

An industry guide to polymer research

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Innovate UK
Knowledge Transfer Network



Contact

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Introduction

This document has been compiled by KTN to give industry an understanding of the areas of polymer research and research bases within the UK. It will be of use as a guide to individuals within organizations wishing to discover particular areas of academic excellence, and of research sectors which are based on polymer technology. These activities may be relevant for innovation projects or engineering needs of the manufacturing industry.

The document presents information about where the significant areas of polymer research currently being undertaken within the UK reside. It has been compiled using data from published university research, the UK Research Councils, Innovate UK and information from independent research organisations. It has been further informed by visits to some of the larger institutions undertaking polymer-related research as well as individual discussions with leading academics and RTO staff.¹

Scope

Polymers range from very hard to very soft materials, and both synthetic and natural polymers play an essential and ubiquitous role in everyday life.

Polymers are studied within the disciplines of biophysics, macromolecular science, polymer science, polymer chemistry and polymer physics. The terms 'polymer', 'plastic', 'elastomer' and 'soft matter' have all been used as criteria for inclusion in this report.

Strictly speaking polymers encompass a huge range of types from synthetic plastics such as polypropylene to natural biopolymers, such as cellulose and DNA. However, this report is limited to polymer research that is essentially non-biological in nature, so research into DNA modification or lipid and animal protein research is excluded. The report includes materials and products resulting from the synthetic linkage of repeating units by covalent chemical bonds, and also natural/biological polymers such as cellulose or starch that are used in products outside of molecular biology.

¹ If you are undertaking or aware of further significant polymer research activity in the UK that is not mentioned here, please get in touch with the author.

Resources and funding

Almost all polymer research in the UK is funded either by companies in their internal research and development departments, or by government (primarily carried out through universities funded by research councils or by direct funds).

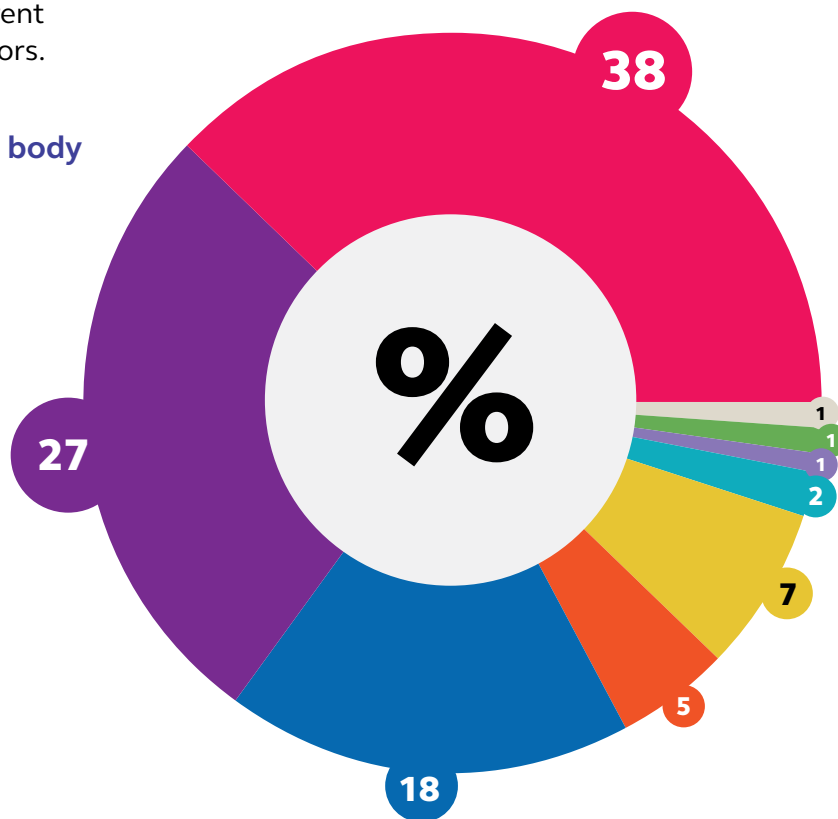
In the case of business, research is often undertaken in collaboration with large academic institutions; as it typically requires specialised and costly equipment that is best situated in a university or Research and Training Organisation (RTO) and used with a number of different projects within different industrial sectors.

Proportion of funding by awarding body

- EPSRC
- INNOVATE UK
- BBRSC
- NERC
- MRC
- STFC
- AHRC
- NC3RS
- ESRC

Funding bodies

In June 2016 the total amount of funding by the UK Research Councils for polymer materials, biophysics and soft matter physics research within the UK was £313.7m. This was split into 408 distinct grants. The proportions spent by each funding body are shown in the pie chart below.



For information on funding body see Appendix 1

The Engineering and Physical Sciences Research Council

The largest research council funder, the Engineering and Physical Sciences Research Council (EPSRC), comprised of 179 separate grants with a combined total of £82.4m. This equates to around 1.8% of the total EPSRC-funded portfolio. EPSRC grants do not need to have an industrial partner and can be purely academic research.

The EPSRC funding total also includes funding for Centres for Doctoral Training (CDTs). The CDTs bring together diverse areas of expertise to train engineers and scientists with the skills, knowledge and confidence to tackle today's evolving issues

and future challenges. They also create new working cultures, build relationships between teams in universities and forge lasting links with industry. The CDTs that undertake a large proportion of polymer activity are all mentioned in this document and are situated at specific universities.

Students are funded for four years and are provided with technical and transferrable skills training. There is also a research element. Many CDTs leverage additional studentships from other sources, such as university funding, EU funding, industrial funding, and private funding. CDTs with significant polymer activities are shown in the table below.

Centre for Doctoral Training	University host/lead	Grant size
Advanced Characterisation of Materials	Imperial College	£6,418,295
Polymers, Soft Matter and Colloids	Sheffield	£4,807,565
Soft Matter and Functional Interfaces	Durham	£4,807,565
Additive Manufacturing and 3D Printing	Nottingham	£4,557,035
Materials for Demanding Environments	Manchester	£4,280,336
Doctoral Training Centre in Science and Application of Plastic Electronic materials	Imperial College QMUL	£4,145,261
Industrial Doctorate Centre in Composites Manufacture	Bristol	£3,926,971
Molecular Modelling and Materials Science	UCL	£3,819,966
Sustainable Materials and Manufacturing	Warwick	£3,358,450
Micro- and NanoMaterials and Technologies	Surrey	£3,193,845

Innovate UK

The second largest funder, Innovate UK, currently funds projects that are industrially focused. They are often collaborative in nature – and therefore in many cases are active in conjunction with the university departments mentioned in this report. The total number of projects awarded

for polymers, plastics and soft materials through collaborative R&D in 2015/16 calls was 105², with a total value of £17.7m, including an Innovate UK contribution of £9m. There were also specific themed calls, which added to the total figure from Innovate UK.



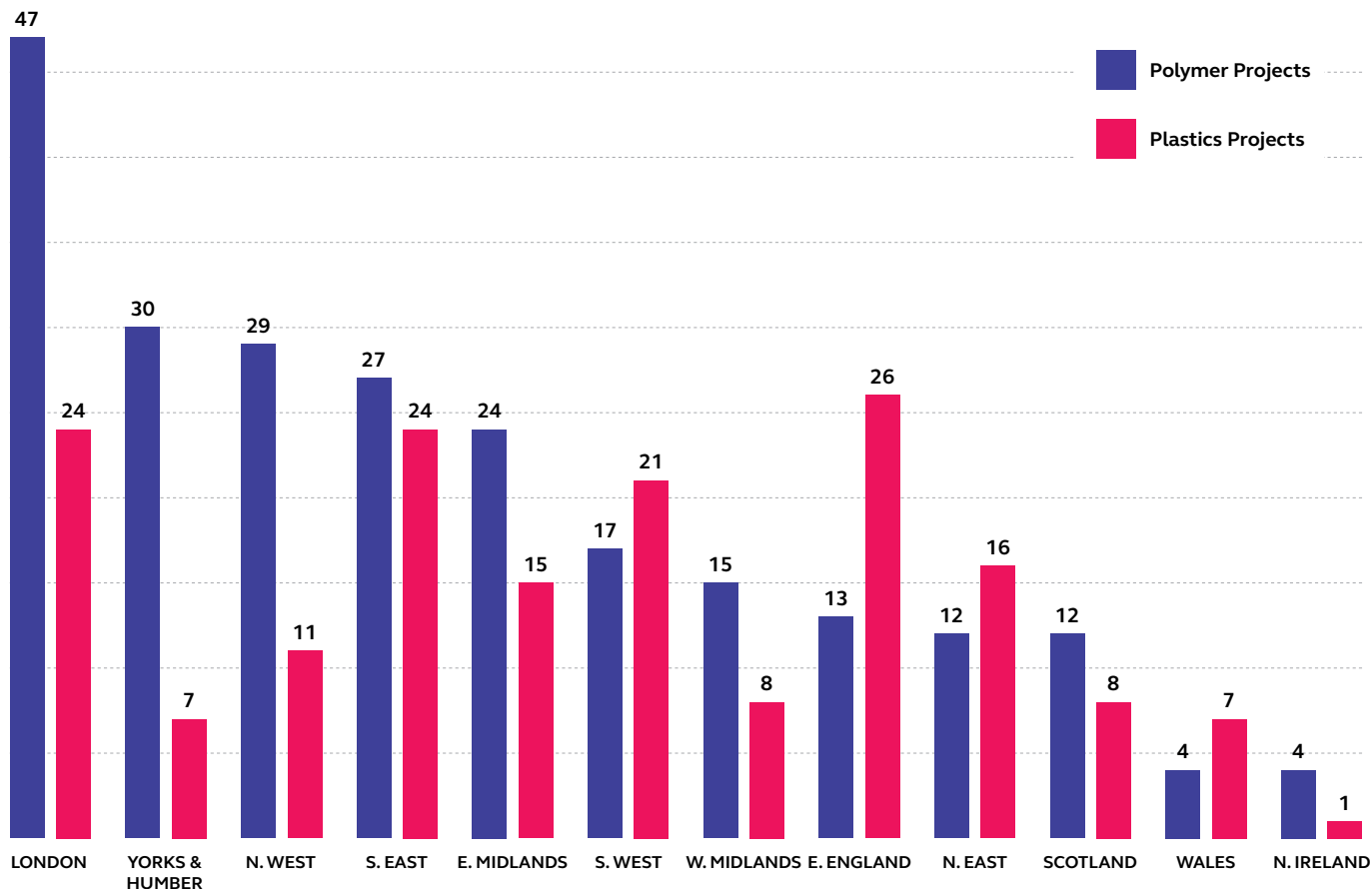
² Some further projects involving polymer research may be active but not visible, due to the descriptors not containing the search term 'polymer', 'plastic' etc., but rather a specific descriptor such as 'PMMA' (polymethyl methacrylate), for example.

Regional variations in polymer research

Using information on specific projects, it is possible to look at regional distributions of research by keyword. The column chart below shows the differences in regional funding by numbers of projects awarded versus research descriptor word.

For example, London, Yorkshire and the North West are weighted towards polymer projects, rather than plastics. This reflects the high number of awards for more fundamental research undertaken by the key universities based at these locations and less on industry. Conversely, the East and North East of England are weighted towards industrially based projects.

Regional variations in 'Polymer' versus 'Plastic' orientated projects





Alphabetical list of institutions

A – Universities

University of Aberdeen

Primary research area: liquid crystals

The duality of properties of liquid crystals has important implications for the applications of such materials; which range from the familiar electro-optic displays to new types of fabrics whose colour changes depending on the mood of the wearer.

Current work at Aberdeen focuses on polymeric liquid crystals, and in particular, side chain liquid crystal polymers (SCLCP). The considerable application potential of SCLCPs in advanced electro-optic technologies, including information storage and non-linear optics, stems from the combination of macromolecular properties (mechanical integrity and ease of processability) with the electro-optic characteristics of low molar mass mesogens. To realise such potential, however, materials with well-defined properties are required.

Research involves:

- The design and synthesis of novel polymers
- Their thermal characterisation
- Micro- and macrostructural investigations.

Principal contact Prof. Corrie Imrie

The Arts University, Bournemouth

Primary polymer research area

The Arts University Bournemouth (AUB) houses the UK's largest collection of polymer artefacts at the Museum of Design in Plastics (MoDiP). MoDiP maintains three distinct collections: the MoDiP collection, consisting of predominantly 20th and 21st century mass-produced artefacts; the Plastics Historical Society collection, which includes examples of the very first man-made plastics; and the Worshipful Company of Horners collection of artefacts made from horn, a natural plastic.

Together, they amount to more than 12,500 artefacts and provide a comprehensive history of the use of natural and synthetic plastics in design. Some research work is being undertaken at AUB to look at the ageing and storage of artefacts within a museum environment.

Principal contact Prof. Susan Lambert

Aston University, Birmingham

Primary polymer research area

The Polymer Processing and Performance Research Unit at Aston undertakes research activities and knowledge transfer in the field of oxidation, stabilisation and modification of polymers and antioxidant chemistry. The unit is well equipped and engages in funded multi-disciplinary collaborative research involving multi-national companies and SMEs, European research institutes and universities. It is aimed at innovation and the application of its research output to industry and real-life problems.

Principal contact Prof. Sahar Al-Malaika

Other research areas

The Polymer and Advanced Materials Research Group is a leading broad-based polymer research group of national and international standing, with expertise in basic and applied multi-disciplinary research into polymers and biomaterials; from novel design and synthesis, to melt processing and the role of specialty additives and antioxidants, through to their performance in service for industrial, biological and medical applications.

The research activities of the group focus on three main areas: design and development of biomaterials, synthesis of polymers, processing, performance and applications of polymer materials.

The group has extensive facilities for polymer synthesis and characterisation, state-of-the-art polymer melt processing, testing and analytical facilities, including extruders and moulding machines; accelerated environmental exposure and ageing devices, and thermal, mechanical, spectroscopic and chromatographic equipment. State-of-the-art facilities are available for the biological and biochemical characterisation of biomaterials performance.

Specific examples of research areas include the development of polymeric matrices for the incorporation of nanoparticles, synthesis of molecular, thermal and optical memories, block co-polymer development for use in organic solar cells and the construction of designer polymer-peptide biomaterials.

Contact Dr Paul Topham

Bangor University

Primary polymer research area

Research in materials chemistry at Bangor concerns the synthesis, functionalisation and engineering of polymeric materials for a variety of applications. A wide range of polymerisation and functionalisation methods are used, including ring opening polymerisation, condensation polymerisation, living controlled free radical polymerisations, such as atom transfer free radical polymerisation (ATRP) and reversible addition-fragmentation chain transfer polymerisation (RAFT), click chemistry and bio-conjugate techniques.

The group has synthesised stimuli responsive hyper-branched polymers as injectable hydrogels materials for tissue engineering and drug delivery. They have also developed photo cross-linkable polymer materials from renewable resources, such as polysaccharides and plant oils. Studies on degradable properties of polymers and polymer blends for packaging applications, like PLA and starch, are also undergoing. Collaborations in these areas include the University of Nottingham (UK), the University of Washington (USA), Utrecht University (The Netherlands) and University College Dublin (Ireland).

Principal contact Dr Hongyun Tai

University of Bath

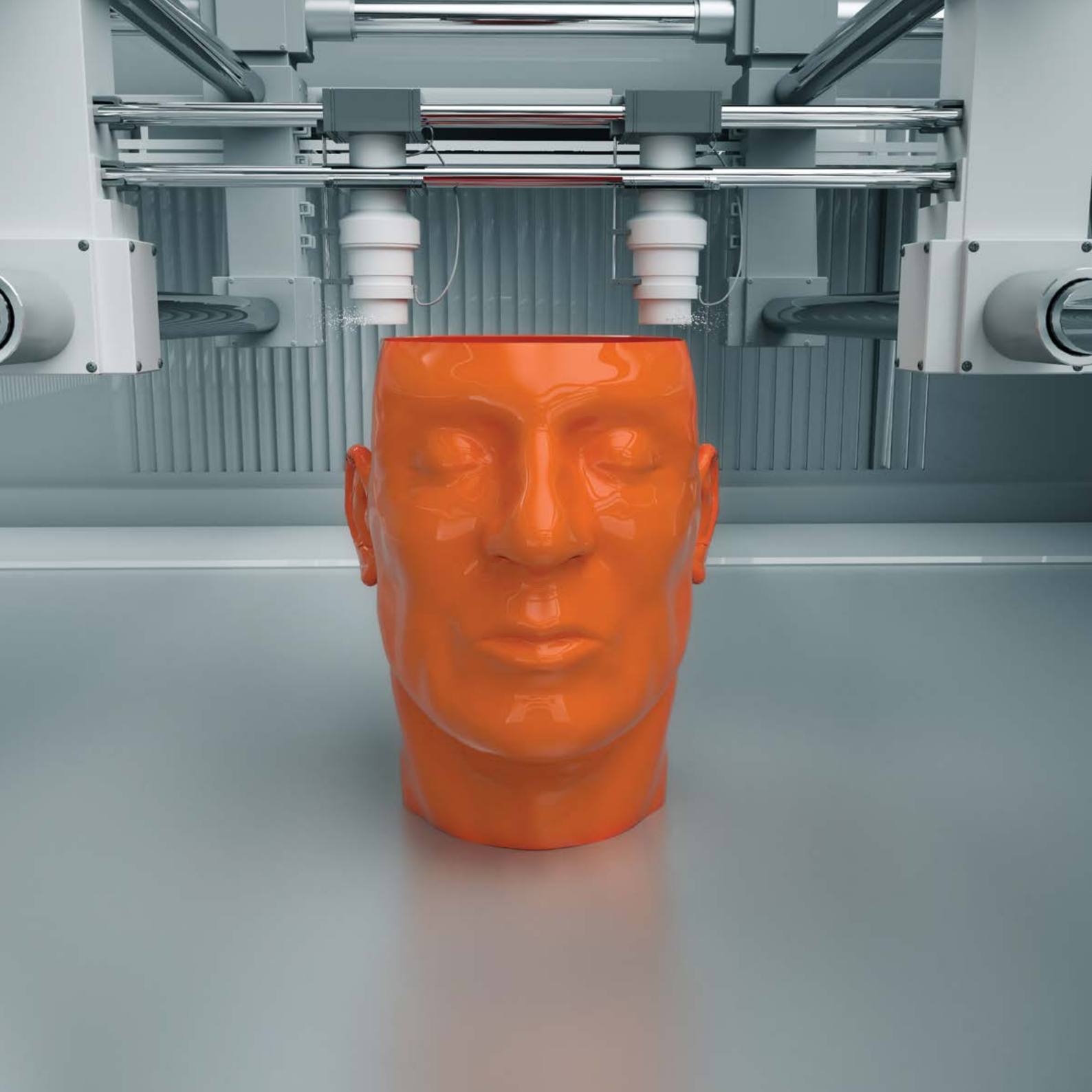
Primary polymer research area

Polymer composites including the repair and strengthening of concrete structures. The use of polymers for impact strengthening and filament winding of polymeric re-inforcement is also key.

The Centre has an international reputation for its work developing the use of fibre re-inforced polymers for the repair and strengthening of existing concrete structures, as well as in new build applications, such as for re-inforcement or permanent formwork.

Work in this field also includes the development of innovative natural fibre composite materials. Materials research specialises in cellulosic materials and polymers. The research includes the creep and fatigue of wood and natural fibre composites, the development of bonded-in technology for joints in timber structures and characterisation of polymers and composites for industrial applications.

Principal contact Dr Martin Ansell,
Associate Professor



University of Birmingham

Primary polymer research area

The Polymer Engineering Research Group carries out research in polymer foam microstructure and micromechanics, impact testing of foams and foam products, crash helmet design, foams used in sports and Finite Element Analysis of foam deformation.

Principal contact Prof. Gerard Fernando

University of Bolton

Primary polymer research area

The Institute for Materials Research and Innovation (IMRI) is a multi-disciplinary centre designed to cultivate research and innovation activities in collaboration with industry and other academic institutions.

The institute leads the UK and is internationally known for its strong applied materials science and engineering applications through the development of new, designer and novel smart and multi-functional materials (fibres, fabrics, films, foams and particles) at nano and micro levels, as well as associated processing technologies that strive to contribute to futuristic solutions and new horizons within the global marketplace.

Principal contact Prof. Elias Soires

University of Bradford

Primary polymer research area

Advanced Materials Engineering research at Bradford is at the forefront of many of the new material development technologies, such as electronic polymers, biomaterials, advanced ceramics, nanocomposites and 'smart' materials.

There is strong research delivery, and extensive collaboration with industry, resulting in many high-quality journal publications, international conference presentations, and research student completions.

The research strengths arise from the combined expertise of world-class advanced material engineering research centres: the UK Polymer Interdisciplinary Research Centre (IRC) based across the universities of Leeds, Bradford, Durham and Sheffield, and the Coating Science and Technology Research Centre. The area leads on two of the research and knowledge transfer centres: Advanced Materials Engineering and Polymer Micro and Nano Technology.

A recent highlight of the university's activity is the UK government-funded Science Bridges China Programme, in which leading Bradford researchers work with leading researchers in China.

The Centre for Polymer Micro and Nano Technology

Recent advances in micro and nano-technology are realising devices with a huge range of applications in the telecommunications, medical, and automotive sectors. This demand has led to the emergence of micro-injection moulding (micromoulding) as an optimum technique for micro-component manufacture that offers all the benefits of conventional injection moulding such as high production capacity at low marginal cost.

Polymer MNT gives access to the equipment and expertise that companies of all sizes need to develop a successful micro-moulding or nano-scale surface feature moulding process.

Polymer MNT is a partner within the Nanofactory consortium, currently supported by £2,511,835 of investment from the European Regional Development Fund (ERDF). Nanofactory helps accelerate innovation and create commercial opportunities in micro and nano technologies by leveraging the groundbreaking work offered by six research-intensive universities in the Yorkshire and Humber region.

Principal contact Prof. Phil Coates

University of Bristol

Primary polymer research area

EPSRC Centre for Doctoral Training in Advanced Composites for Innovation and Science

The EPSRC Centre is embedded within the Advanced Composites Centre for Innovation and Science at the University of Bristol. Its vision is to develop the next generation of technical leaders in advanced composite materials and their structures by stimulating adventurous interdisciplinary research, which bridges the length scales, connects to and interfaces between the disciplines of engineering, chemistry, physics and life sciences, and bestows enhanced and added functionality to composite materials.

The centre's integrated four-year PhD programme incorporates an innovative taught component followed by two parallel PhD streams: applied projects undertaken in collaboration with industrial partners and blue-skies projects that seek fundamental solutions in composites technologies.

The scope of the centre is the manufacture of high-performance engineering structures from polymer matrix composites that use state-of-the-art fibres as re-reinforcement. This encompasses design for manufacture and those novel aspects of materials and processes that relate directly to the development and evaluation of flexible next-generation composites manufacturing processes, based on low cost, short cycle times, efficiency and sustainability.

The applied research projects undertaken by the research engineers in the IDC in Composites Manufacture are industrially defined and positioned in the Technology Readiness Level 3-5 range of R&D activity. They have a natural synergy with curiosity-driven projects undertaken by PhD students within the EPSRC Centre for Innovative Manufacturing in Composites (CIMComp).

Principal contact Dr Ian Hamerton



Brunel University

Primary polymer research area

Polymer processing and biopolymers research aims to improve manufactured polymers by understanding and controlling composition and structure. The Wolfson Centre for Materials Processing, Institute of Materials and Manufacturing brings together expertise in the field of polymer processing with a wide range of industrial techniques, including unique mixing and injection moulding techniques developed here.

Current and recent projects include research into fire retardant textiles, biodegradable packaging and the formulation of biofuels. Work on moulding and extrusion processes has generated a significant portfolio of patents and intellectual property rights, which is reflected in a number of commercial licenses and spinout ventures.

Principal contact Prof. Karnik Tarverdi

Other research

The Wolfson Centre for Materials Processing

The Centre is a Specialist Research Institute that focuses on materials science. Established in 1987 by Professor Mike Bevis with the help of a generous grant from the Wolfson Foundation, the centre has grown to become a distinguished international centre of excellence for materials technology, attracting over £7.5 million in funding under the current Director, Professor Jack Silver, since his arrival in 2006.

Current areas of research include nanomaterials, nanophosphors and nanostructured carbon, biofuels, polymer extrusion and biodegradable food packaging.

The Wolfson Centre has a wide range of techniques available, including scanning electron microscopy, raman spectroscopy, thermogravimetric analysis, differential scanning calorimetry and nano-indentation.

Principal contact Dr Peter Allen

University of Cambridge

Primary polymer research area

The Melville Laboratory for Polymer Synthesis provides the leading role in innovative polymer synthesis in Cambridge University. The Melville labs are based within the Department of Chemistry, with new state-of-the-art facilities that opened in November 2002. The Melville is now home to two research groups, with over 45 post-graduate and post-doctoral researchers.

The Melville Laboratory Group Leaders teach introductory and advanced polymer chemistry courses in the Chemistry Department. These include courses for Part II, Part III, MPhil and PhD students. Within the research facilities, students work on projects for CPGS and PhD. Broader training for all members of the group is provided in the weekly seminars during term time. All PhD students present their work annually in a public lecture

The University of Cambridge has been a centre of excellence for research in the theory and properties of polymeric materials for a considerable time. However, it was recognised that there was a real need to establish a resource in polymer synthesis to manage the design and synthesis of novel polymeric materials, which is vital to a more detailed understanding of polymeric behaviour.

Conjugated polymers

The fabrication and characterisation of polymer light-emitting diodes and solar cells are all areas of current research. This includes:

- Physics of injection, transport, recombination and emission in polymer devices
- Optical properties of organic semiconductor devices
- Optical probing of excited states in conjugated polymers
- Semiconductor nanocrystals: the synthesis of II-VI semiconductor nanocrystals
- Electrical transport in nanocrystalline materials, and
- Charge separation and transport in polymer/nanocrystal composites.

Principal contact Prof. Neil Greenham

Cardiff University

Primary polymer research area

The Advanced Materials and Computational Mechanics Group carries out internationally recognised research into engineering materials and processes that can be applied to improve the economics, efficiency and efficacy of construction materials and the design of safer and more resilient structures. The group also develops real-time and interactive simulation tools for computational steering and surgical simulation using model order reduction algorithms.

Using computer models to understand real world materials – a major emphasis of this group – is the understanding of how the internal microstructure of an engineering material influences its response when applied in the field. Research interests in this area include nanostructured materials and the development of constitutive models of different polymeric, particulate and cement-based composites, quasi-brittle materials such as concrete and ceramics, and foams, from micromechanical principles and experimentation to describe their plastic, fracture, damage and fatigue behaviour.

It also includes analysis of viscoelastic soft dielectric elastomer generators operating in electrical circuits.

Principal contact Prof. Massimiliano Gei

Other relevant research

The Additive Manufacturing Laboratories (AM Labs) at Cardiff facilitate research into intelligent and knowledge-based systems; smart systems; sustainable manufacturing; advanced manufacturing technologies; and micro/nano manufacturing.

The AM Labs produce an average of 40+ parts per day for academic research and industrial R&D using resin-based processes (SLA and DLP), Fused Deposition Modelling (FDM), four plastic powder machines (SLM) and metal powder bed fusion – over 20 years building a mass of expertise.



University of Central Lancashire (UCLan)

Primary polymer research area

UCLan hosts the Centre for Fire and Hazards Science.

As more flammable plastic materials replace traditional materials, such as metal, stone, wood, wool and cotton, so the risk of toxic products in the environment increases. Fortunately, unlike with wood or wool, manufacturing processes allow fire retardants to be added, to reduce a material's flammability. Polymers containing fire retardants may be more difficult to recycle, or may possibly contaminate a batch of recycled material, while effectively fire retarded materials will always be difficult to dispose of by incineration. UCLan has a very wide range of facilities and equipment for quantifying fire behaviour and standard testing which is available for research, consultancy and testing.

Richard Hull is the Professor of Chemistry and Fire Science at the University of Central Lancashire (UCLan). His expertise is in the decomposition and flammability of plastic materials. This has led him to investigate the behaviour and suitability of fire retardants for a range of plastics, and at the causes of fire effluent toxicity, the major cause of death and injury in fires. He is internationally leading in Fire Science, with over 100 publications on fire retardancy and fire toxicity.

Principal contact Prof. Richard Hull

Coventry University

Primary polymer research area

A small amount of work involving polymers is undertaken here principally in composite textiles and fibre reinforcement.

Principal contact Latha Krishnan

Cranfield University

Primary polymer research area

Composites Manufacturing Process Modelling – resin flow simulation, curing of polymers, fabric coverage of surfaces and manufacturing defects. Polymer activities and research interests include:

- Creation of methodology for verification and validation of structural health monitoring technologies
- Development of sensor methods for detecting damage and degradation in metallic and polymer composite structures
- Sensing applications using structurally integrated and embedded components such as fibre-optic smart structures.
- New structural design paradigms based on the ability of structures to ‘self-diagnose’.

Principal contact Prof. Peter Foote

Durham University

Primary polymer research area

EPSRC Centre for Doctoral Training in Soft Matter and Functional Interfaces

Durham University is the lead organization in the EPSRC training centre in the field of soft matter and functional interfaces. Partner organisations are the University of Leeds and Edinburgh, along with 18 industrial partners. The Centre for Doctoral Training covers soft matter, including plastics, paint and foodstuffs. The centre opened in 2014 and provides 16 PhD studentships each year. Companies collaborating include AkzoNobel, Mars, Michelin, Procter & Gamble and Unilever.

Work is undertaken on the molecular rheology of polymers, macromolecular biological physics, Soft Condensed Matter Physics, Biological Physics, and Polymer Molecular Rheology of Entangled Polymer Fluids. The goal is to connect the fundamental physics of entanglement at the molecular level to the emergent viscoelasticity and flow behaviour (rheology) of polymeric fluids. A particular theme has been “long-chain branched” polymers. Since 1999, this research has been framed within the large EPSRC/ Industry Microscale Polymer Processing (MuPP) collaboration.

Principal contact Prof. Tom McLeish

University of Edinburgh

Primary polymer research area

The EaStCHEM Materials Chemistry group is one of the largest materials and macromolecular chemistry groups in the UK. Areas of strength include the design, synthesis and characterisation of functional polymers and macrostructures and strongly correlated electronic materials, battery and fuel cell materials and devices, porous solids, materials at extreme pressures and temperatures, polymer microarray technologies and technique development for materials and nanomaterials analysis.

Principal contact Prof. J Paul Attfield

Edinburgh Napier University

Primary polymer research area

Edinburgh Napier University hosts a Polymer Technology Unit, with full-time and part-time Polymer Engineering programmes accredited by the Institute of Materials, Minerals & Mining (IOM3).

Its focus is Plastics Product Design, Polymer Materials, Polymer Processing, Polymer Characterisation and Testing. It has been also Scotland's National Centre for Polymer Processing for over 40 years, providing education, research and consultancy.

Research encompasses materials selection, injection moulding, moldflow analysis and interpretation of results; compounding, extrusion, blow moulding, thermoforming, rheology, polymer characterisation and testing.

Principal contact Dr Colin Hindle



University of Exeter

Primary polymer research area

The University of Exeter was awarded funding for a Centre for Additive Layer Manufacturing (CALM) from the European Regional Development Fund as a result of its excellent research and development work in the field of additive manufacturing and for its strong links with business, from large multi-nationals to SMEs.

CALM is located in the College of Engineering, Mathematics and Physical Sciences, giving the centre access to a full range of engineering workshop facilities and equipment from other departments.

With unique capabilities and experience in high temperature polymers for laser sintering, the team continues to support businesses across the country within key high value manufacturing sectors, such as the aerospace, medical, defence and automotive industries.

CALM has the only commercially available high temperature laser sintering platform in the UK.

The centre is helping to transform the use of ALM polymers from prototype to production using High Temperature Laser Sintering. This technique can not only be used to build fit and form prototypes, but also to manufacture functional prototypes, such as those developed with Ashwoods Automotive Ltd to manufacture a revolutionary PEEK motor cover for an integrated motor system for hybrid automotive vehicles.

Since its launch, CALM has supported more than 200 companies and has created regional growth of £20 million through its additive layer manufacturing business support. They actively engage in grant-funded research, in addition to supporting companies with contract research.

Principal contact Dr Richard Davies

University of Glasgow

Primary polymer research area

Nanoscience and Materials Chemistry Group

Current research includes: biomaterials and biodegradable polymers, ionic liquids, solid-state NMR of inorganic materials, biosensing, bionanophotonics, microporous solids, conjugated and non-conjugated polymer synthesis and functionalisation, single molecule magnets, photovoltaic materials, liquid crystals and micelles, functional electronic and magnetic materials, sustainable energy and hydrogen storage materials, inorganic nanomaterial synthesis and self-assembly and molecular devices.

Research programmes involve extensive international collaborations with the US, Japan, Korea, India, China, the Middle East and throughout Europe. Research within the grouping is supported by a range of funding organisations, including EPSRC, NSF, the Leverhulme Trust and industry.

Research from this grouping has led to high-profile publications in major international journals, such as Science, Nature Chemistry, Nature Nanotechnology, Advanced Materials, Angewandte Chemie, JACS, Nano Letters, Macromolecules and the Journal of Materials Chemistry.

Principal contact Dr Graeme Cooke

Glasgow Caledonian University (GCU)

Primary polymer research area

Some work is being undertaken on construction materials; in particular, mortars and concrete – which despite their worldwide popularity, suffer from various deteriorative processes.

GCU Reader in Construction Materials and Fellow of the Institute of Concrete Technology Dr Agnieszka Klemm has conducted significant research, and published over 20 journal articles, focusing on the development of materials modified by superabsorbent polymers (SAP).

Principal contact Dr Agnieszka Klemm

Primary polymer research area

Centre for Water Soluble Polymers laboratory

The centre has well-equipped research laboratories. Specialist techniques include:

- Gel Permeation Chromatography and Field Flow Fractionation coupled to Multi-angle Laser Light Scattering to determine the molecular mass distribution of water-soluble polymers
- Differential Scanning Calorimetry to study conformational transitions and the gelation of polymers
- Isothermal titration calorimetry to follow polymer interactions with surfactants
- Controlled stress and controlled strain rheometry for steady shear viscosity and small deformation oscillation measurements
- Capillary break up rheometer (CABER) to measure extensional viscosity
- Electron spin resonance spectroscopy to monitor the configuration of adsorbed polymer molecules
- Photon correlation spectroscopy to determine hydrodynamic volume of polymer molecules and nanoparticles; to measure adsorbed polymer layer thickness
- Doppler Velocimetry for determination of the zeta potential of particles
- Laser diffraction for measuring particle size distributions and flocculation and sedimentation in concentrated emulsions and dispersions
- Matrix-assisted laser desorption/ionisation (MALDI-TOF) for analysis of biomolecules and other macromolecules
- Dynamic surface tensiometry
- Membrane osmometry for determination of the osmotic pressure of aqueous polymer solutions.

Principal contact Prof. Peter Williams



Heriot-Watt University

Primary polymer research area

Research focuses on the development of conjugated microporous polymers (CMPs) for application in heterogeneous photocatalysis. These polymeric materials offer the same advantages of conventional conjugated polymers, with extended p-systems where the electronic levels can be controlled, rendering materials that are semiconducting and have a wealth of applications. Researchers also screen and test the novel CMPs in gas storage and separation and for organic photovoltaics.

Principal contact Dr Filipe Vilela

University of Hull

Primary polymer research area

Research interests at Hull are primarily on polymer polymerisation catalysis, biodegradable polymers and catalysts for biodegradable plastics production. There is also interest in co-ordination chemistry of macrocycles.

Principal contact Prof. Carl Redshaw

Imperial College London

Primary Research Area

EPSRC Centre for Doctoral Training in Plastic Electronic Materials

The EPSRC supported UK Centre for Doctoral Training in Plastic Electronics (PE-CDT) at Imperial College London is run jointly with Oxford University and Queen Mary University of London. The aim is to graduate students with interdisciplinary experience and capability in the science and application of plastic electronic materials and devices, with an understanding of the associated industry and ability to adapt and develop new technologies and applications.

Bringing together over 40 academic staff with an exceptional breadth of physical science and engineering expertise and knowledge, the new centre continues to capture the multi-disciplinary nature of PE – combining formal learning with hands-on training – with much of its content informed from both industrial and academic partners.

Principal contact Prof. James Durrant

Centre for Doctoral Training in the Advanced Characterisation of Materials

A similar EPSRC Centre for Doctoral Training in the Advanced Characterisation of Materials is also run in conjunction with Imperial College London and University College London. Research includes new functional materials for application in energy storage, therapeutics and future manufacturing.

Principal contact Prof. Stephen Skinner

Lancaster University

Primary polymer research area

There are areas of research in the Chemistry and Physics departments that aim to understand polymer Synthesis, Additive Manufacturing/3D laser printing – (from the nano to macro scale), modelling, design, property analysis and Material degradation, (including recovery of materials from waste).

Principal contact Dr Rachel Platel

University of Leeds

Primary polymer research area

Polymer chemistry at Leeds covers the design, synthesis and characterisation of both monomers and macromolecules, in order to generate functional polymers and polymer-containing materials on the basis of targeted applicability and application. Particular interests lie in the following areas:

- Design and development of novel monomers for use in controlled polymerisation reactions to yield highly multifunctional polymers
- Synthesis of biodegradable polymers for biomedical and the more industrial applications
- Synthesis and development of flame retardant, intumescent hydrogel compositions for use in extreme environments
- Polymeric membranes for healthcare applications.

Surface coatings

The research programmes concerning surface coatings (inks, paints, cosmetics, coatings for pharmaceuticals, structural materials and so on) are varied and yet have consistent themes. The themes of research include designed polymer synthesis and conversion, rheological properties, migration phenomena, ageing effects, controlled delivery, appropriate mechanical and dynamic priorities, and end of life strategies (waste handling).

- Study of migration phenomena in/to/from

coatings based on composite formulations as used on metallic containers, plastics and other materials;

- Coatings for use in controlled drug delivery applications and for other biomedical applications;
- Recycling strategies for waste polymeric materials, including coatings.

Colour and Polymer Science

The Department of Colour Science was founded at Leeds in 1879, and joined the School of Chemistry in 2009. The Colour and Polymer Science group carries out globally leading research in applied colour creation and colour application. This is largely achieved through extensive industrially collaborative research activities, aimed at providing novel, science-based solutions for industry.

The focus is on the design, synthesis, evaluation of novel colourants and their applications across important, wide-ranging scientific and technological fields.

Themes of particular interest include:

- Novel photochromic and thermochromic molecules for anti-counterfeit applications;
- Novel dyes for the environmentally friendly colouration of textile fabrics;
- Biological colourants and their applications in photo-medical treatments;
- Functional organic dyes and their use in nano-technological products.

Principal contact Prof. Long Lin

University of Leicester

Primary polymer research area

At Leicester University, teams of inorganic, organic and physical chemists work together. The research into ionic liquids, supercritical fluids and catalysis is of great importance to many industrial processes.

This research group focuses on the production and characterisation of materials and the study and exploitation of interfaces, interpreted in the most general sense.

Materials of interest span the full range, from hard materials and coatings with engineering applications, through polymers, composites and other synthetic soft matter, to nanomaterials and biological systems.

In many instances, these materials are applied to “wet” interfaces, such as electrode surfaces, and in others their natural occurrence is intrinsically interfacial, notably for nanoparticulates and biological cells. Both theoretical and experimental methods are used to study these systems.

Experimental approaches include the use of conventional laboratory-based molecular and macroscopic characterisational tools and large-scale X-ray and neutron facilities.

Principal contact Prof. Karl Ryder

University of Liverpool

Primary polymer research area

Liverpool’s Centre for Materials Discovery (CMD) is engaged in various areas of materials research, with particular focus on energy-related applications, polymers, porous materials, and nanomaterials.

The scientific team based at CMD work closely with the Cooper Group, other academic groups within the Department of Chemistry, and with researchers from external organisations. The scope of research conducted at CMD is broad, but can be grouped into four areas:

- HT method development: the development of new or improved techniques to enhance expertise and capability in the field of HT research.
- New materials discovery: the use of automated synthesis and characterisation to discover wholly new materials with step-changes in performance.
- Material optimisation: “scaling-out” the development of existing products to improve performance, reduce costs or strengthen IP claims.
- Property/behaviour investigation: automated or parallel experimentation to facilitate detailed mechanistic investigations, kinetic studies, reproducibility studies, etc.

Principal contact Prof. Andy Cooper

Queen Mary University of London (QMUL)

Primary polymer research area

Within the Materials Processing Institute at QMUL, the expertise in processing includes methods for novel polymers and composites, hydrothermal processing of carbon materials, electrospinning of nano-fibres, electric field-assisted CVD for catalytic coatings, and spark plasma sintering for nano-structured ceramics.

The Soft Matter Group in the Department of Materials at QMUL has investigated the strength and fatigue life of elastomer components, investigated the friction and abrasion of elastomers, the dynamic behaviour of elastomers, the reinforcing effect of carbon blacks, clays and silica filler in elastomers, the use of nano-structured fillers, fibre-reinforced elastomer systems, dielectric elastomer actuators and smart rubber materials.

Principal contact Prof. James Busfield

With QMUL, there also exists Nanoforce, a group that works on advanced polymers and composites processing, such as:

- Compounding, electrospinning, coating, printing, micro-encapsulation and smart textiles
- Computational modelling: Theoretical and numerical modelling for the dynamic failure of hybrid micro and nano-reinforced materials
- Materials characterisation: Mechanical and chemical testing, thermal analysis, conductivity measurement and spectroscopic analysis.

Loughborough University

Primary polymer research area

Advanced Polymers is the largest and probably broadest research group with the Department of Materials at Loughborough. Research ranges from polymerisation processes through formulation and additive development to include novel manufacturing techniques, recycling technologies and evaluation of structural features on micro- and nano-scale.

The primary research interests of the group are:

- New polymerisation processes and techniques
- Polymers in fuel cell applications
- Incorporation of nano-fillers and preparation of nanocomposites
- Additive manufacturing with polymeric materials
- Biodegradable polymers, polymer weathering and degradation
- Recycling of polymers and use of recycled materials in polymer compounds for industrial applications
- Surface polymerisation and thin films
- Rubber and elastomer formulation and processing
- Interfacial adhesion enhancement and adhesion failure
- Polymer rheology and processing; simulation and process optimisation

Principal contact Prof. Marianne Gilbert

Primary polymer research area

Polymer research in the School of Materials at Manchester has a long and esteemed history. Presently, 16 academic staff have polymer-related research interests and these cover a diverse range of polymer materials and research topics.

The focus is on fundamental studies of structure-property relationships for polymer materials of current and future importance, including controlled synthesis and processing, and effects of detailed chemical structure and nano-, meso- and macro-scale morphology on biological, chemical and physical properties.

Many polymer research projects span several of these themes and topics:

- Biopolymers
- Coatings and Films
- Composites
- Deformation Micromechanics
- Fibres
- Multiphase Polymers
- Polymer Colloids
- Polymerisation
- Polymer Processing
- Responsive Polymers

Polymer research is supported by a full suite of modern facilities that include:

- Several polymer synthesis laboratories
- Gas-liquid and liquid-liquid chromatography for analysis of precursor materials and other small molecules
- Gel permeation chromatography, viscometry, vapour pressure osmometry, light scattering, UV-visible spectroscopy, infrared spectroscopy, Raman spectroscopy and X-ray diffraction for monitoring polymerisations and determination of molecular properties and structure, with access to nuclear magnetic resonance and mass spectroscopy facilities in the School of Chemistry
- Differential scanning calorimetry (DSC), micro-DSC, dynamic mechanical analysis and thermogravimetry for thermal characterisation
- Photon correlation spectroscopy, disc centrifugation and electrosonic electrophoresis for particle characterisation
- Several optical, transmission electron and scanning electron microscopes for morphological characterisation
- Infrared and Raman microscopes for spectroscopic investigation of surfaces, fibres and molecular deformation

- Rheometers for rheological characterisation of polymer solutions, dispersions and melts
- Injection moulding, extrusion, mixing, resin transfer moulding and rapid, reactive processing facilities for processing of polymers and composites
- A wide range of mechanical testing equipment for determination of mechanical and failure

Principal contact Prof. Robert Young

Other relevant research

EPSRC Centre for Doctoral Training in Materials for Demanding Environments

The CDT in Materials for Demanding Environments works with industrial partners in the oil and gas, aerospace and nuclear power sectors, among others. The drive is to meet the need for materials that can work in ever more demanding environments.

Manchester Metropolitan University

Primary polymer research area

The Engineering and Materials Research Centre at Manchester forms an important part of the Faculty of Science and Engineering at Manchester Metropolitan University. It is recently formed from research active staff to co-ordinate the considerable breadth of general engineering research at the university.

The expertise within the centre encompasses subjects as diverse as communication systems, radar and security screening, computational modelling, rail and vehicle technology, surface coatings, electrochemistry, bio-engineering, condition monitoring, industrial computer vision and sustainable (green) power generation and smart grids.

Principal contact Dr Stuart Harmer



University of Nottingham

Primary polymer research area

EPSRC Centre for Doctoral Training in Additive Manufacturing and 3D Printing

The EPSRC Centre for Doctoral Training in Additive Manufacturing and 3D Printing is led by the University of Nottingham in partnership with Loughborough, Liverpool and Newcastle Universities. This CDT delivers a leading training environment in the multi-disciplinary field of Additive Manufacturing and 3D Printing.

Additive Manufacturing has been identified as an industrially relevant and strategically important manufacturing technology for the UK and this CDT coalesces expertise at the UK's primary research-led institutes investigating AM to deliver the talented and multi-faceted engineers and scientists required to keep the UK at the forefront of Additive Manufacturing.

Principal contact Dr Chris Tuck

Northumbria University

Work at Northumbria University is towards the development of advanced materials (ceramics, polymers, metals and composites) and nanomaterials (including fullerenes and graphene) for aerospace, petroleum, industrial, defence and bio sectors.

Principal contact Dr Inam Fawad

University of Oxford

Primary polymer research area

Research is undertaken on a range of polymer and polymer composite materials. Particular areas of interest include polymer surfaces and interfaces, nanocomposites, thin film deposition onto polymers, including vacuum roll-to-roll deposition, thin film flexible electronics and photovoltaic materials.

Polymer Processing: the Oxford web coater is able to deposit a wide variety of thin coatings (polymers, aluminium, other sputter-deposited layers such as oxides or metals) on a variety of substrates. Typically PET, PE or PP might be used, but other polymers are possible as well as paper, textiles, etc.

The Polymers Group at Oxford

Principal contact Prof. Hazel E Assender

University of Portsmouth

Primary polymers research area

Advanced Polymer and Composites (APC) Research Group

The Advanced Polymer and Composites (APC) Research Group led by Dr Zhong Yi Zhang is affiliated to the School of Engineering at the University of Portsmouth. The APC Research Group undertakes a variety of research and development activities, including analysis, formulation, characterisation, manufacturing, design, modelling, rapid prototyping, testing, repair, structural integrity evaluation, applications and technology transfer of thermoplastics, thermosets, coatings, elastomers, adhesives, polymeric composites and nanocomposites.

Principal contact Dr Zhong Yi Zhang

Queen's University Belfast

Primary polymer research area

Polymer Processing Research Centre

Research in various aspects of polymers, including their processing, has been carried out in the School of Mechanical and Aerospace Engineering at Queen's for over 25 years. During this time, substantial investment has been made in establishing and maintaining state-of-the-art processing and analytical facilities.

Building on the long-established processing expertise at QUB in rotational moulding and polymer extrusion and extending into injection moulding, blow moulding and thermoforming.

The Polymer Processing Research Centre (PPRC) was established in 1996 to conduct and support leading edge, industrially exploitable, fundamental and applied R&D to demonstrably improve industrial competitiveness. In 2002, there followed the establishment of the Medical Polymers Research Institute (MPRI) forum for collaborative work in the field of new polymeric materials, products and processes for the medical devices and drug delivery industries.

In addition to undertaking industrially relevant research and development into new polymeric materials and processes, the centre has a central supporting role to much of the more strategic and longer-term polymer research undertaken in the Advanced Materials and Processing Research Cluster at Queen's University.

Principal contact Dr Peter Martin

University of Sheffield

Primary polymer research area

EPSRC Centre for Doctoral Training in Polymers, Soft Matter and Colloids

Polymer science and engineering has been identified as a UK priority area with a projected major skills shortage in the future. As part of a national competition, EPSRC agreed to fund a £7.0 M Centre for Doctoral Training (CDT) at the University of Sheffield in November 2013.

This new single-site CDT draws upon the 48 academic members of the Polymer Centre as PhD supervisors. The CDT is supported by a wide range of industrial companies, who part-fund research projects, provide efficient routes for technology transfer and offer advice regarding our strategic direction.

Five cohorts of 10 PhD students per annum are planned over the next five years. The CDT brings together the brightest postgraduate scientists/engineers, academic staff and various industrial partners in a unique research environment. Our aim is to tackle the challenging technical problems currently facing industry and our wider society.

Research is undertaken on polymer synthesis, macromolecular self-assembly, conducting polymers, characterisation of materials using advanced methods, morphology, advanced manufacturing (including 3D printing), polymer processing, materials science, surfaces and thin films, computational modelling, (nano) composites, tribology, polymers in sports and mechanical engineering applications, such as lubrication.

Biomaterials and healthcare – for example, tissue engineering, biocompatible polymers, biologically-derived materials, polymers for healthcare, dental materials and facial prosthetics, are also areas of research at Sheffield.

Principal contact Prof. Steve Armes

Sheffield Hallam University

Primary polymer research area

Research encompasses petroleum-derived and bio-based polymers, minerals and composites. Techniques such as vibrational spectroscopy and thermoanalytical methods are used to characterise the innovative materials under investigation. There is significant knowledge and expertise in auxetic materials include those polymeric based.

The interests of the Polymers, Composites and Spectroscopy Group (PCAS) encompass polymers, minerals and composites. Representative research areas include:

- Fire retardant and barrier properties of clay polymer nanocomposites
- Transport mechanisms in polymeric and composite systems
- Thermal and biodegradation of polymers and composites
- Crystallisation and deformation behaviour of polymers
- Gelation mechanisms of polymers

Principal contact Prof. Andy Alderson

University of Surrey, Guildford

Primary polymer research area

The Polymer Research Centre at the University of Surrey undertakes:

- Plasma processing structure property relationships
- Life cycle analysis
- Polymer ageing
- Electrostatic force microscopy
- Polymer modelling
- Flame retardants

Surrey also has a Centre for Doctoral Training in Micro-and Nano Materials and Technologies (MiNMaT) at the University of Surrey specialises in solving academically challenging and industrially relevant problems in materials science and engineering, through understanding processing–microstructure–property relationships.

Principal contact Dr Constantina Lekakou

Swansea University

Primary polymer research area

EPSRC Centre for Doctoral Training in Industrial Functional Coatings

Swansea Sustainable Product Engineering Centre for Innovative Functional Industrial Coatings (SPECIFIC) provides 40 research engineers with training and research focused on developing and up-scaling industrial functional coatings for energy generation, storage and release, creating buildings as power stations.

The CDT is supported by numerous multinational industries, including BASF, NSG Pilkington and Tata Steel, to help realise the aim of revolutionising energy capture and use by functionalising the building envelope.

Principal contact Prof. Dave Worsley



University College London (UCL)

Primary polymer research area

At the Institute of Materials Discovery, in collaboration with the University of Manchester, UCL are striving to design nano-filled polymer coatings that can endure high-stress voltages for extended periods of time. The current research focus is to precisely control their structure and composition through their polymer matrix and the filler particles.

We have managed to improve the time to breakdown and to slow down growth of electrical trees inside polymer coatings exposed to high-stress voltages through careful control of structure and composition using novel non-vacuum processing method.

Current research focuses on the phenomena at the polymer interface that results in slower electrical tree formation and lateral expansion of the trees and that induces breakdown around the coatings rather than through them, all of which show improved resistance to high-voltage stress breakdown.

Principal contact Prof. Kwang-Leong Choy

Other relevant research

EPSRC Centre for Doctoral Training in Molecular Modelling and Materials Science

The CDT provides a comprehensive training and research programme in functional materials with practical applications in sustainable energy, catalysis, healthcare and smart nano-technology.

The design and manufacture of nano-filled polymers for dielectric applications has been recently pursued towards the production of electrical insulating coatings with high capacity for thermal dissipation.

Principal contact Prof. Ivan Parkin

University of Warwick, Coventry

Primary polymer research area

Warwick University is a global centre of excellence for polymer chemistry. Eight core research groups drive the research activities and Warwick is at the international forefront of science, with wide industry support.

The state-of-the-art scientific infrastructure, involvement of over 100 researchers, an excellent MSc programme, and extensive polymer and colloid education in the Warwick Chemistry Undergraduate programme make Warwick University one of the most active places in the world for Polymer Chemistry.

Warwick also hosts a 'Polymer Club' consortium, which links Warwick Polymer Chemistry to global industries with an interest in polymer science. Members benefit from the scientific infrastructure and expertise at Warwick Polymer Club network conferences, access to education, the opportunity to advise on and direct new collaborative research and outputs, and access to future employees specialised in polymer and colloid chemistry.

Warwick is also the location of the National Polymer Processing Centre, where research is built upon four foundational principles for materials processing:

- Innovating the manufacturing process – including scale up of materials and processes
- Adding functionality to materials and components
- Full integration into structure – maximising multi-functionality for high-value manufacturing
- Sustainability and holistic environmental design, including end of life

Principal contact Prof. Tony McNally



University of Wolverhampton

Primary polymer research area

Research involves involves structural studies of biocompatible copolymers and blends of controlled biodegradability containing synthetic analogues of natural polyhydroxyalkanoates and copolymerisation reactions to novel polymeric materials with “made-to-order” structure and properties, with a variety of catalysts, including metal-free anionic initiators.

Principal contact Marek Kowalczyk

University of York

Primary polymer research area

The materials chemistry group are primarily interested in molecular material based upon liquid crystals. There are active industrial research contacts with more than 10 companies.

Major themes include chirality, device materials, super- and supra-molecular liquid crystals, polymers and dendrimers, data storage materials, liquid crystal nanoparticles, lyotropics, bent-core mesogens and metallomesogens, biaxial nematics, device demanufacture, electroluminescent materials, gel materials as phantoms for the X-ray treatment of tumours, and biomaterials.

Principal contact Duncan Bruce

Research and training organisations

Whilst the institutions listed here are not funded directly by government or the Research Councils, they are collaborators in UK polymer research projects currently being undertaken in the UK; offering significant polymer and elastomer knowledge and expertise available to both industry and academics alike.



ARTIS - Rubber Independent Rubber Consultants

Primary polymer research area

ARTIS is an independent material consultancy specialising in the testing, analysis, development and recycling of rubber and elastomeric materials. While its expertise is in the rubber industry, having formed from the Research and Development department of Avon Rubber Plc, it also has the ability to test and develop a range of other materials

Launched as an independent testing laboratory in 2007, ARTIS has a wide selection of equipment to enable an extensive range of rubber testing and analysis to be carried out. A comprehensive knowledge of a range of rubber materials also enables the development of compounds for specific applications.

It is involved with numerous SME and academic institutions and is a recipient of both private and public funding for polymer research.

Principal contact Martyn Bennett



Smithers RAPRA

Primary polymer research area

Smithers Rapra offers a very wide range of capabilities in the Polymer Research field and is recognised as a specialist in:

- Materials selection and application support
- Product design and development
- Manufacturing process assessment and development
- Prototyping and small scale/specialist production
- Engineering and tooling
- Fault and failure diagnosis
- Material, product testing and analysis

Principal contact Michael Lock

The Tun Abdul Razak Research Centre (TARRC) – Hertfordshire

The Industry Development & Engineering Products Division is a centre of excellence for the development and design of rubber engineering components, ranging from small automotive mounts and bushes to anti-seismic devices and large marine fenders. Engineers are not only experts in the principles of design of elastomeric engineering components, but also in general engineering functions such as shock, noise and vibration control.

It encompasses the Advanced Materials and Product Development Unit, headed by Paul Brown, the Materials Characterisation Unit, headed by Paul Gugan, and the Biotechnology Unit, headed by Dr Maria Kolesnikova-Allen.

The division is at the forefront of the development of new polymer materials with enhanced properties. One particularly successful area of R&D work is concerned with the development of a range of TPVs based on different elastomers. More recent developments include work on developing rubber nanocomposite materials containing organoclays.

Principal contact Dr Stuart Cook

Appendix 1 - Abbreviations and Acronyms

AHRC – Arts and Humanities Research Council



ESRC – Economic and Social Research Council



BBSRC – Biology and Biological Sciences Research Council



Innovate UK – the UK's leading funding body for industry

Innovate UK

EPSRC – Engineering and Physical Sciences Research Council



MRC – Medical Research Council



NC3RS – National Centre for the Replacement,
Refinement & Reduction of Animals in Research



NERC – Natural Environment Research Council



STFC – Science and Technology Facilities Council



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