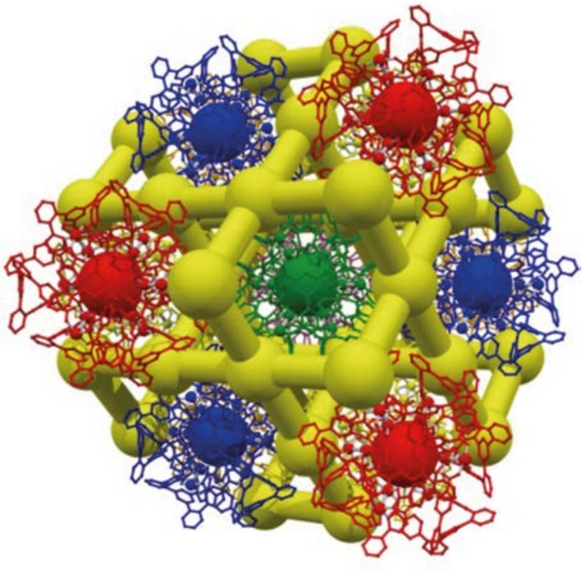
Senior Research Fellow and Manager of the Crystallography Service, School of Chemistry



Materials investigated: The crystallography laboratory has the facilities to analyse single crystal (crystal size > 10 µm) and powder crystalline materials. Structures are routinely determined for organic and inorganic molecular materials from research groups across the School of Chemistry.

Methods used: Single crystal X-ray crystallography allows atomic structures of crystalline molecules and materials to be determined by analysing their scattering. Powder X-ray crystallography allows the identification of bulk phases and mixtures of materials.

Applications: Crystallographic structure determination permits colleagues in the School of Chemistry to identify the outcomes of their chemical syntheses and relate the properties of new molecules and materials to their structures.

Elena Besley

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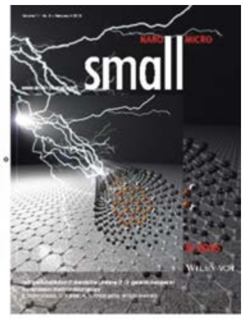
Professor of Theoretical and Computational Chemistry, School of Chemistry

Materials investigated: Carbon nanomaterials, porous solids, soft matter, aerosols and colloids, molecular organisation on engineered surfaces.

Methods used: Density functional theory, molecular dynamics, grad canonical Monte Carlo, analytical theory development.

Applications: Gas sensing devices,nanocatalysis, drug delivery.



Deborah **Kays**

Professor of Inorganic Chemistry, School of Chemistry

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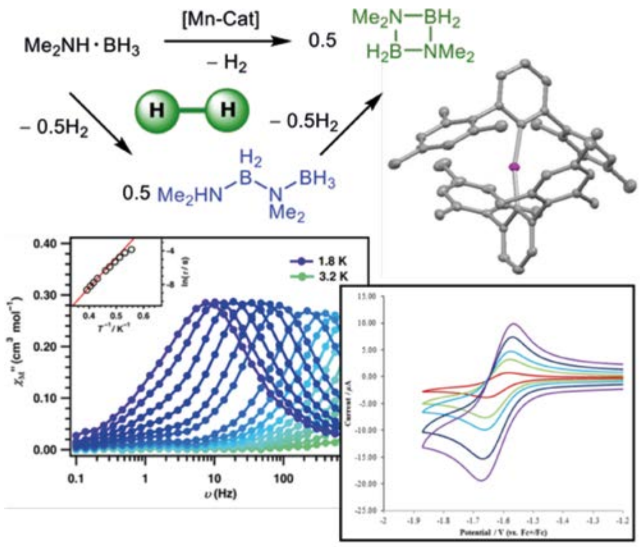
Materials investigated: We make, process or study (experimentally or theoretically): highly reactive main group and transition metal compounds, reaction catalysts, single molecule magnets.

Methods used: We use (experimental or theoretical): anaerobic techniques, single crystal X-ray diffraction, multinuclear NMR spectroscopy, mechanistic investigations, magnetometry, electron paramagnetic resonance, electrochemistry.

Applications: we explore and develop: valorisation of small molecules, catalytic methodologies, magnetic materials, radical species, hydrogen storage technologies.



Graham **Newton**

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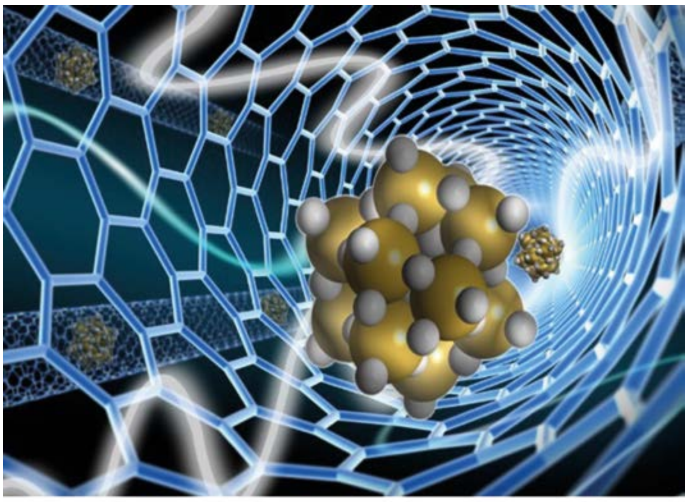

Materials investigated: We make, process or study (experimentally or theoretically): redox-active molecular metal oxides; multinuclear coordination compounds; hybrid nanomaterials; energy materials; self-assembled soft materials; additives for next generation batteries.

Methods used: We use (experimental or theoretical): Inorganic and organic synthesis, electrode fabrication, cyclic voltammetry, absorption spectroscopy, mass spectrometry, electrochemical Raman spectroscopy, electron microscopy, 3D printing, nuclear magnetic resonance, dynamic light scattering, fluorescence spectroscopy.

Applications: We explore and develop: next generation batteries, molecular electrocatalysts, visible-light-sensitive photocatalysts.

Ben Pilgrim

Research Fellow, School of Chemistry

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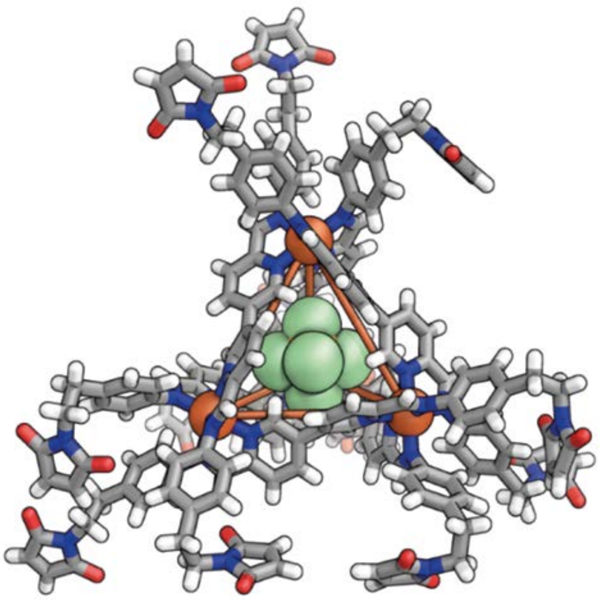

Materials we make, process or study: Self-assembled molecular coordination capsules (metal-organic cages), stimuli-responsive materials, interlocked molecular materials.

Methods used: Organic and supramolecular synthesis techniques, NMR (1H, 13C, 19F, 2D techniques, DOSY), mass spectrometry (soft ionisation and ion mobility), X-ray crystallography, UV-Vis spectroscopy.

Applications: we explore and develop: supramolecular catalysis (i.e. nanobox reactors), stimuli-responsive systems, click chemistry and conjugation reactions, new strategies to access rotaxanes and catenanes.

Simon Woodward

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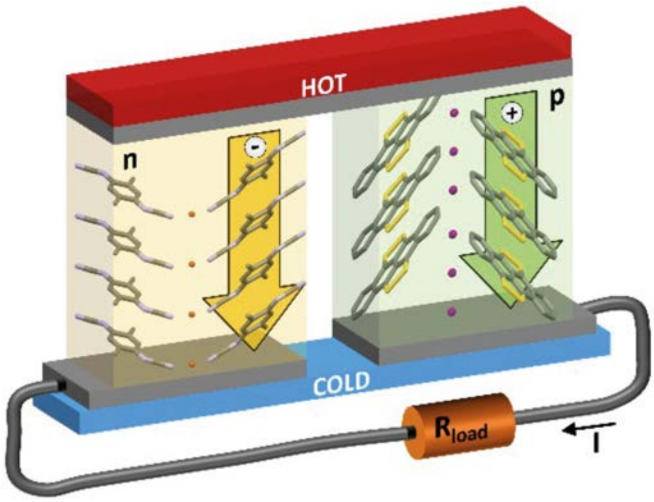
Professor of Synthetic Organic Chemistry, GSK Carbon Neutral Laboratory, School of Chemistry

Materials investigated: Organic and hybrid thermoelectric materials and their potential precursors.

Methods used: we use modern organic synthesis chemistry methods and collaborate to measure thermoelectric properties across the University and beyond.

Applications: Waste heat recovery and motionless cooling devices (both in theory and application).



Ifty Ahmed

Associate Professor, Advanced Materials, Faculty of Engineering

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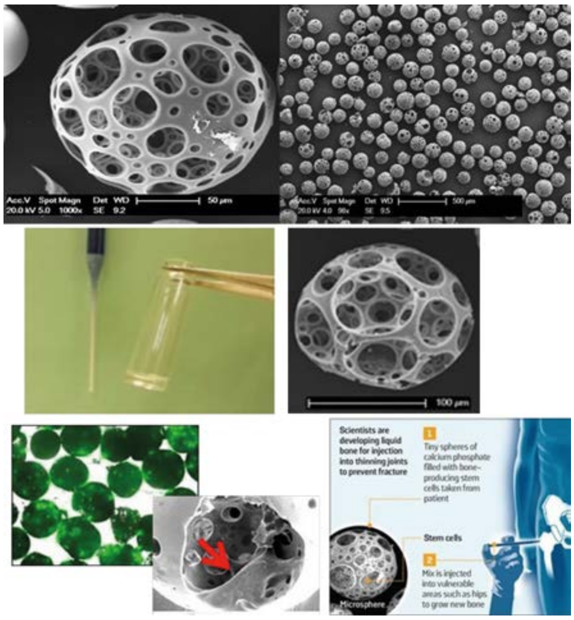
Materials investigated: Glasses and glass ceramics, phosphate-based glasses, glass fibres, porous glass microspheres, bioglasses, fully resorbable biocomposites.

Methods used: glass manufacturing labs, glass fibre manufacturing facilities, microsphere manufacturing booths (current production between 1-3 kg/h), BOSE mechanical tester, ion release kit, high temperature glass viscometer.

Applications: Orthobiologics, Regenerative Medicine, Stem cell delivery, Drug Delivery, Wastewater treatment.



Jesum Alves-Fernandes

Associate Professor in Chemistry, School of Chemistry

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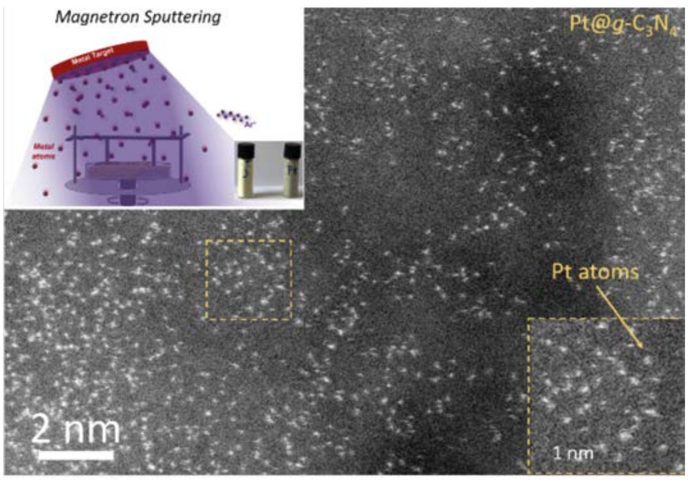

Materials investigated: we use physics method, called magnetron sputtering, to produce metal catalysts with controllable size (from metal atoms to nanoclusters to nanoparticles); composition and shape. Crucially, this method does not use solvents or chemical reagents generating no waste and ‘naked’ surfaces, and thus highly active and accessible for chemical reactions.”

Methods used: We use (experimental or theoretical) to characterise our novel materials: electron microscopy imaging and analysis, x-ray photoelectron spectroscopy analysis, x-ray absorption are the most used in our research.

Applications: we explore and develop thermal activated catalytic reaction such as ammonia synthesis and decomposition; and photocatalytic hydrogen generation.

Matt Clark

Professor of Applied Optics, Faculty of Engineering

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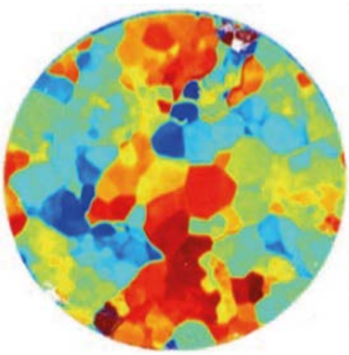

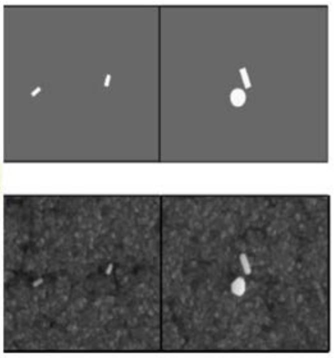

Materials investigated: We make, process or study (experimentally or theoretically): metallic, non metallic, polymer and biological materials from the cm scale down to the nanoscale.

Methods used: We use phonons and photons to determine and image their structure and mechanical properties.

Applications: We explore and develop: imaging and measurement techniques to non-destructively characterise materials with high spatial resolution.

Neil Kemp

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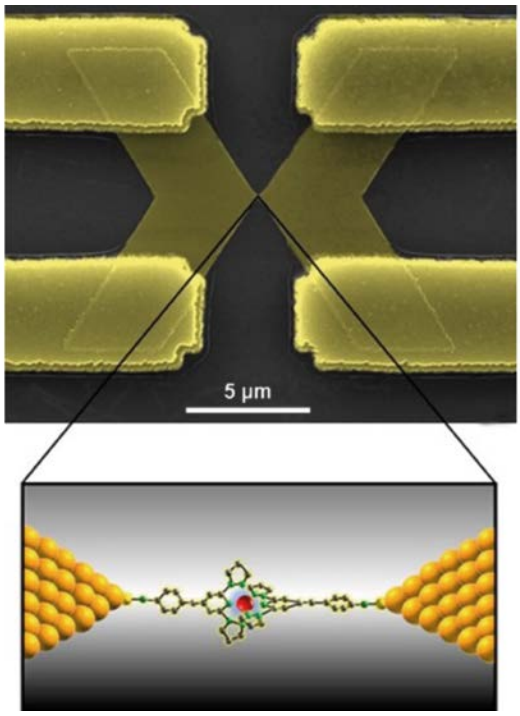
Assistant Professor of Experimental Condensed Matter Physics, School of Physis and Astronomy

Materials investigated: Spin crossover molecules with anchoring groups for integrating with industry relevant materials and device architectures. We also study hybrid nanocomposite inorganic/organic materials, quantum dots, metal oxides and chalcogenides.

Methods used: We use advanced nanoscale fabrication methods (including electron beam lithography, nanoimprint lithography, electromigration) to make devices with electrode spacing of just a few nanometers for the inclusion of few or single molecules. Devices are characterized using sophisticated DC and AC impedance spectroscopy methods and low temperature magnetic, electrical, and optical techniques. We also make novel nanoparticle alloy materials under vacuum conditions using DC and RF magneton sputtering methods.

Applications: We explore and develop new types of nanoscale devices switchable using electrical and optical pulses and/or magnetic fields for applications in emerging non-volatile memory, spintronics, optical computing, artificial intelligence and neuromorphic computing.



Anabel Lanterna

Assistant Professor, School of Chemistry

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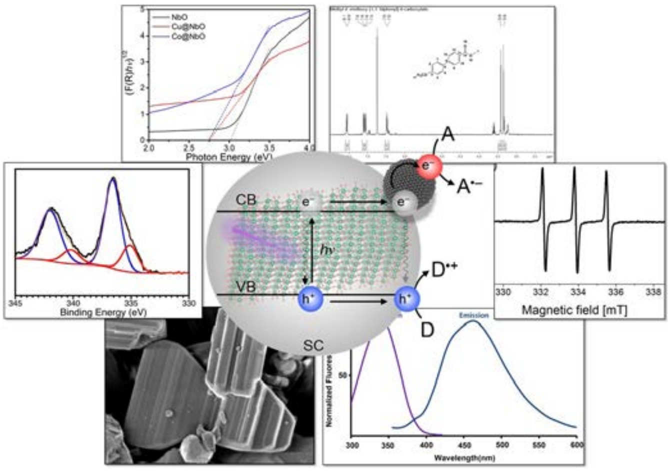
lanternaresearchgroup.com

Materials investigated: We make inorganic or organic semiconductors and design light-responsive, nanocomposite materials (metal-semiconductor heterojunctions) using metal nanoparticles/clusters or organic dyes.

Methods used: We explore different materials and organic synthesis methods, and use a variety of characterisation techniques: electron microscopy imaging and analysis, surface chemical analysis, steady-state and time-resolved spectroscopies.

Applications: We explore and develop photocatalytic processes for synthesis of organic molecules (e.g., fine chemicals, pharmaceuticals), generation of green hydrogen, and degradation of pollutants.



Maria Marlow

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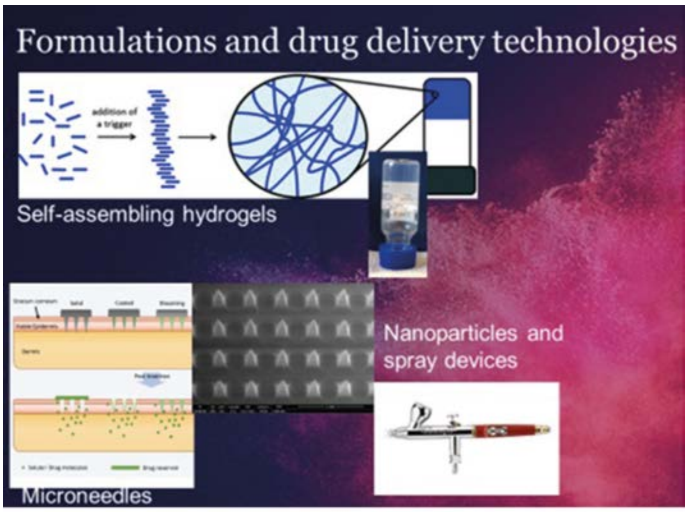
Associate Professor of Pharmaceutical Materials and Formulation Science, School of Pharmacy



Materials investigated: Supramolecular gels, nanoparticles, nanocomposite gels and microneedles.

Methods used: Organic synthesis of gelators, characterisation of gels (microscopy, fluorescent imaging and analysis, rheology, NMR), characterisation of nanoparticles (DLS, TEM, HPLC), release of therapeutics, in vivo fluorescent imaging.

Applications: Delivering small molecules, DNA, proteins, and peptides for cancer therapy/cancer vaccines, pain management, HIV and skin diseases.

Neil Thomas

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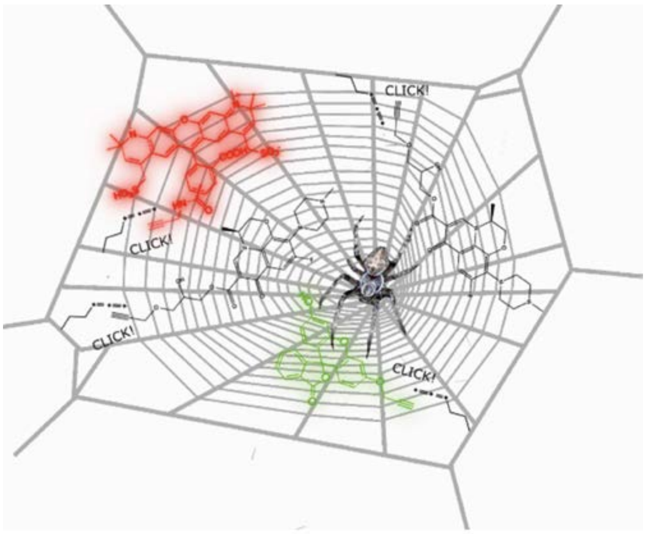

Materials investigated: We make, process or study (experimentally or theoretically): Self-assembling proteins including human apoferritin and Dps self-assembling nanocages (12 nm and 9 nm diameter spheres); recombinant spider silk; Near-Infrared (PbS) Quantum Dots and hybrid organic-inorganic nanoparticles.

Methods used: We use (experimental or theoretical): Synthetic biology; un-natural amino acid mutagenesis with bio-orthogonal amino acids; 'click'-chemistry (copper (I) catalysed and strain promoted) with fluorophores, MRI imaging agents, antibiotics and other drugs for controlled release. Aqueous, ambient temperature QD synthesis; mammalian cell toxicity testing; DLS; FRET; BRET.

Applications: We explore and develop: Targeted drug and theranostic agent delivery; Tissue scaffolds for regenerative medicine and wound healing.

Lyudmila Turyanska

Associate Professor, Faculty of Engineering

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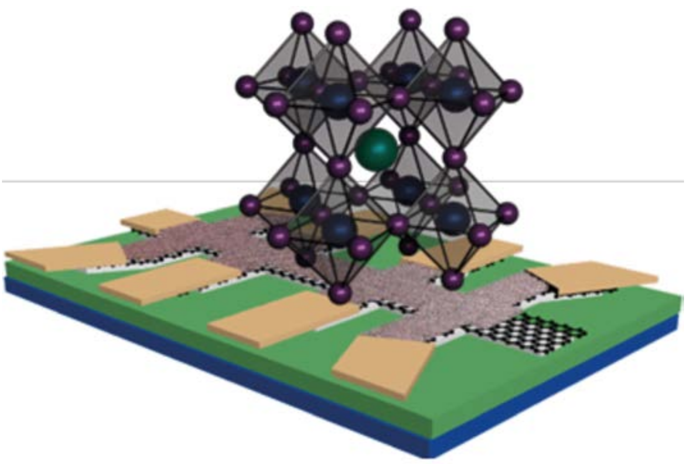
Materials investigated: We produce and study low dimensional materials: from 0D metal nanoparticles, semiconductor quantum dots, perovskite nanocrystals to 2D graphene networks. We also develop and explore use of nanoscale materials for drug delivery applications.

Methods used: colloidal synthesis; morphological, optical and electrical characterization; deposition by additive manufacturing technologies.

Applications: we explore potential applications of nanomaterials in the areas raging from optoelectronic devices (photon detectors, LEDs, etc) to biological imaging and cancer therapy.



David Grant

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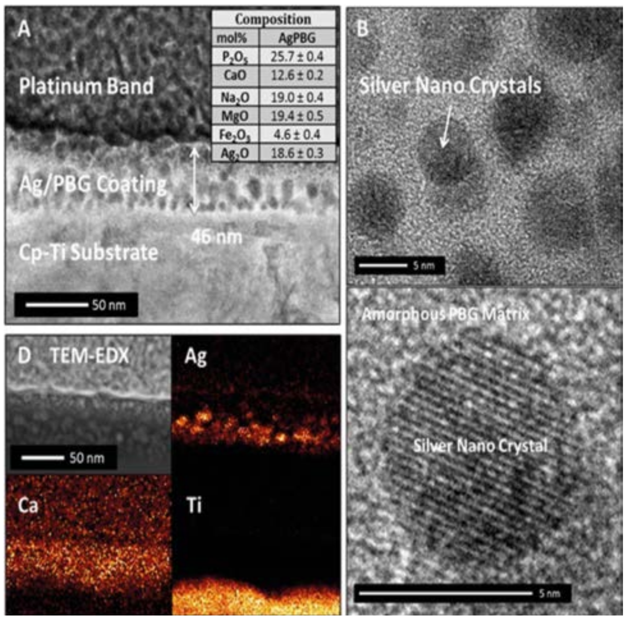
advanced-materials-research-group

Professor of Materials Science, Advanced Materials, Faculty of Engineering

Materials investigated: We make metals and alloys for metal hydrides and complex hydrides for hydrogen storage. Composites of biopolymers, ceramics, and glasses for degradable biomaterials.

Methods used: Methods for synthesis mechanical milling and chemical synthesis of nanoparticles, physical vapour deposition of multilayer thin film structures using reactive sputtering, arc and induction melting, spray deposition and gas atomisation. For characterisation, electron microscopy imaging and analysis, surface chemical analysis, XRD and neutron diffraction, thermal and gravimetric analysis.

Applications: Hydrogen storage, thermal stores, hydrogen compressors, purification, devices requiring thermal conduction or functional properties, biomaterials and biodegradable applications.



Xianghui Hou

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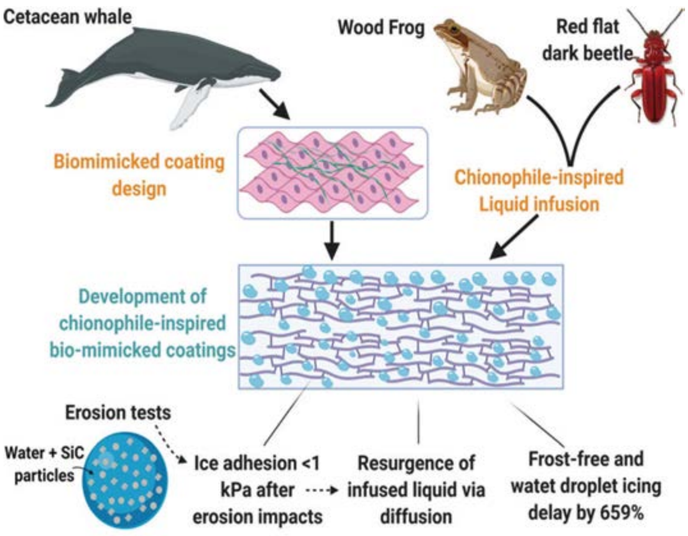
Associate Professor of Materials Science, Faculty of Engineering



Materials investigated: Icephobic (anti-icing/de-icing) coatings, erosion resistant coatings, self-lubricating coatings, and thermal interface coatings/sheets (high thermal conductivity and high electrical insulation), etc.

Methods used: Nanocomposites, Nanostructured surface, Nanocomposites coatings; and Surface texturing.

Applications: Ice Protection and Functional Coatings for Aerospace, Wind Energy, Automotive and Marine sectors.

Tanvir Hussain

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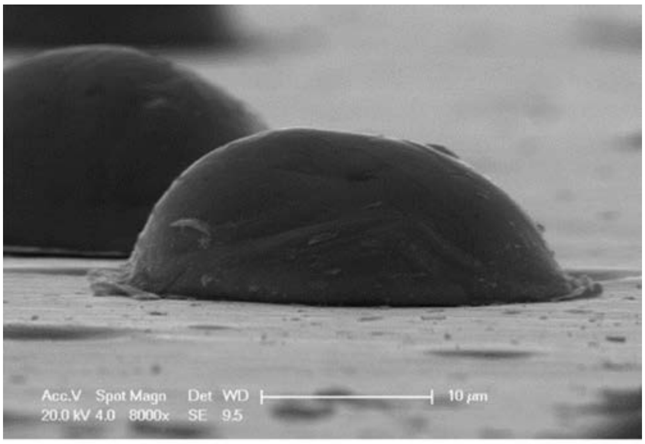

Materials investigated: Nanocomposite coatings with carbon nanotubes and graphene; oxide based ceramics in thermal barrier coatings (TBCs) and environmental barrier coatings (EBCs); cermet (ceramic and metallic) coatings and metallic coatings.

Methods used: Processing-microstructure-properties- performance relationships in suspension and solution precursor thermal spray; cold gas dynamic spray, spray and laser cladding. High temperature oxidation, corrosion and wear of coatings and their analysis through electron microscopy, surface analysis and Raman spectroscopy.

Applications: Wear, corrosion and high temperature oxidation in aero-engines; power generation (boiler, gas and steam turbines); renewable energy (wind turbines, fuel cell, solar cell) and functional electronics.

Antonino La Rocca

Assistant Professor in Thermofluids, Faculty of Engineering

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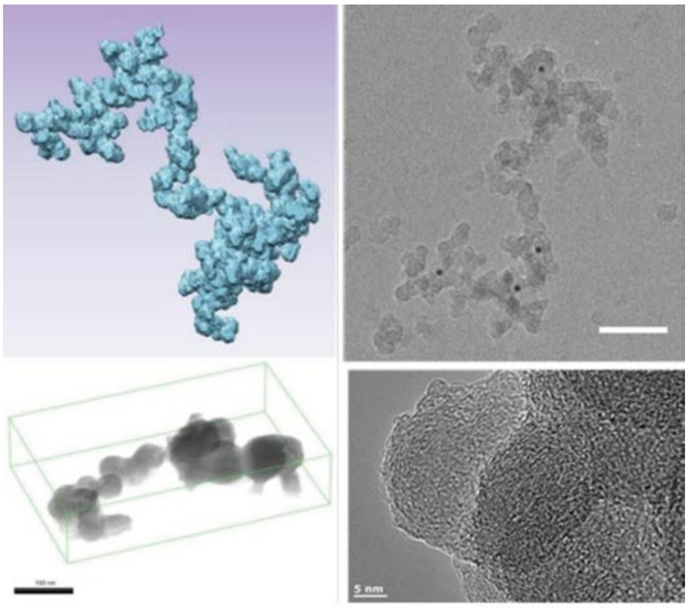
Materials investigated: Particulate Matter (soot) emitted by internal combustion engines poses a real threat for human health and the environment; it also affects engine durability and oil change intervals.

Methods used: New characterisation tools have been developed by the group allowing for insight into the fundamental understanding of soot formation and oxidation, its morphology and its impact on health and engine durability.



Snow Stolnik

Professor of Pharmaceutics, Director of EPSRC SFI Centre for Doctoral Training in Transformative Pharmaceutical Technologies, School of Pharmacy

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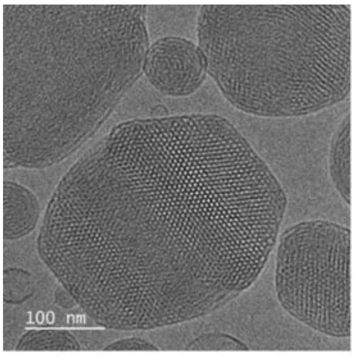
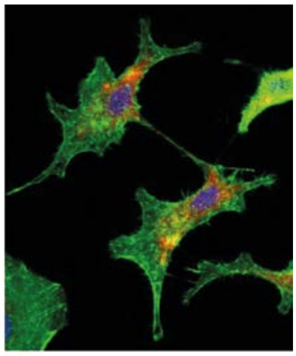
Materials investigated: **Nanomedicines in biological environment.** We study how a nanomedicine loaded with drug is transported across biological barriers of the body to access and enter target tissues and cells, in order to achieve its desired therapeutic effect. Nanomedicine can be drug-polymer complexes, polymeric nanoparticles, lipid nanoparticles (liposomes), liquid crystalline phase nanoparticles (e.g. hexasomes shown in the image), and they can be loaded with small molecular weight compounds or biologics (e.g. siRNA, protein, antibody).





Methods used: physicochemical characterisation in terms of size, morphology, and colloidal properties of nanoparticles, cell culture models, confocal microscopy (shown in the image) and flow cytometry.

Applications: targeted delivery to cellular targets of antibodies, peptides, and nucleic acids to treat diseases such as cancer; biologics formulations to promote absorption from gastrointestinal tract or lung.

Fang Xu

Assistant Professor, Faculty of Engineering

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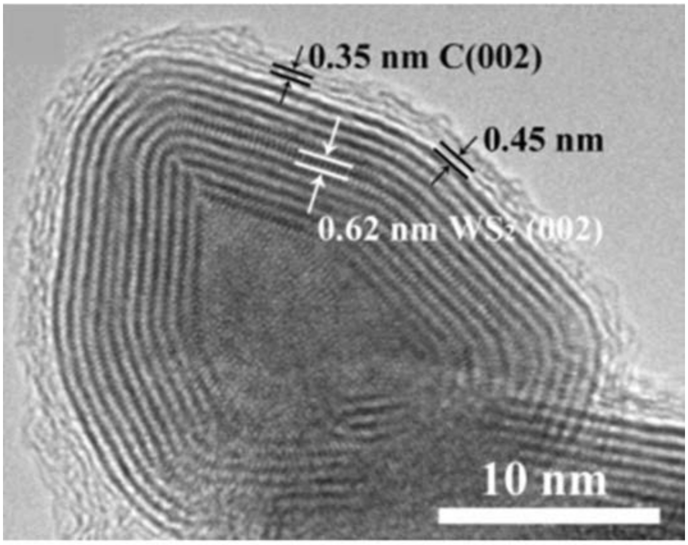

Materials investigated: 0D inorganic fullerenes, carbon coated nanostructures; 1D nanorods/nanowires; composites of these nanomaterials with metal or polymer matrices.

Methods used: Synthesis of nanostructures by CVD, hydrothermal, ALD, sol-gel, chemical exfoliation etc; preparation of nanocomposites using hot pressing, spark plasma sintering; characterisation of materials by electron microscopy imaging and analysis, surface chemical analysis, Raman spectroscopy, thermophysical properties evaluation etc.

Applications: Lubrication and shock absorbing, Thermal management, gas sensor and electronic devices.

George Zheng Chen

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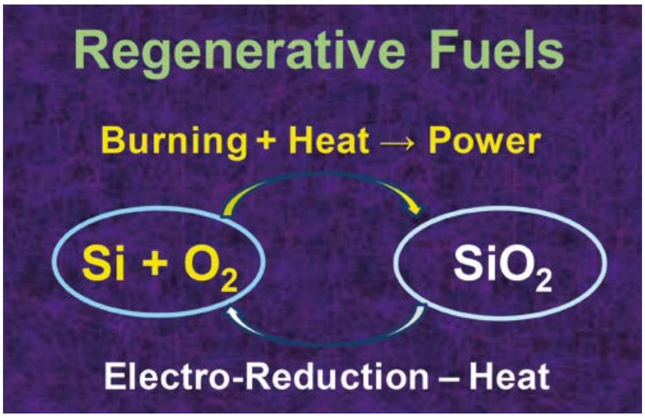
Professor of Electrochemical Technologies, Faculty of Engineering



Materials investigated: We make, process or study (experimentally or theoretically):

- Silicon, aluminium and iron as resource-sustainable & emission-free regenerative fuels.
- CO2 capture and utilisation (CCU) for functional materials and clean fuels.
- Nano-materials and liquid salts based energy stores, including supercapacitor, supercapattery, and metal ion (e.g. lithium ion) batteries.
- Production, processing and recycling of structural and functional materials, particularly titanium, silicon and polymer composites (e.g. electron or ion conducting membranes, thermochromic films).

Methods used: We use (experimental or theoretical): Molten salt electrolysis, wet chemical and mechanical processing and various electrochemical and materials characterisation methods.

Applications: We explore and develop: Energy storage devices and technologies for domestic, transport and power grid applications. Production and processing of metallic materials, and recycling metallic wastes for commercial applications.

Roger Bayston

Professor of Surgical Infection, School of Medicine

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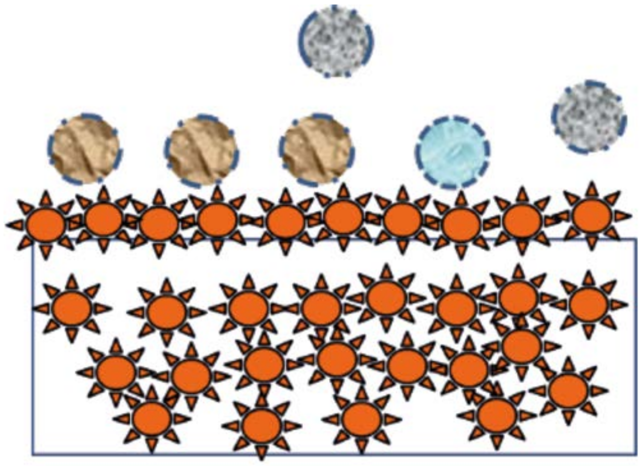
nottingham.ac.uk/news/expertiseguide/medicine/professor-roger-bayston.aspx

Materials investigated: We specialise in antimicrobial biomaterials for use in neurosurgery, neurotrauma, urology, spine surgery and orthopaedics. We design and make prototypes, design innovative clinically predictive testing, conduct clinical trials and commercialise.

Methods used: Most of our biomaterials are not coatings, and rely on specialist impregnation techniques to give long duration (≤3 months) activity with avoidance of antimicrobial resistance and activity against highly drug- resistant bacteria. Some of our biomaterials are specifically for drug delivery.

Applications: Two of our neurosurgery / neurotrauma anti-infective devices are in use in 66 countries and have saved hundreds of brain infections and re-operations, as well as millions of dollars in healthcare costs. Several more are in the pipeline, with one starting RCT imminently.



Hany Elsheikha

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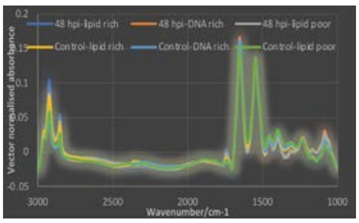
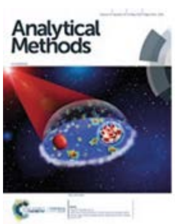
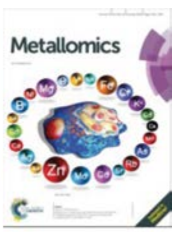
Associate Professor of Parasitology, School of Veterinary Medicine and Science







Materials investigated: We work at the interface between biology, chemistry, material science and physics. We also use a range of in vitro and in vivo models.

Methods used: We apply systems biology, single-cell, and spectroscopic approaches, including conventional Fourier-transform infrared (FTIR) microspectroscopy, synchrotron-based FTIR microspectroscopy, X-ray fluorescence microscopy, ICP-MS, Raman spectroscopy, and electron microscopy, and various 'Omics' technologies.

Applications: Inter-kingdom signalling communication. We study how and why parasites alter host signaling pathways and metabolism and apply these alterations for therapeutic benefits. We also test and develop novel anti-infective drugs, novel therapeutic approaches, elucidate drug mode of action and adverse effects.

Sara Goodacre

Professor of Evolutionary Biology and Genetics, School of Life Sciences

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Materials investigated: We study (bioinformatically and physically): natural and synthetic spider silk (spidroins); biodegradable, biocompatible polymers with a diversity of physical properties.

Methods used: Molecular genetic and bioinformatic analysis of silk rRNA and genomic sequences, tissue culture of spider silk glands.

Applications: We collaborate with chemists to develop chemically functionalised synthetic versions of the silks (spidroins) that we have identified with material properties of interest.

Angela Seddon

Professor of Inorganic Materials, Faculty of Engineering

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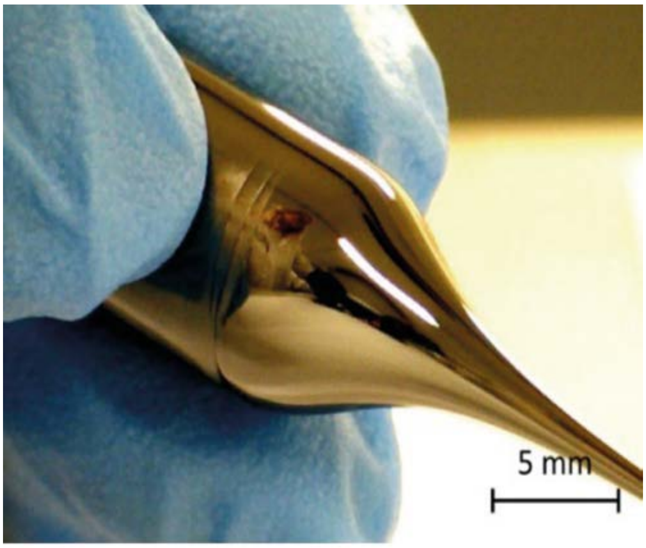
nottingham.ac.uk/research/groups/ggiemr/our-research/optics/mid-infrared-photonics.aspx

Materials investigated: We are world-leading in fabricating both active (light emitting) and passive, mid-infrared optical fibres in our dedicated facility, unique in the UK. In 2021, we reported first fibre lasing > 4 μm wavelength.

Methods used: We melt sulfide, selenide and telluride chalcogenide glasses, followed by extrusion, and fibre-drawing in Class 10,000 cleanroom.

Applications: New generation mid-infrared sensing and imaging for many applications including cancer diagnosis, pollution detection, food/drink security, agri- and aqua-culture monitoring.



Amanda **Wright**

Professor of Optics, Faculty of Engineering

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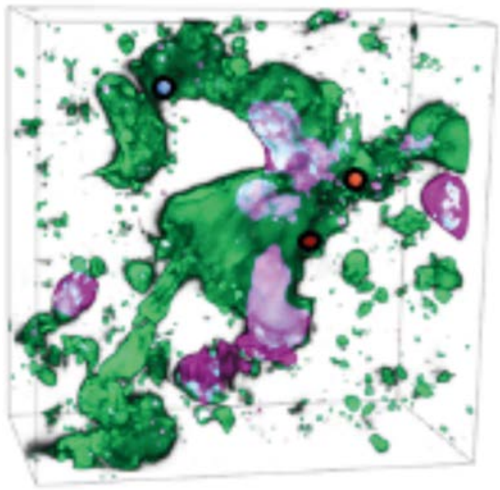
Materials investigated: We design and implement novel optical approaches for characterising biological samples. Our current work focuses on studying 3D cell clusters, spheroids, single cells and chromosomes and we look to characterise the properties of these samples at the sub-micron level. The samples we work with a soft, live and highly complex.

Methods used: We use a wide-range of optical techniques including non-linear microscopy, light sheet microscopy, fluorescence, optical trapping, multiplane imaging and wavefront correction approaches. Often our instruments combine several approaches. Currently we are combining imaging with studying the biomechanical properties of our samples.

Applications: imaging deep into biological samples, exploring the role of biomechanical cues in diseases such as cancer.



Gleb **Yakubov**

Associate Professor of Food Physics, School of Biosciences

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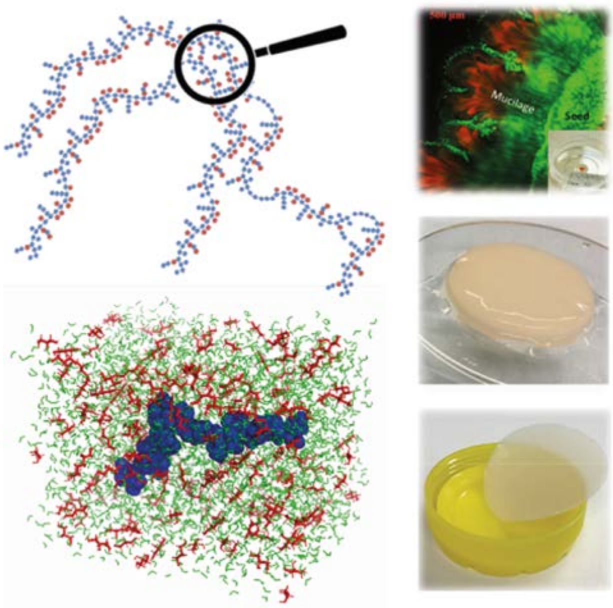

Materials investigated: we make, process and study (experimentally or theoretically) polysaccharide and glycoprotein assemblies: from molecular coacervates and functional surface coatings to gels, fibres, scaffolds and polysaccharide films.

Methods used: Rheology, tribology, atomic force microscopy and colloidal probe force spectroscopy, mechanical analysis, quartz crystal microbalance, thermal analysis, small angle scattering techniques and molecular dynamics simulations.

Applications: We explore and develop: food gels and complex food composites (including meat analogues), food packaging materials, surface coatings and biomimetic mucus films.

Nanoscale and Microscale Research Centre

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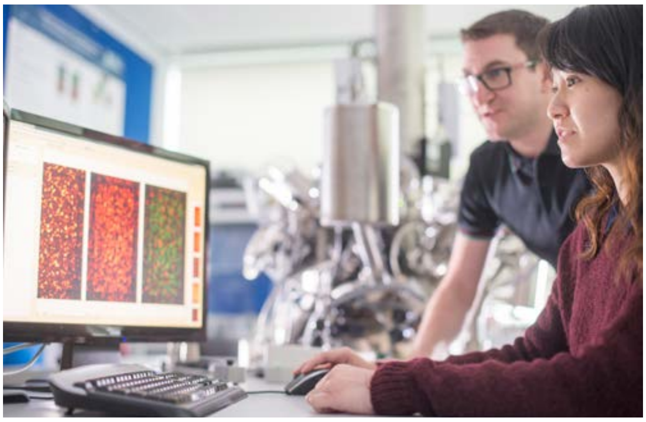
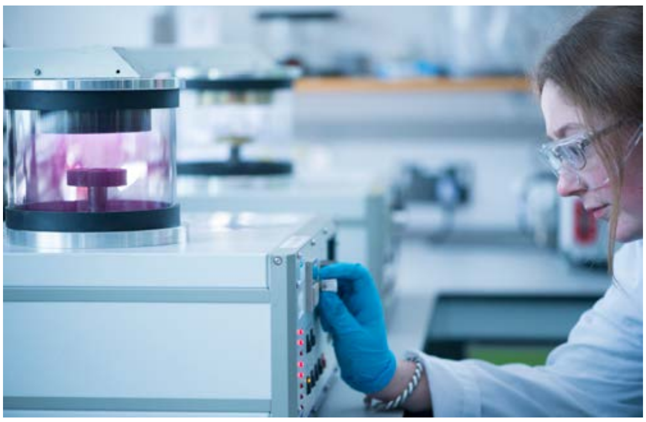
nottingham.ac.uk/nmrc





The Nanoscale and Microscale Research Centre (nmRC) is a cross-faculty research institute providing materials characterisation services and expertise to the university and research communities beyond. The centre offers state-of-the art facilities for micro- and nano-scale imaging as well as chemical characterisation and specialist correlative workflows.

The breadth of synergistic capabilities at the centre actively underpins research applications across the engineering, physical and life sciences. Furthermore the high end analytical capabilities are allied to expansive in-house technical and academic expertise from a range of backgrounds; meaning the centre is well placed to support and deliver research excellence.

The centre welcomes external engagement and indeed operates a dedicated commercial unit, the Interface and Surface Analysis Centre (ISAC) to ensure professional and timely services are available to e.g. other universities, SMEs, national and multinational companies etc.

The nmRC is located in the Cripps South Building, University Park Campus and is happy to receive enquiries of any nature via the contact details. For more details please visit our website.

Equipment / techniques available

1. Scanning Electron Microscopy (SEM)
   - Including Cryo-SEM, FIB-SEM, FEG-SEM, ESEM and more
2. Transmission Electron Microscopy (TEM)
   - Including Cryo-TEM
3. X-ray Photoelectron Spectroscopy (XPS)
4. Confocal Raman Microscopy
5. Time-of-Flight Secondary Ion Mass Spectrometry with OrbiTrapTM Detection (3D OrbiSIMS)
6. Optical and Confocal Laser Scanning Microscopy (CLSM)
7. Electron Micro Probe Analysis (EMPA)
8. Biosafety Level 2 (BSL2) Cryogenic Analytical Transfer Laboratory (CLEM)

Nanofabrication Nottingham

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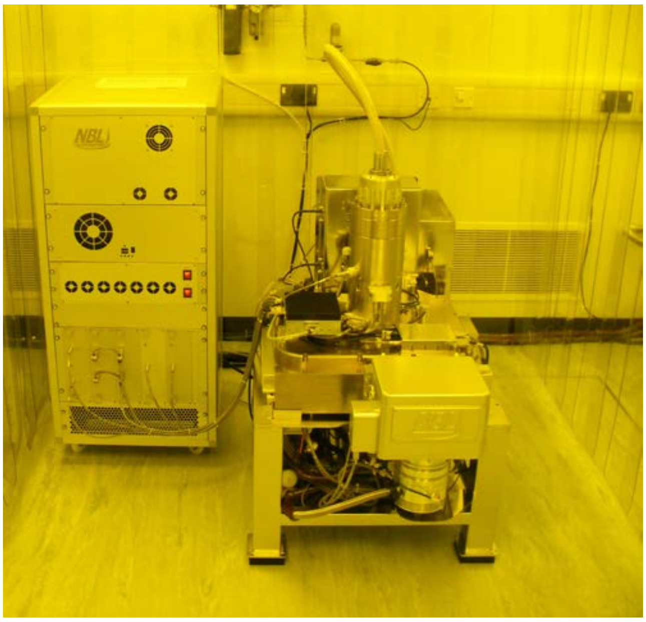
Nanofabrication Nottingham (NaNo) is an ISO 5 (class 100) cleanroom located within the nmRC. It houses a nanobeam nB5 electron beam lithography tool that can create features as small as 30nm on a range of substrates including silicon, glass and GaAs. For larger patterns we have a maskless photolithography tool (Alvéole Primo), with a resolution of 1.2 µm, which can be used to make microfluidic devices without the need for costly masks. This can also be used to pattern substrates allowing for cells to be deposited in specific areas allowing for easier and more relevant imaging.

In addition to our lithography equipment we also have an Accurion ep4 imaging ellipsometer that can be used to measure the thickness and optical properties of thin films with a lateral resolution as small as 5µm making it ideal for measurements on flakes of 2D materials.

Equipment / techniques available

1. Electron Beam Lithography
2. Microfluidic cell fabrication
3. Imaging ellipsometry
4. Cell adhesion control



Nottingham Analytical

Delivering industrial and regulatory scientific services

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nottingham.ac.uk/chemistry-bpu

Nottingham Analytical offers companies and research organisations access to state-of-the-art analytical techniques available at the University of Nottingham to meet the needs of your business. Managed by the Business Partnership Unit, within the University's School of Chemistry, our team has experience working with numerous partners ranging from large corporate entities to small and medium sized enterprises (SMEs). We are able to leverage our proven academic and technical expertise to solve a range of challenges relating to the analysis of chemicals and materials.

Nottingham Analytical is managed by the Business Partnership Unit. The Business Partnership Unit, established in 1999, is responsible for co-ordinating, supporting, and developing commercial knowledge transfer and entrepreneurial activities within the School of Chemistry.

Areas of expertise

- Regulatory and consultancy support (e.g. REACH)
- Commercial formulation Research and Development
- Product analysis to identify trace substances, impurities, and contaminants
- Providing access to specialist analytical equipment
- Preparing literature reviews, market analysis and patent landscaping
- Providing QC support

We have worked with companies from a range of sectors including:

- regulatory consultants
- agrochemicals
- medical devices
- fine and speciality chemicals
- pharmaceuticals
- food/drink
- personal care
- nanoparticle manufacturers
- laboratory equipment
- textiles
- universities
- museums

Nottingham Analytical has access to state-of-the-art analytical equipment including:

- Nuclear Magnetic Resonance Spectroscopy [400, 500, 800 MHz] (NMR)
- Mass Spectrometry
- Gas Chromatography-Mass Spectrometry (GC-MS)
- Chromatography
- Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP)
- Dynamic Scanning Calorimetry (DSC)
- Powder X-Ray Diffraction (PXRD)
- Infrared Spectroscopy
- UV/Vis Spectroscopy
- Light Microscopy
- Thermogravimetric Analysis (TGA)
- Karl Fischer
- Elemental Micro Analysis (CHN)
- Ion Chromatography (IC)
- Single Crystal X-Ray Diffraction
- Circular Dichroism Spectroscopy (CD)
- Gas Sorption Analysis (BET, isotherms)

Knowledge **Transfer Partnerships**

ktp@nottingham.ac.uk

Knowledge Transfer Partnerships (KTPs) are a UK-wide part grant-funded scheme helping businesses of all sizes to innovate using the knowledge and expertise of UK universities. KTPs are a three-way collaboration between:

- A UK-based business of any size or a not-for-profit organisation
- An academic or research organisation i.e. the University of Nottingham
- A suitably qualified graduate, with the capability to lead a strategic business project.

Notes

Contact

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