Advanced materials capabilities

Advanced materials capabilities

Developing and applying the advanced materials of the future is part of our exciting journey towards net zero.

Cranfield is at the heart of engineering innovation and key factors to consider include sustainability of resources, reliability, performance efficiency and commercial necessity.

At Cranfield, we have an enviable track record in the development and application of a wide range of advanced materials and their associated processing and manufacturing technologies.

Organised in sector-focused themes, rather than the traditional subject-based departments, our facilities in materials science and engineering span a range of capabilities.

This insight and expertise enables us to carry out projects from concept to high technology readiness applications. Focused on best practice, responsible resource management and sustainability, our people are passionate about sharing their knowledge and experience.

We are home to world-leading, industrial-scale research facilities, from our global research airport to our specialist coatings technologies and explosives blast-testing range. Built in partnership with industry and underpinned by government investment, they demonstrate our ability to deliver projects for fledgling SMEs to major initiatives of national and international significance. Some of these facilities are referred to in this brochure and you can also read more about them at: **www.cranfield.ac.uk/materials**.

There are huge opportunities ahead of us as we move towards a smarter, cleaner, greener future. We look forward to continuing to play our part.

Professor Dame Helen Atkinson DBE
FREng
Pro-Vice-Chancellor, Aerospace, Transport Systems and Manufacturing

Professor Mark Richardson
Pro-Vice-Chancellor, Defence and Security

Professor Christopher Fogwill
Pro-Vice-Chancellor, Water, Energy and Environment

Aerospace • Defence and Security • Energy and Power
Environment and Agrifood • Management • Manufacturing • Transport Systems • Water

Front cover: Foam aluminium crash impact material - see page 23.

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There are many ways we can collaborate, dependent on your **project scope.**

TESCAN Vega scanning electron microscope

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Advanced characterisation

Electron microscopy reveals a high level of detail and complexity beyond optical imaging to accurately measure and determine the composition, structure, and characteristics of materials, giving unique access to the properties and performance of products.

Our range of state-of-the-art electron microscopy techniques and facilities support investigations of a wide variety of materials, such as contaminated soil and clay samples from India and Nigeria, biodegradable carpets for reducing landfill, anti-reflective coatings on ships' telescopes, sand erosion of desert solar panels, quantum dots for electronic displays, high temperature oxides for gas turbines, natural fibre for motorsport composites door panel inserts, flexible energy-saving smart windows and rare meteorite samples from primitive asteroids and the Moon.

Recent multi-million-pound investment in our microscopy suite has equipped us with the latest generation analytical microscopes with extensive preparation facilities for materials development and investigation. These systems include:

- Focused ion beam combined with field emission scanning electron microscope for ultra-high resolution imaging and micro/nanomachining with a choice of ion source – gallium ions for high precision and xenon ion plasma for high throughput, large area tomography.
- Electron backscatter diffraction analysis for rapid identification of crystallographic phase mapping with grain orientation, texture, and grain size statistics.
- Energy dispersive X-ray spectrometry and time-of-flight secondary ion mass spectrometer elemental mapping with excellent spatial resolution at the sub-micron scale.
- Tungsten gun variable pressure scanning electron microscopy for high resolution imaging of a range of samples including, conductive metals, non-conductive ceramics, glasses and polymers together with wet, oily, dirty and delicate samples.

3D Isotope and elemental mapping

Cranfield has developed its capabilities in carrying out 3D chemical mapping using a powerful and unique combination of a high-throughput milling-focused ion beam scanning electron microscope and integrated time-of-flight secondary ion mass spectrometer. This system configuration is new, installed in only a very few high-end research facilities in the nuclear, semiconductor and battery research industries, enables 3D elemental mapping with capabilities to detect light elements distinguishing individual isotopes. This specialised capability, supplied by Cranfield's close partners TESCAN, puts the University firmly at the forefront of research in the UK and extends the frontiers of analytical methods available in the field of electron microscopy.

Materials characterisation in forensic science

The use of materials analysis and characterisation is becoming increasingly vital for a multitude of public, private and government services.

The recent investment of £7.2 million into the latest forensic equipment and the establishment of a new integrated facility will enable Cranfield University's Forensic Institute to build on our well-established track record of innovation and expertise.

Some of the capabilities in materials science include:

- analysis of tool marks by using a number of techniques including microscopy, XRF and Raman to identify obliterated serial numbers seen in criminal and terrorist activities,
- gas chromatography-mass spectrometry for the purposes of the chemical identification and ageing of forensically important insects, providing highly robust analysis for the court of law,
- analysis of explosives, explosive devices and associated components by a range of visual, elemental and phase techniques in order to determine viability and provenance,
- analysis of metallic components using microscopy and X-ray microtomography for failure analysis investigations,
- creating a biological profile for human skeletal remains from prehistoric to modern contexts by analysing age, sex, pathology, place of birth, etc.
- biomechanics studies of crime cases by material characterisation,
- science and concepts of operations in sensing CBRN Hazards for Detection Identification,
- advanced imaging for security screening, in particular using novel X-ray optics,
- analysis of art and antiques by a range of elemental and phase techniques to determine age and provenance especially in glass, ceramics, stone and metal objects of many periods.

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Fakes and forgeries

In 2019, the global art market was estimated to have been worth in excess of £50 billion. Increasingly it is also a market exploited by criminals. A survey conducted by Deloitte reported that 'authenticity, lack of provenance, forgery, and attribution' are the biggest threats to credibility and trust in the art market.

Cranfield's analysis of ancient and historical materials initially came to the attention of Bonhams auctioneers, with work on Meissen snuffboxes. The reputation for novel research soon spread to other auction houses and has led to requests for analysis, collaboration and advice by a wide range of clients, including more than 20 university and national museums worldwide, such as Harvard, Oxford and the major London museums.

Cranfield has specialised in developing bespoke non-destructive analytical techniques, building on technologies used in forensic or archaeological science, to aid UK and European police on preventing smuggling and identifying forgeries of art and antiques.

Chemistry laboratory for defence research, Shrivenham

Test track to increase testing and reduce costs

Air Command and DSTL need to assess the output from air launched countermeasures in realistic environmental conditions. COTEC designed and built a test track which removed the need for aircraft launch, dramatically increasing the amount of testing carried out at a greatly reduced cost. This was the first such facility in the world.

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Energetic materials

Trials of energetic materials, ordnance, and weapon systems, plus the testing of non-explosive items are undertaken at the Cranfield Ordnance Test and Evaluation Centre (COTEC). Situated on the edge of Salisbury Plain in Wiltshire, England, COTEC is part of Cranfield University, academic provider to the UK Defence Academy at Shrivenham.

COTEC performs independent test and evaluation on munitions, weapon systems, pyrotechnic and explosive stores, and conducts disposals and demilitarisation. Its extensive range of facilities is suitable for testing other materials and equipment. Site facilities include a Ministry of Defence (MOD) licenced independent testing range. Extensive instrumentation and data capture facilities including Flash X-ray and doppler radar are available and in-depth data analysis is undertaken by Cranfield University experts. COTEC staff have experience in carrying out standard and bespoke testing for the MOD and all major UK defence contractors and offer extensive workshops, ammunition storage and ammunition processing on site.

Fragmentation capture and velocity measurement of high explosive shells

Rheinmetal Italia had a requirement to compare the performance of 155mm high explosive shells filled with a new composition against the standard filling. COTEC built an arena with fragmentation capture and velocity measurement and in conjunction with staff from the Centre for Defence Engineering delivered extensive trials data in the required format.

Centre of Excellence in Energetic Materials (CoEEM)

Founded by Cranfield University, Defence Science and Technology Laboratory (Dstl), the Atomic Weapons Establishment (AWE) and Defence Equipment & Support (DE&S), the aim of CoEEM is to secure national capability in energetic materials by providing technical leadership and strategy to the UK Government. Hosted at Shrivenham, it facilitates coordination and collaboration across government, academia, and industry.

Centre of Excellence in Energetic Materials

Testing facility development to simulate harsh environment

COTEC developed an Explosive Atmosphere Testing Facility to simulate the harsh environment associated with the weapons bay of an aircraft in flight. This environmental testing has been provided for customers such as MBDA and Kongsberg to provide confidence in the safety of munitions deployed on their relevant platforms.

Potential difference corrosion fatigue rig for the evaluation of materials' performance

Coatings for extreme environments

The National High Temperature Surface Engineering Centre (NHTSEC), an Associate Member of the Henry Royce Institute, designs and tests surface treatments for components subjected to extreme and hostile environments.

The Centre is majority funded by industry, and is the sole university provider of electron-beam physical vapor deposition (EB-PVD) thermal barrier coatings to Rolls-Royce gas turbine engines. These advanced materials are developed and manufactured on-site at Cranfield and have led to significant fuel, and resultant cost, savings in the aviation industry. This ongoing sponsorship recognises our unique coating capabilities for metallic and ceramic coating deposition/manufacture.

The Surface Engineering and Precision Centre offers a wide range of deposition methods from EB-PVD to Sol-gel and spin coating methods. Coating systems are used not only to protect our high temperature materials, but also for sensors, solar energy, and structural engineering.

Additionally, the Welding Engineering and Laser Processing Centre can lay down advanced metallic cladding via the Wire Arc + Additive Manufacturing (WAAM) process.

To complement our coating capability, we offer world-leading high-temperature corrosion, stress-corrosion, corrosion-fatigue and aqueous corrosion testing to assess materials' performance for selecting alternatives and generating data for life assessment models.

HENRY ROYCE INSTITUTE

ROLLS ROYCE

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High temperature burner rig

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Corrosion and erosion

The energy materials laboratory contains a range of facilities to enable the evaluation of the corrosion performance of metallic and ceramic materials in a wide range of environments that are found in the power generation industries.

The materials exposure facilities are usually used as parts of programmes targeted at the development and understanding of materials performance in specific plant environments. As well as experimental exposures, we also have extensive materials preparation and analytical facilities and expertise.

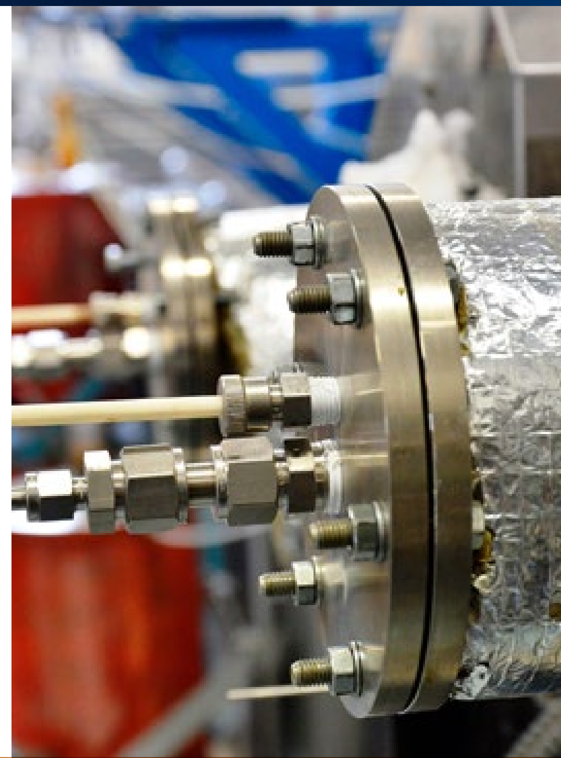
The laboratory is used extensively in business with a number of partners and clients including Siemens Energy, Rolls-Royce, Alstom, and Doosan Babcock. We also work with funding bodies such as the Engineering and Physical Sciences Research Council (EPSRC), the European Union, the US Department of Energy, and with other universities.

Some of our activities focus on utility scale power generating systems as well as offshore oil and gas production:

- high temperature corrosion (hot corrosion) for industrial gas turbines,
- high temperature corrosion (fireside corrosion) for heat exchangers,
- high temperature oxidation and carburisation,
- methods for systematically investigating and quantifying high temperature corrosion in the various environments,
- development of new corrosion protection coating systems for both gas turbines and heat exchangers,
- erosion/corrosion and aqueous corrosion.

Flexible and efficient power plants

To meet targets for 80% reduction in CO_2 emissions by 2050, there needs to be increasing constraints on the operation and environmental performance of conventional power plants. This is causing challenges for the component integrity in conventional gas-fired power plants which are needed to maintain security of supply. The Flex-E-Plant research programme considers the key issues of plant efficiency, plant flexibility, fuel flexibility and sustainability and how these four intersecting themes impact upon plant operation and design, combustion processes in general and the structural integrity of conventional and advanced materials utilised in conventional power plants.



High temperature controlled atmosphere corrosion furnaces

Precision diamond machining of an acoustic resonator used to determine the Boltzmann constant

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Surface and precision engineering

Modern industries depend on advanced manufacturing technologies to precisely tailor the surface chemical, physical and mechanical properties of the components.

Surface Engineering and Precision Centre (SEPC) expertise in advanced functional materials, thin film deposition, nanotechnology and precision device manufacturing, coatings and surface treatments, and ultra-precision machining and associated metrology, enables us to progress our research from simple design to full manufacturing process integration.

Research facilities include clean rooms, laboratories and test/fabrication services through to prototype component manufacture, with extensive analysis, modelling, synthesis, and characterisation capability. A non-exhaustive list of our offer includes:

- PVD, CVD, sol-gel coating and printing,
- specialism in piezoelectric, pyroelectric, thermoelectric, catalytic, radiation detectors and biosensors,
- design, testing and analysis of coating systems,
- surface treatments for components subjected to extreme conditions,
- corrosion, wear and fatigue performance of coatings,
- ultra-precision machining of fine features over large areas,
- extensive materials and geometrical characterisation techniques.

Carbon fibre composite raw material

Innovation in thick composites manufacture

A successful feasibility study by the Engineering and Physical Sciences Research Council (EPSRC) Future Composites Manufacturing Hub, which includes Cranfield University, established that layer by layer (LbL) curing, a process likened to 3D printing, to manufacture thick laminate composite materials can achieve equivalent interlaminar properties and porosity to those made using conventional processing. Testing showed that LbL cured laminates have properties matching those of conventional laminates, but that production with LbL reduces process time by 75%. Ongoing research focuses on scaling the process and adapting it to complex geometries and components.

Composites for specialist performance

Cranfield's researchers, in partnership with Meditech Gloves, a leading manufacturer of high-quality surgical gloves, have used novel composite technology to enhance the properties of the surgical gloves. This includes the addition of ceramic particles to the rubber for X-ray protection and embedding graphene for needle puncture protection.

Meditech Glove factory, Malaysia

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Innovative high-performance composites

To meet industrial materials issues head-on, innovations in composite materials and structures are essential. By developing new composite materials with unique capabilities and integrating these into structures to improve sustainability and lower costs, we are pushing the boundaries of composite manufacturing and leading the way for the future use of composites.

Our experts not only have deep scientific knowledge, but also understand how this knowledge needs to be applied to solve real-world problems.

At our Composites and Advanced Materials Centre, a core partner in the strategic EPSRC Centre for Innovative Manufacturing in Composites (CIMComp), supported by major manufacturers, we are investigating and developing materials and processing technology for lightweight and efficient structures and combining an expertise in low cost manufacturing with modelling, simulation, and structural health monitoring technologies.

We are able to integrate advanced technologies in areas such as autonomous systems and intelligent automation, as well as reducing the time from innovation to industrial application.

Developing the next generation of Unmanned Aerial Vehicles (UAVs) with BAE Systems

For the £6.2 million six-year FLAVIIR (Flapless Air Vehicle Integrated Industrial Research) project to develop and evaluate a range of technologies for the next generation of UAVs in partnership with BAE Systems, the Enhanced Composites and Structures Centre produced the complete unmanned aircraft airframe (fuselage and wings) using a novel low-cost composite manufacturing process. This process saw some 50% cost savings on the standard manufacturing process and resulted in the DEMON demonstrator, the world's first flying gas turbine engine-powered 'flapless' aircraft.

Graphene nanotube reactor

Graphene and carbon nanotubes

Modern material applications demand improved strength, heat and electric current carrying capacity, enhanced low-carbon manufacturing and sustainability.

At Cranfield's Composites and Advanced Materials Centre we are achieving advancements in high-performance nanomaterials (such as graphene and carbon nanotubes) and their use for manufacturing advanced multifunctional composites for the aerospace, automotive oil and gas, healthcare, and marine sectors.

Graphene, a two-dimensional thermal performance, and mechanically stable material, has the potential to truly revolutionise modern products and work is underway to define standards and procedures to facilitate its deployment in various forms across applications that will impact daily life, such as aircraft structures, oil, paint, helmets, hydrogen pipes and in sustainable gloves and face masks, to support the fight with Covid-19.

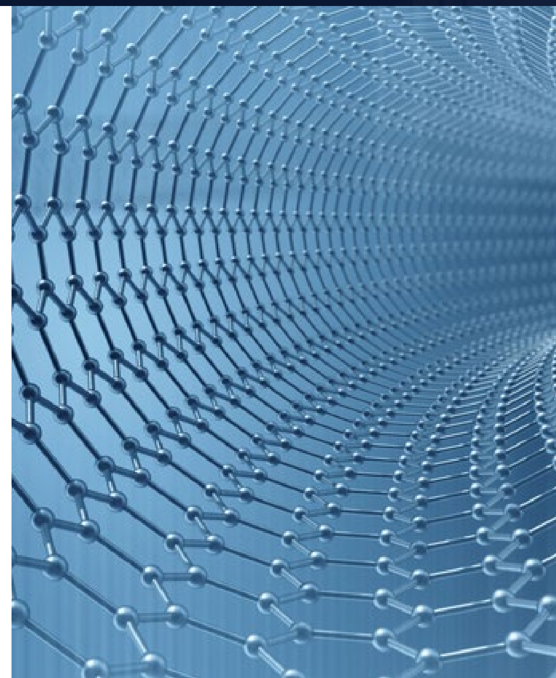
Another area of focus is the material manipulation and manufacture of carbon nanotubes. By manipulating the chirality of these tubes at an atomic material level we can manufacture them into semiconductors, insulators, or semimetals, which can be embedded into other composite materials in a variety of industry sectors.

Carbon nanotube wires, yarn and film

Research within the Composites and Advanced Materials Centre is underway to advance these products at a molecular level. By changing and controlling the chirality of the material we can manipulate the electrical properties at a microscopic level. This manipulation can change the final material's conducting capability and determine if it can replace copper or aluminium wire or if it can replace silicon as a semiconductor. Our unique reactor manufactures solid carbon nanotube wires, yarn and film from hydrocarbon gas; the reactor can produce 20 metres of carbon nanotube wire per minute.

Solid carbon from gas – net zero material manufacturing

The team at Levidian Nanosystems Ltd and Cranfield University have developed a unique and sustainable technology to transform methane (natural gas) into solid carbon (specifically graphene) and clean fuel (hydrogen). This is an industrial process and a unique technology using 'greenhouse gas' on an industrial scale with the first plant running in Cambridge.



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Lightweight structures and impact

The analysis of composite and metallic materials structures is a significant contributor to the development of innovative lightweight structures. World class research projects in the design analysis and testing of advanced lightweight composite and metallic structures are for the automotive, marine and aerospace industries are undertaken at Cranfield.

Cranfield's structural integrity laboratory offers a wide range of state of the art testing facilities including a gas gun, a Hopkinson Bar and a full-scale wing test rig. Areas of expertise include structural and load path analysis and airframe integration along with new advanced analysis and design techniques.

Projects have received significant funding from the Engineering and Physical Sciences Research Council, the Aerospace Technology Institute, Innovate UK and industry.

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Full-scale wing test in the structures rig in the Aerospace Integration Research Centre (AIRC)

Cranfield Impact Centre

Physical impact testing and computer modelling complement each other at CIC and we are in a unique position to offer both services independently or in conjunction. We can access impact analysis for a variety of structures, such as restraint systems, seats and F1 vehicles through physical and virtual testing techniques.

One of just two FIA (Fédération Internationale de l'Automobile)-approved crash test centres in the world, Cranfield Impact Centre is an approved testing facility for the driver crash-protection system (the 'halo') in Formula 1 cars before they can be used in races. Our state-of-the-art testing laboratories feature a range of test rigs for both static and dynamic testing of materials and structures. Tests can be carried out for certification or research purposes.

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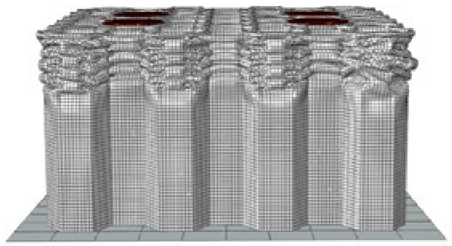
Crash safety development for road service vehicles in Thailand

Each year, about 13,000 people die in road accidents in Thailand and several hundred thousand are injured. Many of these accidents occur when drivers crash into road service vehicles as these have to operate while traffic flows. Cranfield Impact Centre is working with industry partner, The National Metals and Materials Centre (a member of the National Science and Technology Development Agency in Thailand) to develop an aluminium foam crash box which can be installed at the rear of road service vehicles to avoid potential structural damage if another vehicle crashes into it while stationary. The project involves designing lightweight, low-cost solution that is able to absorb high levels of energy and cushion impact safely.



Metal additive manufacturing

With continued research into additive manufacturing, 3D printing and layer by layer (LbL) manufacturers can not only produce very complex shapes or geometries that would be otherwise impossible to construct, but at a lower cost, to shorter production times and with minimal waste.

Additive manufacturing is having a major impact in many industry sectors. This is because it has demonstrated potential for substantial material, cost, and lead-time reductions, combined with increased design flexibility.

Within the Welding and Additive Manufacturing Centre research has focused on wire-based directed energy deposition additive manufacturing using arcs, lasers, or combinations of these. These technologies enable production of large-scale engineering structures with high integrity and excellent mechanical properties. Working for more than 15 years with industry partners such as Airbus, BAE Systems and Lockheed Martin the technology has now been commercialised.

The biggest 3D part ever made in one piece

Our researchers manufactured this complex aircraft part using Cranfield's Wire + Arc Additive Manufacture (WAAM) process.

The six-metre long, 300-kg, double-sided spar was made from aerospace-grade aluminium on Cranfield's 10-metre 3D metal printer. This innovative technique enables the production of metal parts at significantly reduced time (a year down to a few weeks) and cost (approximately 70% waste reduction) when compared to existing methods. Virtually any shape can be created by adding successive layers of material.

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Multi-energy source for large-scale additive manufacture research

Multi-energy source for next generation research

Recently a new multi-energy source (MES) has been established for research into the next generation of large-scale additive manufacture research. The facility comprises multiple high-power laser sources with scanning galvanometers, a variety of arc sources coupled together with the latest robots and part manipulators for industrial-scale component manufacture. The facility also includes in-process mechanical work using rolling or peening. The facility was part of the Open Architecture Additive Manufacture (OAAM) project, funded through Innovate UK and the Aerospace Technology Institute (ATI). The facility is supporting our large Engineering and Physical Sciences Research Council (EPSRC) programme grant, New Wire Additive Manufacturing (NEWAM), as well many other grant-supported and industrial projects.

Structures and mechanical testing

Over time mechanical and environmental conditions take their toll on materials and components, but by undertaking structural and mechanical property testing it is possible to build models to predict the effects of damage, identify corrosion fatigue and welding residual stress, and construct reliability-based inspection and maintenance regimes.

Cranfield's structural integrity laboratory offers a wide range of state-of-the-art equipment to test and study the mechanical behaviour of components and material samples, using destructive and non-destructive methods. This unique facility is one of the biggest in the UK and tests on materials can be undertaken on actual components from small to large structural level.

Structural integrity laboratory facilities:

- Simulating environmental damage (such as corrosion and temperature effects) in mechanical testing,
- advanced non-destructive evaluation (NDE) techniques for damage detection and crack growth monitoring,
- examination of surface treatment effects on fatigue life,
- examination of fatigue and fracture behaviour of additively manufactured parts,
- mechanical testing of complex joints (such as flanged bolted connections used in offshore wind turbines),
- laser peening and study the improvement of dynamic performance of component,
- residual stress profiling by incremental center hole drilling (ICHD), synchrotron X-rays and neutron diffraction,
- fatigue testing and modelling of fatigue life for aerospace structures.

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Fatigue life of aircraft fuselage

In a project with Airbus, structural joints and friction stir welded fuselage structures were studied for fatigue life and long fatigue crack propagation rate. The process of peening improved the fatigue life of fuselage structural joints by up to four times and application of peening in retarding fatigue crack propagation was studied and modelled by FEA (Finite Element Analysis). This study helped to develop fundamental science on fatigue crack propagation.

The influence of residual stresses on the structural integrity of renewable energy marine structures

Fatigue crack growth tests in air and seawater using a new neutron imaging facility – IMAT (Imaging and Materials Science and Engineering) – to measure the residual stresses on fatigue, fracture mechanics and structural integrity in welded components of offshore wind turbine foundations is taking place at both Cranfield and the ISIS Neutron and Muon Source, based at the STFC Rutherford Appleton Laboratory.

Autonomous non-destructive robotic testing

Planning for maintenance in complex systems is difficult, expensive and uncertain. Degradation on transport networks can cause lateness, damage and hazards but regular non-destructive testing automated measurement can lead to prevention, rather than having to cure. In addition, automatic scheduling of the most cost-effective actions can send people to repair at the right place at the right time.

Our expertise includes research across all transport systems, such as embedded sensors on railway tracks and UAV or drone thermographic imaging on aircraft fuselage. Monitoring of materials and a rigorous approach to cost estimation and benefit analysis forms part of the full maintenance cycle. Some of the industrial drivers used on our projects include location, automation, connectivity and optimisation of cost, with over thousands of interventions each year. Such automation has become increasingly important during the pandemic and ensures the safety of employees.

Infrared thermography for damage characterisation and assessment

Covid-19 has emphasised the value of automated techniques to protect staff. UAV and infrared technology provides a complete portrait of large structures much faster, accurately and reliably. However, the raw data that is acquired often contains environmental noise and algorithms are needed for image processing to produce accurate results. Cranfield is working with the National Research Council in Canada and Universite Laval in Quebec in the MultiAcT project (www.fireflyinspect.com), focusing on video stabilisation techniques and decision-making tools.

NetworkRail

Autonomous inspection

We are exploring the development and integration of command and control into a robotic platform for high-value systems, with the backing of several industrial partners including Network Rail, by conducting research in novel sensing, e-maintenance systems, and decision-making strategies. The Warthog unmanned ground vehicle travels railway tracks and is fitted with accurate positioning systems, cameras and a robotic arm.

Prototype of the CompInnova vortex robot on the underside of an aircraft fuselage

Detecting fuselage damage

The CompInnova project, led by Cranfield and involving five EU organisations, is working on an autonomous vortex robot, capable of carrying novel phased array hardware, 3D damage detection and visualisation, using a powerful air suction system to climb surfaces irrespective of orientation.

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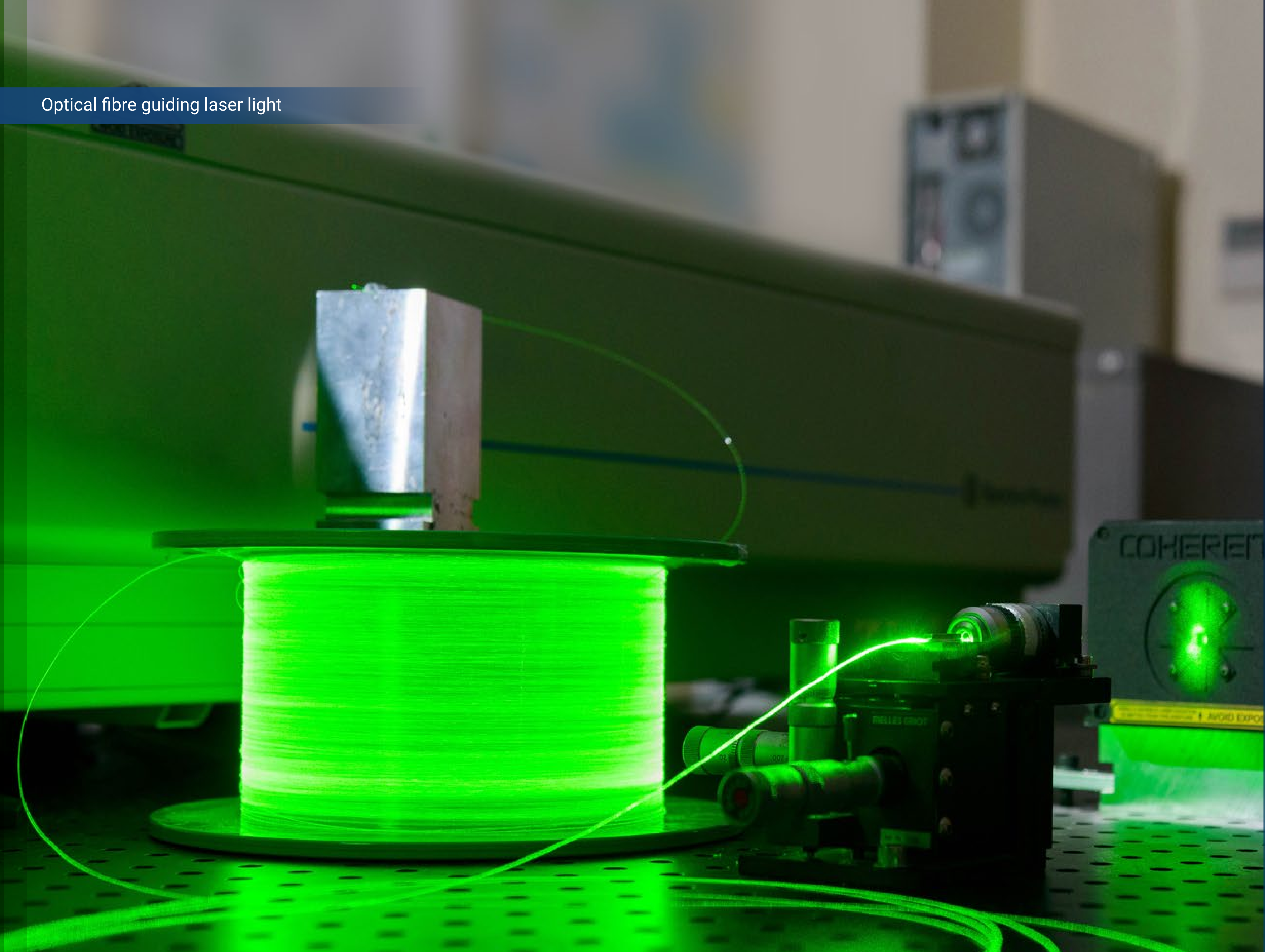

Optical fibre guiding laser light

End-to-end engine health management (E2EEHM)

The E2EEHM project, funded by the ATI and led by Rolls-Royce, is developing, and linking together future equipment health management technologies to create future value for products and services. Cranfield experts are using fibre optic sensors to measure the strain on a Rolls-Royce gas turbine engine fuel pump during high temperature and high pressure testing with aviation fuel. The aim is to demonstrate the sensors' potential to manage the health of the engine and thereby reducing operational disruption and maintenance costs.

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Engineering photonics

Instrumentation and sensors underpin all aspects of engineering and applied science and are an invaluable asset in research, preventative maintenance, measurement and monitoring.

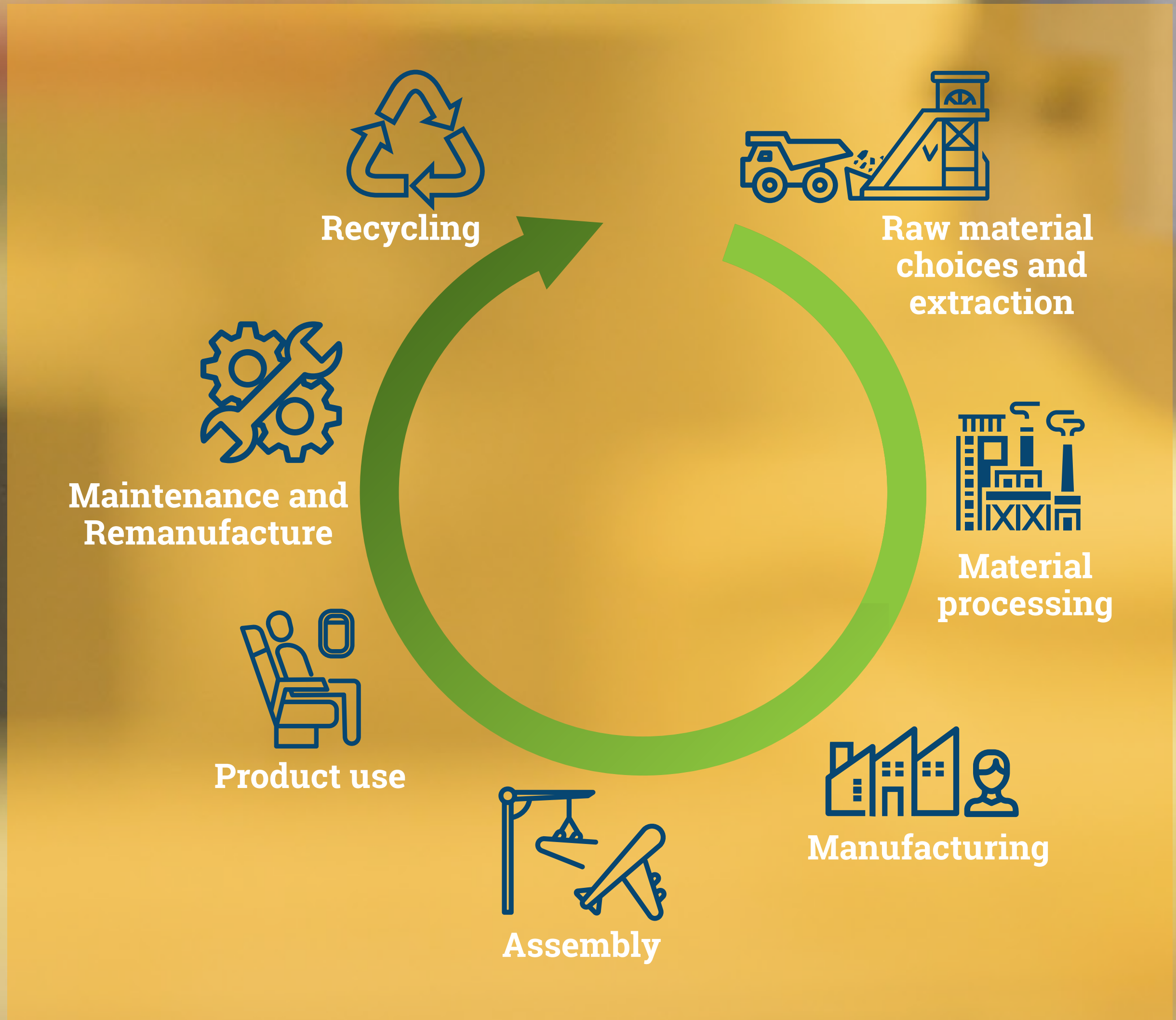
At the Cranfield Centre for Engineering Photonics, we have a long history of developing innovative optical sensors and instrumentation to provide measurement solutions in challenging environments across multiple industry sectors including aerospace, transport, manufacturing, healthcare, agrifood and environment.

The emphasis of our activities lies in the design, development and integration of instrumentation to tackle engineering measurement problems, such as maintenance, repair and inspection. Our portfolio encompasses fibre optic sensors, optical gas sensing, optical flow measurement, optical interferometric non-destructive testing, optical imaging and signal processing.

Monitoring helicopter safety with rotor-mounted optical fibre sensors

The BLADESENSE project has revolutionised health monitoring for rotorcraft by investigating the aeroelastic behaviour of rotor blades and developing state-of-the-art fibre optic sensors. Funded by the Aerospace Technology Institute (ATI) and led by Airbus Helicopters UK, the sensors were mounted along the length of each blade to measure their strain and shape and determine their 'health' and identify changes, sending an alert for further checks, saving costly labour-intensive manual checks and helicopter down-time.

Read more on our website:
www.cranfield.ac.uk/bladesense



Developing sustainable materials from paper manufacturing waste

Cellulose can be found in by-products from the paper manufacturing process. A million tonnes of paper mill sludge waste, currently being recycled for low value applications, such as agricultural land spreading, is produced annually in the UK. However cellulose can be processed into nano-crystalline cellulose (NCC) which has properties comparable to current engineering materials such as carbon fibre and steel. By-products from paper mills in the UK are being analysed to ascertain if they can substitute conventional materials used in applications such as MDF (medium density fibreboard), logistics pallets and hardboards.

We are developing tests at pilot scale to contribute to identifying a new value stream for waste management with environmental benefits for the paper manufacturing industry and reducing dependence on some raw materials.

Circular economy and waste repurposing

A circular economy aims to increasingly decouple production from the consumption of finite resources, and emphasises keeping products and materials at their highest value and utility, at all times. Cranfield's multi-disciplinary approach seeks to help business to be more restorative and regenerative – rather than the 'take, make, dispose' model traditionally followed.

We lead thinking in the circular economy through our research on sustainable design and corporate responsibility. Experts in materials science, energy and power generation and carbon capture, as well as experts in Cranfield's Centre for Competitive Creative Design (C4D) are developing innovative and strategic plans for organisations. These are all aiming to assist in the drive towards net zero. From regulatory policy advice to alternative material choices and full lifecycle analysis, our work is helping business create a more sustainable future.

TransFIRe (Transforming Foundation Industries Research and Innovation hub)

TRANSFIRE
Transforming Foundation Industries Research and Innovation Hub

The foundation industries (cement, ceramics, chemicals, glass, metals and paper) produce 75% of all materials, valued at £52 billion, but accounting for about 10% of the UK total CO2 emissions. TransFIRe is a consortium of more than 75 organisations with expertise across all sectors led by Cranfield. It aims to assist with technology development and transfer, new business developments and new opportunities in materials and technologies to help to achieve the UK Government's net zero 2050 target.

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Materials recovery from waste

Businesses across the globe are making changes to meet net zero targets, including investing in new materials, fuels and carbon capture technologies.

Reducing material losses in product lifecycles and making better use of materials at the end of a product's life is central to achieving net zero. However, this needs careful planning. Managing waste material and prolonging the material lifecycle is a huge part of this.

Waste management is a global problem, and there is a fundamental need for businesses and industries to understand materials degradation and prolonged lifecycle management. Research into developing greener processes and technologies that allow material recovery or diversion from landfill will ultimately improve resource use and reduce environmental pollution. This could generate wealth from recovered trace metals in contaminated land or nutrient, materials, or energy recovery from waste. By transitioning to a more sustainable business model, industries will be on their way to meeting their environmental targets.

Within the Centre for Climate and Environmental Protection, thermal hydrogen production processes, energy from waste, pyrolysis and gasification, as well as landfill mining and materials recovery are in development.

Real-time methods for solid waste characterisation

Cranfield researchers are investigating ways to characterise waste during the waste management process to implement the recovery of valuable material resources whilst reducing contamination levels. By improving efficiencies using process analytical technology tools, such as existing sensor technologies that can measure critical waste characteristics, waste management facilities could provide the data required by existing legislation, potentially aid waste treatment processes and assist stakeholders in decision making.

Treating contaminated land to recover materials

This £2.5 million project, in collaboration with Warwick, Birmingham, Edinburgh and Newcastle universities, addressed the challenge of treating contaminated land to recover materials for future use and economic gain. Known as Cleaning Land for Wealth (CL4W), the project focused on increasing the value of phytoremediation processes (treating environmental problems using plants) as a land remediation technology and developing an engineered bioprocess to produce high-value co-products and renewable energy from plant biomass.

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