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Welcome to Materials Science at Lancaster

Lancaster University is a global top 1% institution with over 12,000 current students and a network of over 130,000 alumni in 183 countries worldwide. Our research has been rated as “world leading” in the 2014 Research Excellence Framework, which assesses the quality and impact of research by UK universities. Lancaster has an outstanding track record of collaboration with businesses, delivering support to over 5,000 Small and Medium Enterprises (SMEs).

The newly created Lancaster Materials Science Institute (LMSI) is a truly multidisciplinary research centre with project teams including chemists, physicists, engineers, computer scientists, biologists and social scientists, advancing all development stages from modelling a new material, material synthesis and characterization to applying that material in the ‘real world’. The Institute actively engages in academic and industrial collaborations across the UK and worldwide to expedite the realisation of new materials and products.

The Institute builds on the world leading expertise within the Departments of Chemistry, Engineering, Physics, Biomedical and Life Sciences and works in conjunction with the Cockcroft Institute, Graphene NOWNANO CDT, Marie-Curie ITNs and other areas of research excellence across Lancaster University including our Management School, Design via ImaginationLancaster, Mathematics, Computer Science, Environmental Science, and the Faculty of Health and Medicine.

Our facilities include new £4m class 100 and class 1000 clean rooms, the new award winning Engineering Department, unique ultra-isolated environment IsoLab, and the cTAP state-of-the-art materials characterization centre.

Our research focuses on four areas:
1) Artificial engineered materials
2) Chemical and biological materials
3) Photonics and nanostructures
4) Quantum sciences
These will evolve into over-arching themes that will break down traditional disciplinary silos and provide new stimuli to accelerate successes of the Institute and its industrial and academic collaborators.

We invite local and medium enterprises, large organisations, the public sector and academic researchers to discover how our expertise and capability could underpin their future successes, and form enduring partnerships with the Lancaster Materials Science Institute to gain technological and competitive advantage.

“At the LMSI we are establishing strong interdisciplinary research teams comprising internal and external academic and industry players. Working in tandem on both the basic and applied science of materials we will accelerate new materials and product developments. The LMSI will address current and future societal and economic demands, via leading-edge fundamental material science research.”

Professor Oleg Kolosov

PROFESSOR OLEG KOLOSOV
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We are investigating the use of different classes of artificial materials and surface waves to develop breakthrough technology across the whole RF spectrum, from microwaves to Terahertz frequencies, covering applications in wireless communications, healthcare, imaging and security, and tailoring of optical response from the engineering of metal clusters in compound materials from the visible to the near-infrared range of the spectrum.

Our artificial materials have been engineered to realise a novel family of compact, high-power THz vacuum electron sources for applications in wireless communications and security. Engineered materials are also being explored within The Cockcroft Institute, a UK-wide accelerator science institute led by Lancaster University, to offer new solutions to the design of novel particle accelerators where current technology is working at the physical limits of materials. We are developing new fabrication approaches to foster the widespread of artificial materials, by enabling their realisation in large quantities at a low cost.

**ACCESS EXPERTISE**

- Metamaterials and photonic bandgap materials
- Composite materials via controllable laser-assisted formation of metal nanoparticles in glass matrices
- Millimetre waves technology
- Vacuum electron devices
- Advanced manufacturing techniques (additive manufacturing, laser machining, and UV-LIGA)
- Plasmonics
- Computational modelling

"We have a broad expertise and a wide range of activities encompassing all stages from modelling to realisation of advanced artificial materials to foster collaboration both with industry and academia. We are keen to develop partnerships with external organisations to respond to their needs, as well as shape our research portfolio for the future widespread use of these concepts in everyday technology."

Dr Rosa Letizia

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**Our research:**

**Artificial Engineered Materials**

By combining the effect of constituent materials and the way these are spatially arranged in a composite structure, outstanding opportunities to design the electromagnetic properties of matter can be unlocked. These so-called ‘artificial materials’ offer ways to interact with electromagnetic radiation which go far beyond what traditional materials can accomplish, allowing responses which do not exist in nature, for example negative refraction.

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For more information visit www.lancaster.ac.uk/msi
We at Lancaster are equipped with an extensive array of new instrumentation and equipment to support the materials-related research activities of academics, students, and researchers in the chemical industry across a variety of sectors. We have a strong track record of highly successful collaborative research projects that traverse traditional disciplinary boundaries, such as biology, chemistry, engineering, IT, mathematics, materials science, medicine, pharmacy, and physics. This skills base enables us to study and develop functional materials, examples of which include low cost solar cells, liquid crystal displays, porous materials for gas storage, polymer-based materials for extreme environments (e.g. base of the sea), sensors, drug delivery devices and tissue scaffolds for regenerative medicine.

We generate high quality peer-reviewed publications and intellectual property used by industrial partners, and our research has a broad impact on the economy, environment, health, public policy, security, society, technology and products.

One exciting example of such research aims to treat Alzheimer’s and other neurodegenerative diseases, through the development of nanoliposomes coupled to a ‘retro-inverted’ peptide that penetrates the brain and prevents the formation of toxic beta-amyloid oligomers and fibrils. These ‘peptide-inhibitor nanoparticles’ are being progressed into human clinical trials in collaboration with MAC Group, a contract research organisation based in the North West, with expertise in running many previous trials on patients with dementia.

“Chemistry is at the interface between many disciplines represented at the Materials Science Institute at Lancaster University. We aim to address scientific and technological problems of local, national and international importance, and to generate solutions to societal grand challenges. We will engage with the public, charities, governments and industry to ensure the maximum impact of our research.”

Dr John Hardy
Our research:
Photonics and Nanostructures

Our research involves the growth of new semiconductor nanostructures, including quantum dots, nanowires and 2D materials and studies of the fundamental quantum phenomena at the nano-scale. The devices are fabricated using the state-of-the-art nanofabrication facilities including e-beam lithography, photolithography and thin-film deposition techniques.

We deploy a range of scanning probe microscopies, including world leading nanomechanical and nanothermal mapping tools. Our 3D nano-mapping and cross-sectional imaging techniques are used to image and characterise the materials and industrial devices at the nano-scale. Our research is carried out in collaboration with industrial partners including: IQE, CST, GSS, Amethyst, Oclaro, Pilkington, and SELEX, as well as worldwide academic groups.

ACCESS EXPERTISE
- 2D materials and devices
- Advanced scanning probe microscopy
- Complex oxide-based dielectrics and semiconductors for flexible optoelectronics
- Electron-beam lithography
- Hybrid structures of III-V materials integrated with 2D and organic polymers
- Infrared imaging and detection
- Low-dimensional semiconductors
- Mid-Infrared Photonics
- Molecular beam epitaxial growth of III-V materials
- Nanoscale fabrication
- Nanoscale microscopy of biomaterials
- Single photon detection
- Solar cells
- Terahertz technologies
- Thermophotovoltaics

“Our research focuses on the growth and characterisation of nanostructured materials and their applications in novel photonic devices including LEDs, lasers, photodetectors and solar cells. We are particularly interested in forming partnerships with organisations in the areas of communication, healthcare, security and defence, energy, and environmental monitoring.”

Dr Peter Carrington

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They require the creation and manipulation of quantum states at the ultimate possible level - the single quantum, be it a single photon, single charge, single flux quantum or a single phonon.

We are creating and manipulating materials to facilitate the extreme level of control required to harness their underlying quantum properties.

We have a wide range of expertise and equipment covering a diverse variety of activities, developing materials, probing their fundamental properties in extreme isolated, low noise environments, and working closely with industrial partners to incorporate them into their products.

ACCESS EXPERTISE

- 2D materials, graphene and beyond, including biosensors, quantum light emitting diodes, nanomechanical resonators with quantum sensitivity, security devices and thermoelectrics
- Hybrid metal-superconductor structures, including quantum standards and metrology
- Quantum fluids and nanomechanical devices for detection of quantum phenomena
- Semiconductor nanostructures, including telecoms lasers, infrared single photon detectors and sources
- Superconducting device technologies, including building blocks for quantum processors and ultra-sensitive detectors for magnetic fields
- Testing devices in new facilities free from all forms of noise

“We are keen to collaborate with new businesses and develop new products and processes. Research, in collaboration with Oxford Instruments, is developing a new platform to lower the barrier to studying the quantum properties of new materials. This technology could soon underpin advances in this field.”

Dr Robert Young

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Partnerships

Our partnerships extend beyond business and Enterprise team can help your organisation achieve its goals through sharing knowledge, resources, contacts and providing access to funded R&D through:

- Collaborative research
- Student engagement
- Facilities for research and development
- Professional training
- Commercialisation of Intellectual Property

Wide ranging Partnerships

Our partnerships include researching into robust plastic manufacture; materials analysis at low temperatures, scanning probe microscopy and cross-sectional imaging and analysis; nano-scale security technology; ceramic-based friction materials; and rapid prototyping, selective laser sintering and 3D printing for product development, on a wide range of projects such as bespoke display unit, product materials, and rapid prototyping, selective laser sintering and 3D printing for product development, including office space and hot desks. Our award winning buildings enable high-tech businesses to co-locate onto the Lancaster University campus and work alongside our cutting-edge researchers in a unique collaborative environment.

Our Track record of SME Engagement

Lancaster has a successful track record in the delivery of projects which increase the innovation capacity of businesses and in particular SMEs. A range of innovative engagement programmes have enabled Lancaster to work with more than 5,000 SMEs since 1999, creating more than 250 new businesses and more than 4,000 new jobs. We are committed to ensuring research, innovation and skills are embedded into SME supply chains of relevance to materials and advanced manufacturing, including leadership development. We recognise the challenges that SMEs have in accessing university expertise and we have the experience of making those interactions as straightforward as possible utilising the expertise across the campus through a variety of different mechanisms.

- Ranked Top 10 for SME interactions
- Multi-award winning team
- Over 5,000 successful partnerships
- Over 4,000 jobs created
- Exemplar facilities according to government

“Work with us and discover how new materials are changing the world and providing scientific and commercial opportunities.”
Dr Mark Rushforth

Wide Ranging Expertise

We can tap into expertise from across the University and our external collaborative partners across these areas:

- Advanced Manufacturing
- Chemistry
- Design
- Energy
- Environment
- Health and Human Development
- Information and Communication Technology including Data Science
- Leadership and Management
- Quantum Technology
- Security including Cyber Security
- Social Sciences

Co-Locating space on Campus for Collaboration

We have a huge range of cutting-edge facilities for collaborative research and development, including office space and hot desks. Our award winning buildings enable high-tech businesses to co-locate onto the Lancaster University campus and work alongside our cutting-edge researchers in a unique collaborative environment.

Increasing Understanding of the Manufacturing of Robust Plastics

Robust plastics are hugely prevalent in manufacturing, and any improvement in their manufacturing procedure would be important to costs and efficiency. Victrex Plc. wanted to research polyaryletherketone polymers and the chemistry behind their manufacture. Chemistry student Callum Wallace was recruited through the Science and Technology Internship Programme to undertake the research and reported findings to company personnel. The company gained a better understanding of the core chemistry underpinning the manufacture of polyaryletherketone polymers. “Callum was very helpful and we couldn’t have completed this research as quickly without his help and the Lancaster University Science and Technology Internship Programme.”
Adam Chaplin, Victrex Plc.

Delivering a Market-Changing USP to the Climbing World

King Kong Climbing are specialists in designing and manufacturing bespoke climbing walls throughout the UK. King Kong Climbing approached the University to help them develop and launch the latest concept in climbing walls – illuminated routes. Traditional climbing walls use moulded holds that can be costly to replace and become discoloured over time. A group of Engineering students carried out design development and produced a fully-working prototype of a new system, which introduces coloured LED lights embedded within the holds to create routes for climbers to follow, programmed and controlled from a computer on the ground.

“In illuminated holds are a very exciting new idea in climbing walls, and an area we have been looking at in order to grow our business, so we started looking for alternatives and approached the University.”
Paul Cornforth, Managing Director, King Kong Climbing

Case Studies

Access to a Specialist Team to Help Build Partnerships

For more information visit www.lancaster.ac.uk/msi

Our award-winning Business Partnerships and Enterprise team can help your organisation achieve its goals through sharing knowledge, resources, contacts and providing access to funded R&D through:
NEW ALZHEIMER’S DRUG ENTERS CLINICAL TRIALS

Currently there are about 850,000 cases of dementia in the UK, with numbers expected to reach over a million by 2021. The most common cause of dementia is Alzheimer’s disease, which begins when a protein called beta-amyloid forms senile plaques that start to clump together in the brain, damaging nerve cells and leading to memory loss and confusion.

Professor David Allsop is leading a team researching treating Alzheimer’s disease and other neurodegenerative diseases through the development of nanoliposomes coupled to a ‘retro-inverted’ peptide that penetrates the brain and prevents the formation of toxic beta-amyloid oligomers and fibrils. These ‘peptide-inhibitor nanoparticles’ are being progressed into human clinical trials in collaboration with MAC PLC, a contract research organisation based in the North West, with expertise in running many previous trials on patients with dementia.

Dr Steve Higham, Chief Operating Officer of MAC Clinical Research said, “Preventing Alzheimer’s disease progression remains a critical unmet need for millions of people worldwide. We are very pleased to begin this exciting partnership with Lancaster University.”

NANO-SCALE ‘FINGERPRINT’ COULD BOOST SECURITY

New technology being patented at Lancaster University and commercialised through the spin-out company Quantum Base, enables the unique identification of any product with guaranteed security using next-generation nanomaterials. Current authentication solutions, such as anti-counterfeit tags or password-protection, base their security on replication, difficulty, or on secrecy, and are renowned for being insecure and relatively easy to forge. The ground-breaking atomic-scale devices do not require passwords, and are impervious to cloning, making them the most secure system ever made. Coupled with the fact that they can be incorporated into any material makes them an ideal candidate to replace existing authentication technologies. This and their ability to be produced in large quantities has resulted in smaller, more power-efficient devices that are future-proof to cloning.

Phil Speed, co-founder of Quantum Base said, “This is truly a step change in authentication and authorisation. Lancaster and Quantum Base are looking forward to talking to prospective markets and customers alike to bring this new, cutting-edge, Great British technology into mass market adoption.”