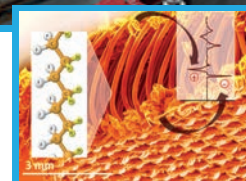
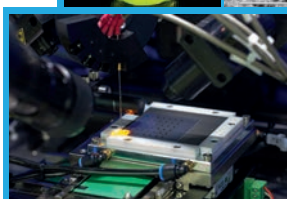
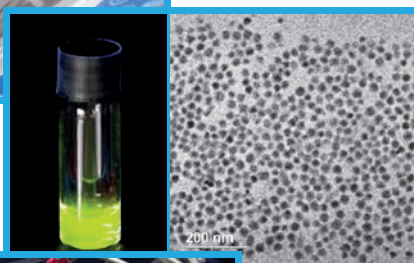
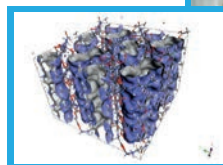
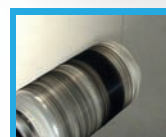
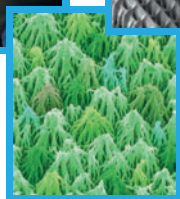
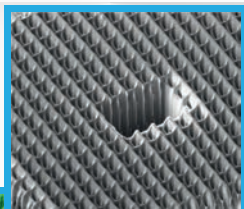
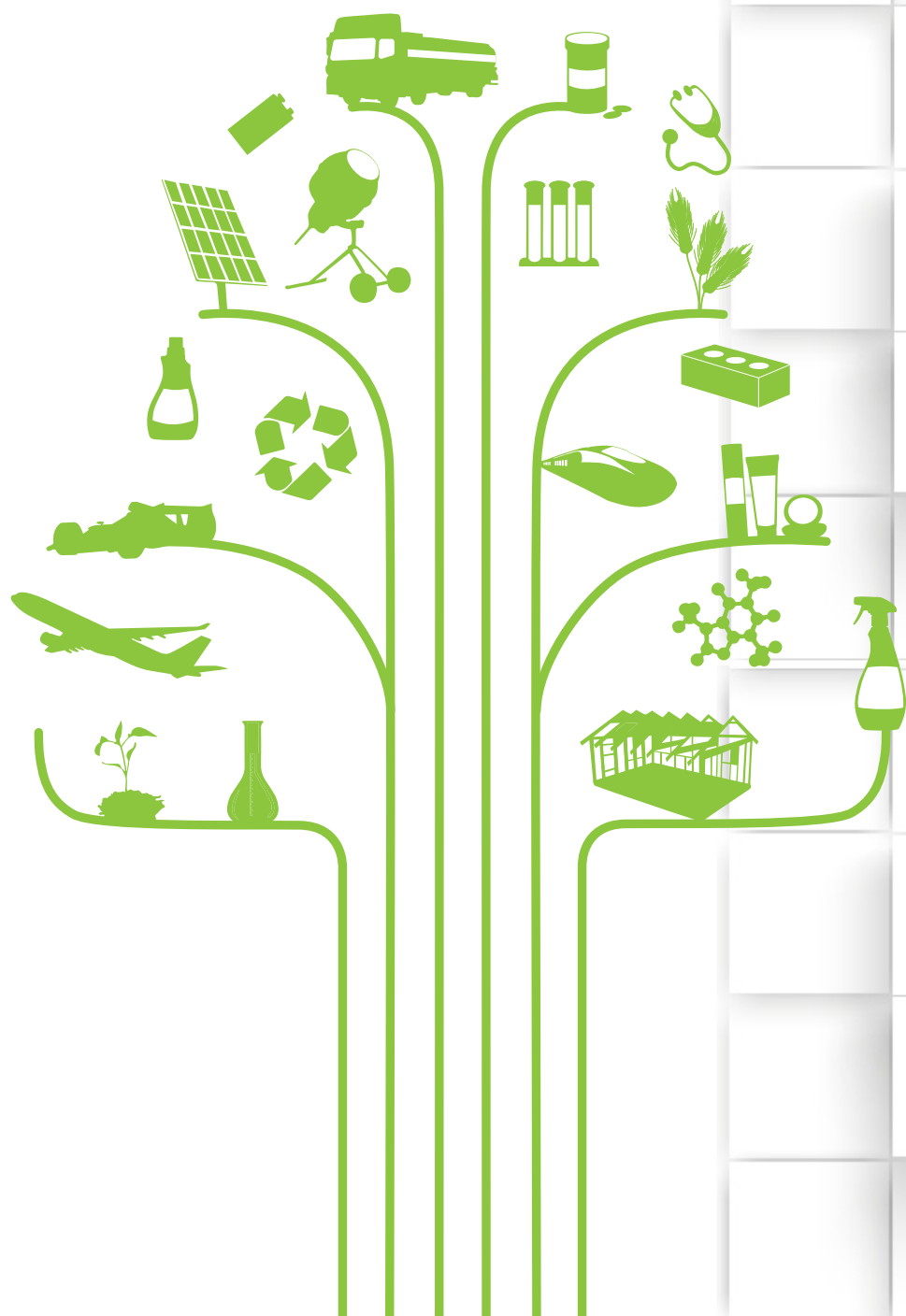


KNOWLEDGE CENTRE
MATERIALS CHEMISTRY
Annual Report 2015





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Materials Chemistry SIG

Connecting industry with the research base...

"The need to connect industry with the research base remains as strong as ever — and the value of the Knowledge Centre for Materials Chemistry (KCMC) as a business unit of the Knowledge Transfer Network (KTN) remains obvious.

KCMC helps innovative companies access and leverage knowledge within UK universities. It plays a key role in helping them develop by providing a link to expertise and specialist information that may otherwise be inaccessible. As part of KTN, KCMC contributes to and benefits from a huge network covering many sectors, ranging from nanotechnology to the creative industries. Together, they look for new applications for developing technologies and help the right ideas reach their potential. However, this is not to be understood as a 'tech push' approach. KTN's network and scoping activities give a unique oversight of the needs and challenges of many different

industries. KTN and KCMC look to create the best possible collaborations to help meet these business needs.

KCMC's innovative model, which enables and fosters collaborations between the research base and industry, continues to deliver fresh approaches and products to the marketplace. It supports numerous cross-sector and business-to-business collaborations. Focussing on materials chemistry, KCMC is an excellent example of how just one unit within KTN can boost growth across multiple sectors by nurturing cross-cutting technologies.

KTN will soon be announcing the results of its business survey and I am confident that these will demonstrate its value to businesses and the UK economy. KCMC is a key part of helping KTN deliver in its mission to advance innovation in the UK and contribute to economic growth."



Chris Warkup
Chief Executive, Knowledge Transfer Network (KTN)

Supporting delivery of a high-productivity UK economy...

Universities are a key part of a knowledge-based, high-productivity UK economy. University collaborations with business have a vital role in delivering this vision through providing business with new processes and technologies, highly skilled people and access to world-leading expertise. The Knowledge Centre for Materials Chemistry (KCMC), now in its sixth year of service to the UK innovation community, represents one proven approach to achieving this impact.

KCMC drives the development of new materials to meet the future needs of manufacturing industry. This is an inherently interdisciplinary activity, where materials chemistry research plays a leading role in the design and development of new products for business competitive advantage. The Chemistry Growth Partnership laid out the business challenge in its 2013 strategy. The KCMC mission is to help realise the multi-billion-pound opportunities identified in the strategy through accelerated innovation with our partners in the chemistry-using industries.

The KCMC is expanding its capabilities which will help both to address gaps and to open up new fields of innovation for new materials design and development. Investments at KCMC partners include the Materials Innovation Factory at the University of Liverpool, expansion of High Performance Computing capabilities in the Hartree Centre at STFC, and the recently announced Henry Royce centre for advanced

materials research led by the University of Manchester.

In addition to these major investments at the current KCMC research partners, in 2014-2015 we have seen step-growth in KCMC's capability with the accession of the University of Bristol to the partnership, bringing a new breadth of capability and geographic reach to the partnership. This report is our first opportunity to highlight some of the collaboration opportunities this will bring.

In line with its national remit to support innovation, KCMC has held workshops and worked with strategic partners on materials chemistry needs for the energy sector, and also to support growth of the UK composites industry.

In parallel with this, in mid-2014 the KCMC made the transition to the Knowledge Transfer Network, the UK's national innovation network established by Innovate UK and providing connectivity for innovators across all UK industry sectors. Multiple project areas have already benefited from this wider engagement, including developments in sensor technologies, energy materials for the automotive industry, and composites.

KCMC's proven business model emphasises the focus on meeting industry needs through close working with industry partners both through the KCMC Industry Steering Group and individual company engagements. Significant new industry project collaborations

have been delivered in fuel cells, advanced coatings, and novel chemical processing. The growth of investment in industry projects on application of high-performance computational modelling techniques is striking and reflects an industry-wide trend to atomistic, 'bottom-up' material design.

The KCMC Governing Board will continue to press for further expansion of the KCMC to help further the innovation goals of key stakeholders in both industry and Government. The Governing Board is confident that the KCMC will continue to help develop and provide the necessary environment in which academia and industry together contribute to the growth of a high-productivity knowledge-based UK economy.



Colin Bailey
Chair of KCMC Governing Board. Deputy President and Deputy Vice Chancellor, University of Manchester.



Executive summary

Materials chemistry is a vital enabler of the new advanced materials required for sustainable solutions for society and industry, especially in energy, health and transport.

KCMC uniquely connects and networks academia and industry, facilitating collaborative R&D that can help companies to deliver accelerated innovation-to-market timescales.

Key highlights of KCMC achievements in the year to 31 March 2015 include:

Cumulative six-year industry cash income is **£7.2m**. This is the first full year following completion of the original 5-year business plan.

2014-15 saw **42 first-time company introductions** to the five university partners – of which 26% were SMEs.

Continued expansion in capability to include the University of Bristol Chemistry Department as a full partner in the next financial year.

55% of industry projects are **repeat business** - 84 companies have benefitted from multiple interactions with the KCMC research partners.

Increasing focus on **'advanced materials'** continues including composites, graphene and materials for energy, all applied to industry sectors where materials chemistry is important to deliver industry growth strategies.

At the end of its sixth full year, KCMC has delivered projects to the value of **£19.4m** – **150% above the original government investment** - and the pace of new industry engagement remains at similar levels to prior years.

500 companies have engaged with KCMC since start-up in 2009 – and the total number of industry engagements is above **800**.

New business sector focus in long-fibre reinforced **composites and energy** – both with gaps in UK supply chains and opportunities to grow UK capability.

KCMC **delivered ahead of five-year targets** in its original (2009) business plan. It is now on track in the three-year business plan agreed between the research institution partners and Innovate UK.

KCMC at a glance...

- KCMC's mission is to accelerate product and process innovation through collaborative R&D in materials chemistry.
- KCMC is now in the second year of a funding partnership with Innovate UK – aligned with the UK's 2013 Chemistry Growth Strategy. KCMC is a key contributor to the Accelerating Innovation group at the Chemistry Growth Partnership.
- The University of Bristol is the latest research institution to join the KCMC network, extending research capabilities across many facets of materials chemistry, and with particularly strong links to developments in long-fibre reinforced composites.
- KCMC collaborations bring added value to the materials science that translates advanced materials for high-value markets into commercial opportunity and competitive advantage for UK companies.
- KCMC is a virtual centre hosted by the UK Knowledge Transfer Network (KTN). KCMC provides highly flexible access to multi-disciplinary academic research and expertise through its partners. The current partners are universities at Manchester, Liverpool, Bristol, Bolton and the Science and Technology Facilities Council (STFC) at Daresbury
- Dedicated resources deliver competitive advantage for businesses in industrial timescales with reduced business risk
- KCMC innovation networks provide accelerated access to national capabilities in materials chemistry and their application to industry challenges
- KCMC catalyses innovation in advanced materials across applications in energy, health, home and personal care, transport, construction and ICT. It offers companies single-point access to its research partners, rapid project start-up via dedicated scientists, and ready access to support grant proposals.

David Prest chair of the Chemistry Innovation Strategy Board at the KTN

"We see a huge potential for advanced materials in the UK. Through the Chemistry Growth Partnership we're aiming to connect up opportunity with delivery. We need to support companies that are developing materials and connect them with the right people to accelerate innovation and bring new products to market. The KCMC is working with companies where flexible access to universities and the wider knowledge base across the UK can help drive and accelerate this innovation"



David Prest,
Chair of the Chemistry Innovation Strategy Board at the KTN

KCMC Leadership Team

Prof. Baljinder Kandola,
University of Bolton

Dr. John Conti-Ramsden,
KCMC Director

Prof. Matt Rosseinsky,
University of Liverpool

Prof. Mike Turner,
University of Manchester

Dr. Paul Sherwood,
STFC

KCMC's role in the UK innovation landscape



2014-2015 has seen continued UK investment in innovation in the chemistry-using industries with the recent announcement of the National Formulation Centre and the formation of the Medicines

Manufacturing Industry Partnership. And there has been sustained growth in key industry sectors where materials chemistry is critical for bringing new products to market and developing next generation technologies - for example automotive, aerospace and the life science industries.

The focus on 'integrated solutions' and 'collaboration' has continued with an additional drive to simplification of the innovation support mechanisms available in the UK.

We are already seeing the benefit of the new unified KTN structure in allowing accelerated working across

multiple industry sectors. And Innovate UK is developing a simpler framework for supporting innovation with the recently announced 'five key priorities'.

In the second year of the partnership between KCMC and Innovate UK, the focus has been on delivery of new capability and connection in key industry priority areas, including long-fibre reinforced composites and new materials for energy. This is already driving the development of new collaboration between industry and the knowledge base.

John Conti-Ramsden
KCMC Director

Energy Update

New materials discovery activity is essential for delivering solutions to the technology challenges rooted in the energy trilemma (CO₂ reduction, lower cost and security of supply). The University of Liverpool and the Stephenson Institute for Renewable Energy are developing materials for energy generation, harvesting and storage, with the use of earth-abundant, low-cost elements at the core of the design philosophy.

Of note is the recently-awarded EPSRC grant to develop catalytic

materials and engineered processes for producing liquid fuels from waste CO₂. The activity in conjunction with the University of Cardiff and Imperial College sets out to provide the materials chemistry know-how for technology to lower the carbon intensity of liquid fuels for consumption by industry and transport.

Developments in thermoelectric materials for converting waste heat into electricity are also an important focus at Liverpool, and are targeting

high-temperature environments such as in automotive emissions control applications, helping to establish routes to meet future passenger car CO₂ emissions. These activities are complemented at the University of Manchester through the research of Prof Robert Freer (<http://www.manchester.ac.uk/research/Robert.freer/>) and the hosting of the EPSRC Thermoelectric Network (<http://www.thermoelectricnetwork.com/home.html>).



Composite capabilities - cutting-edge research at KCMC partner universities

Three KCMC academic partners – the Universities of Bristol, Bolton and Manchester – are playing a crucial role in delivering to industry new composite materials technologies. The University of Bristol is highly active in materials chemistry research, facilitated by several relevant EPSRC Centres

for Doctoral Training (CDTs), which provide flagship national research, training and collaboration opportunities in Chemical Synthesis, Advanced Composites, Functional Nanomaterials, Catalysis, Diamond Science and Technology, and Theory and Modelling.

Cross-faculty research at Bristol

The Advanced Composites Centre for Innovation and Science (ACCIS) is a world-leading centre for composites research and education that combines cutting-edge fundamental science activities across several University faculties while also having strong industrial links for exploitation and technology transfer. Its close association with the National Composites Centre (NCC) in Bristol also facilitates these links. Specific areas of interest for materials chemistry in this area are structural materials with added functionality, e.g. for sensing or self-repair, and new material structures based on novel fibres and nanomaterials.

Thermal stability studies at Bolton

The University of Bolton brings unique capabilities to the development of materials for this important sector, focussing on thermal stability and fire performance of composites, and the opportunity for introducing nanomaterials and novel surface treatments to enhance their properties.

New composites test equipment at Manchester

At the University of Manchester, a new Instron 8806 2.5 Meganewton (MN) test machine has been installed to support the ATI Concept Integration Project (Wings of the Future) at the National Composite Certification and Evaluation Facility (NCCEF). The machine is the first installation in NCCEF's new national large-scale composite research facility, and is being dedicated to fundamental research of composites damage and fracture behaviour.

The NCCEF is located within the University's Northwest Composites Centre, which has a focus that includes low-cost, low-energy,

low-cycle-time manufacture of composites and, more specifically, manufacture of structural textile composites, non-destructive and SHM testing (with state-of-the-art X-ray tomography equipment in the Henry Moseley X-ray Imaging Facility), and design and failure analysis of polymer composites.

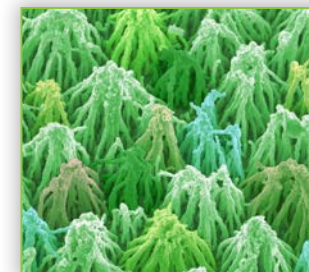
NCCEF serves industry's short-term needs, however this can lead to long-term R&D collaboration. It is an independent ISO 17025 accredited test laboratory (test centre No 4566), assessed by the United Kingdom Accreditation Service (UKAS) against a suite of international ASTM composite material test procedures.



Teaching Intensive Research Informed



The University of Manchester



'Triffids' is an SEM of a diamond-coated carbon-nanotube forest; the nanotubes have clumped together into pointed 'teepee' shaped, useful for field emission or high area electrochemical electrodes.

The current project at the new composites research facility is a two-year £5.9m collaboration between NCCEF and Airbus UK, the National Composites Centre and Spirit Aerosystems. The project is funded through Innovate UK (formerly TSB) and the Aerospace Technology Institute (ATI), and aims to provide first-tier suppliers in the UK aerospace, automotive and wind sectors with a better understanding of subsurface damage formation as well as guidance on how to improve the application of coupon-derived material data to the design of extended substructures at full scale.

Chemistry Growth Partnership Update

The Chemistry Growth Partnership (CGP) is making good progress in the following thematic areas:

1

Competitive Energy and Feedstocks, with the principal attention on UK energy policy, shale gas, waste, CCS and decarbonisation of the chemical industry;

2

Rebuilding UK supply chains, aiming to increase the capacity to supply of chemicals and intermediates from within the UK, boosted by GSK's policy to increase its sourcing of chemicals from UK suppliers (7% in 2014) by a factor of at least 2 by 2020;

3

Innovation, with a target to increase UK GVA in the chemistry-using industries through accelerated innovation by £35bn by 2030. The past year has seen the funding of the National Formulation Centre, which is now close to operational. Over the next three years there will be a strong focus on the opportunities for innovation and growth involving materials chemistry. This will include potential growth areas such as composites and materials for energy generation and storage.

The Innovation theme is working closely with KTN and KCMC to ensure that UK centres of activity (such as the Catapults and Centres funded by the Research Councils and Scottish Enterprise) are jointly developing their activities and future plans so that the UK can benefit from the combined strength.

A dialogue has been established between the Chemistry Growth Partnership and the new Government and agreement has been reached that a minister will attend future meetings of the CGP. The new ministers in BIS are particularly interested in transformational new technology and accelerating growth in SMEs, which fits well with the aims and activities of KCMC. The CGP is working hard to secure continued government support for innovation and is engaged in detailed discussions with other Industry Councils, Innovate UK and the Research Councils to ensure that there is a coherent and compelling strategy to support that outcome.

Steve Fletcher

Head of Chemistry, Knowledge Transfer Network (KTN)



Innovate UK



BIS

Department for
Business Innovation
& Skills

Getting the right investment

"Access to Funding and Finance is a new cross-cutting business unit within the Knowledge Transfer Network. We help companies grow by providing opportunities to engage with the funding community, from investors and finance suppliers to grant-givers.

A nationwide grant-searching capability that allows companies to look at all known grants they can apply for has been rolled out. The KTN run a network of pitching events, bringing companies that are looking for funding face-to-face

with investors ready to invest. This feeds into the Venturefest Network, a national network of one-day innovation showcases.

This year we have been rolling out a network of Entrepreneur Forums, a series of peer-to-peer support groups. These groups help anyone interested in starting up or growing a high-tech business. They do this by sharing experiences, tips, tools and techniques that will be useful to them as they grow their companies and look for investment."



Ian Tracey

Head of Access to Funding and Finance, Knowledge Transfer Network

Europe – the bigger picture

"A further important context for KCMC is how UK innovation fits within and benefits from the wider, European picture and funding opportunities.

2014-15 saw the launch of a new research and innovation strategy by SusChem, the sustainable chemistry forum, which aims to improve industrial and academic engagement with European Commission research initiatives – and with which KCMC works closely in the UK. The new strategy highlights the role of the chemical industry in boosting innovation in Europe and the potential for sustainable chemistry technologies to tackle societal challenges, as outlined in the European

Commission's research programme, Horizon 2020.

2014-15 also saw the implementation of the first round of annual Horizon 2020 calls. Horizon 2020 couples research and innovation with emphasis on excellent science, industrial leadership and tackling societal challenges. With almost €70bn in funding, it is proving extremely popular and with a strong focus on innovation it aims to increase multidisciplinary and cross-sector working along value chains to get new projects launched quickly – and achieve results faster."

Claire Claessen

Head of Horizon 2020, Knowledge Transfer Network



Successful innovation

"For successful innovation, you need to think about the future market and consider what is driving the business opportunity you have identified. The Horizons tool is designed to help you to build social and environmental factors fully into your thinking to better describe that future market. It was developed by Innovate UK with NGO Forum for the Future and Aviva Investors, and is used by Innovate UK when shaping its programme strategies, competitions and Catapults.

The tool can be accessed free of charge via <http://horizons.innovateuk.org/>

Please make use of the Knowledge Transfer Network for support using the tool, as well as assistance exploiting the insights gained through its use, for instance locating partners with specific expertise. Get in touch via horizons@ktn-uk.org"

Ben Peace

Sustainability Lead, Knowledge Transfer Network



CONNECT

In 2014-2015, the host business for KCMC made the transition from Chemistry Innovation Ltd to KTN Ltd, following the formation of the single KTN in April 2014. While not directly having an impact on KCMC day-to-day operations, it has opened up new network links that we are starting to see turn into collaboration opportunities in the KCMC project pipeline.

2014-15 also marks the first full year for KCMC outside of the founding five-year business plan, with the partnership continuing to tackle major challenges in materials chemistry innovation.

KCMC progressed 220 industry engagements in 2014-15, closely mirroring the prior year despite a change in knowledge transfer personnel during this financial year. Of these engagements, 5% originated or were developed with wider involvement of the KTN – this figure is expected to rise as working links get established across the new organisation. A small but significant number of engagements developed alongside the participation of the University of Cardiff in KCMC in 2014.

The balance of work across industry sectors maintains an even split between companies focussed on chemicals and materials, and companies specialised in other industries. Most striking

is the growth in engagement with companies specialised in the energy and environment sectors (up by 70% over the prior year). This reflects a significant KTN team focus, supported by wider KTN expertise. Additionally, a number of new company links have been established in long-fibre reinforced composites, reflecting KCMC Industry Steering Group activity in the area.

New company introductions were up slightly in 2014-2015 at 42 (38 in the prior year), and of these, 33% were in the priority areas of composites and energy.

figure 1:
Companies by Type

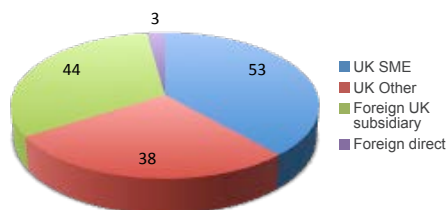


figure 2:
Companies by Sector

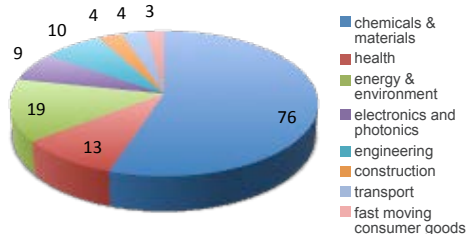


figure 3:
SME by Industry Sector

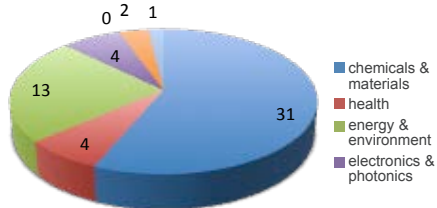
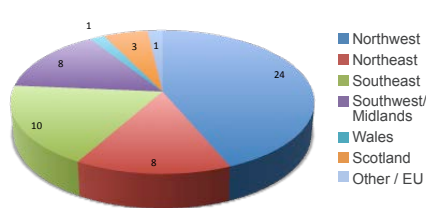


figure 4:
SME by Region



SME Update

SMEs are a major source of innovation in the development of new materials. SMEs are a priority for KCMC support, through networking and timely collaborative R&D.

SME engagement statistics are broadly consistent with prior years and are highlighted above in Figures 3 and 4.

The sectoral focus of SMEs supported is again principally on developing chemicals and materials for cross-sector application, with the exception that there has been a substantial growth in engagement with SMEs that are working to address energy challenges. A significant achievement for the KCMC

collaboration approach has been a technology licensing agreement to support a UK SME in the energy sector, facilitated by access to the project scientist resource.

A priority is to offer SMEs the opportunity to engage and influence the development of new approaches to

Cross KTN working

The KCMC collaboration business model has been developed and refined over the past 6 years, building on in-depth working with both industry and the knowledge base in materials chemistry innovation.

The breadth of industry representation and connectivity in KTN and the wider Innovate UK family provides a comprehensive network resource for industry to accelerate innovation on a broad front.

Areas where KCMC, KTN and Catapult industry experts from multiple sectors have worked together to accelerate innovation in 2014-15 have included:

- long-fibre reinforced composites,
- new materials for addressing the energy trilemma
- solar fuels
- sensor technologies
- smart materials
- graphene commercialisation.

More details can be found about the KTN and Catapults can be found at:

KTN: <http://www.ktn-uk.co.uk>
Catapults: <https://www.catapult.org.uk>

FACILITATE AND DELIVER

Cumulative five-year research income now stands at £19.4m. Rolling five-year research income is £17.2m, slightly down from 2013-14 (£17.8m), reflecting a lower than anticipated grant income contribution, although industry income was up 50% on the prior year at £0.9m.

In this first full year of the materials chemistry partnership with Innovate UK, goals for industry engagement, case studies and expansion were met.

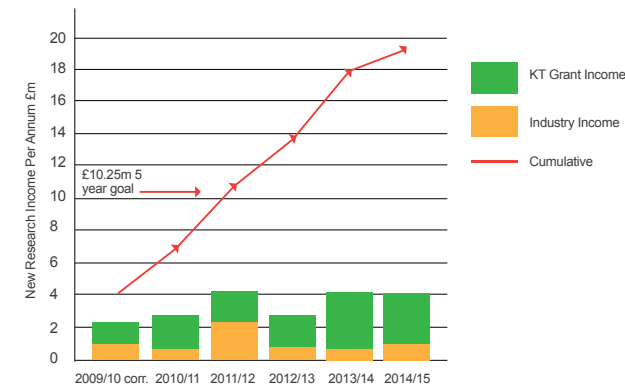
Project areas developed included sensors, fuel cells, graphene materials, novel chemical processing and formulation modelling.

The major investment in advanced computational modelling at the STFC's Hartree Centre in Daresbury continues to drive the development of new collaborations, with the single biggest

industry collaboration in 2014-15 coming in that area. There is strong industry interest in advanced computational

modelling for accelerating the development and commercialisation of new, advanced materials.

KCMC Collaborative Research Income 2009-2015



materials chemistry innovation.

In the field of new materials for energy, a KCMC cross-sector event involved 20 industry representatives drawn from across energy supply chains, with a particular focus on renewable energy generation and storage. Six

of the companies were SMEs bringing new materials innovation to market, ranging from hydrogen generation and storage, fuel cells, nanomaterials and coatings and semiconductor materials. The event also involved Innovate UK (innovation 'surgeries' were provided for SME attendees) and the High Value

Manufacturing Catapult.

As in previous years, the full breadth of the collaborative R&D toolbox has been exploited, including SMART, KTP, Innovate UK collaborative R&D and KCMC project scientists working together.

University of Bolton

The Institute of Materials Research and Innovation at the University of Bolton continues to make a significant contribution to the development of new industrial technologies. Internationally known for its expertise in applied materials science and related engineering applications, the Institute develops new designer, smart and multifunctional fibres, fabrics, films, foams and particles at the nano and micro scales, as well as production technologies that enable these novel materials to serve global market needs.

It houses a number of internationally recognised

specialist groups working in the areas of fire retardancy and flammability; biomaterials and speciality materials with health care related functionalities; technical performance textiles; and designer materials and smart composites. These groups have a number of long-standing relationships and collaborations with industry that meet real industrial needs through applied research and subsequent technology developments. In addition, due to the multidisciplinary nature of these activities, the Institute also engages with other academic disciplines and research organisations to support and

enhance work being done in their specialist fields.

In February of this year, the University's Board of Governors underscored its commitment to the furtherance of science and engineering study and research with the confirmation of an investment of £10m in a new teaching facility to be completed in 2016.



Teaching Intensive Research Informed

University of Liverpool

The University of Liverpool's Materials Innovation Factory (MIF), due to open in early 2017, will draw together world-leading, multi-disciplinary research expertise, unparalleled technical facilities and a dynamic support infrastructure to revolutionise industrially focussed research and development.

The project builds on a deep understanding of how academia, industry and commerce can work effectively together, offering businesses a competitive advantage through faster and smarter materials innovation enabled by unique facilities provided by the MIF. Located in the heart of Liverpool's Knowledge Quarter, the University Enterprise Zone and with easy access to the chemical industry of the North-

West region, the MIF will be well-placed to set the future agenda for functional materials discovery.

Construction of the £68m, state-of-the-art facility is well underway. With a team of highly skilled staff, the MIF will house £10m of equipment designed to help bridge the gap between materials chemistry, robotics, data-management and modelling.

For more information visit <https://www.liv.ac.uk/materials-innovation-factory/> or contact mifinfo@liverpool.ac.uk



Science and Technology Facilities Council (STFC) Hartree Centre

The STFC's Hartree Centre continues to develop at a rapid pace underpinned this year by the Government awarding £113m for the development of a cognitive and data-centric computing centre of excellence in collaboration with partners IBM. IBM will provide further support to the Centre with a package of technology and onsite expertise worth up to £20m. This investment further strengthens the Hartree Centre's position at the forefront of research & development using HPC, Big Data, cognitive and visualisation

technologies, and recognises the successful work already achieved with leading industry collaborators including Unilever and Infineum. The potential benefits of these emerging technologies in terms of economic impact and competitive advantage will be realised by UK-based companies and the public sector, and will play a central role in the development of new advanced materials for the future



University of Manchester

In March 2015, Professor Martin Schröder was appointed as the new Vice-President and Dean for the Faculty of Engineering and Physical Sciences at the University of Manchester. Professor Schröder has considerable expertise in the application of materials chemistry, in particular metal organic frameworks, to help solve the challenges associated with gas separation and storage.

Advanced materials research has been identified as one of the 'Research Beacons' at the University of Manchester. It is underpinned by major recent investments including the National Graphene Institute (£61m, opened in March 2015), the Graphene Engineering Innovation Centre (£60m, due for completion in 2017) and the Sir Henry Royce Institute for Advanced Materials (£235m,

announced in December 2014). The Institute has its hub at the University of Manchester and spokes at the founding partners, comprising the Universities of Sheffield, Leeds, Liverpool, Cambridge, Oxford and Imperial College London. The aims of the Royce Institute include:

- The acceleration of the use of advanced materials in existing and emerging industrial sectors within the UK.
- To underpin and provide growth to the entire UK manufacturing base and reduce the time to market from invention to application for new materials,
- To invent and innovate new materials in various sectors and to provide the 'missing link' in the development of materials within the UK.

An example of the University's research in advanced materials is the award of a €1.9m European Research Council grant to Dr. Cinzia Casiraghi (School of Chemistry). The research will focus on the use of 2D crystals to open new horizons in the understanding of nucleation of organic crystals by using a multi-disciplinary approach, which combines chemical engineering, materials chemistry, graphene physics and sensors technology.



The Hartree Centre – supporting industry with high-performance computing and modelling

Advanced simulation and modelling techniques have had a revolutionary impact on materials chemistry over the past ten years from applications in energy such as photovoltaic and fuel cells to health care and biomedical materials. The Science and Technology Facilities Council's (STFC) Hartree Centre is a KCMC partner that specialises in computational science for materials chemistry applications, from modelling and simulating advanced material characteristics to using data analytics to identify patterns that aid pharmaceutical drug manufacture. With clients including Unilever, the National Physical Laboratory (NPL) and GSK, the value of computational modelling and simulation to speed up processes and reduce experimentation costs has long been proven, and is set to stand the test of time.

Computational chemistry expertise can benefit a wide range of materials applications, including the energy sector, in biofuels, enhanced oil recovery, photovoltaic and fuel cells; sustainable materials; electronics and photonics; health care and biomedical materials; formulated products and pharmaceuticals; and multi-functional materials, including micro-porous materials, membranes, novel catalyst/material combinations and nanoparticles.

Unilever is taking advantage of the Hartree Centre's expertise to model how key ingredients of typical

home and personal care products combine to structure everyday liquids. On the energy side, ACAL Energy has used modelling and simulation to provide useful insights into key properties and the reaction mechanism features that can affect the performance of liquid catalyst fuel cells. And health care company GSK is using the Centre's expertise to identify connections between different genes and diseases, with a view to developing more effective treatments. These are just some examples of how the Centre is currently helping industry achieve competitive advantage.

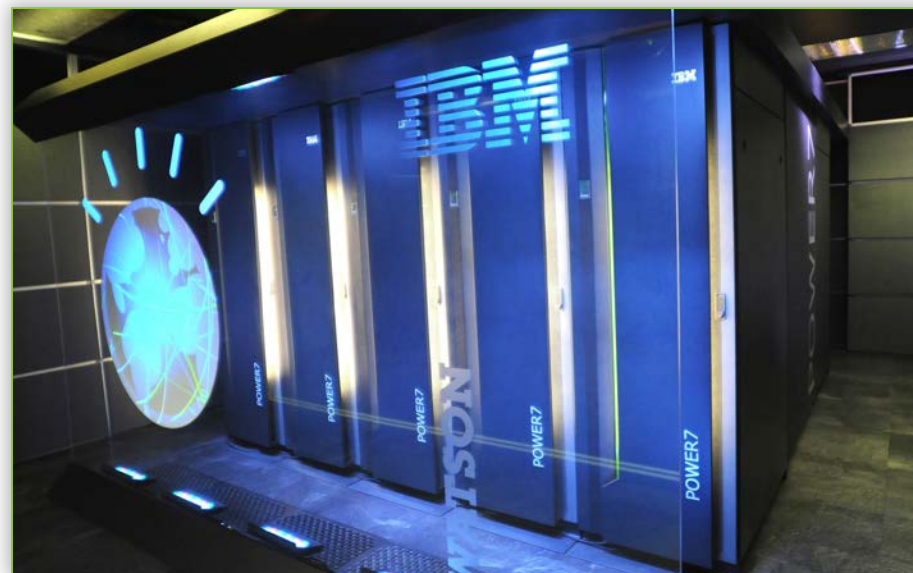
Another significant development highly relevant to materials chemistry challenges is the way 'Big Data' is changing the way information is used – extracting more value and deeper insight out of it. 'Big Data' has become a key area of technology for the UK and its impact could transform every business sector and every scientific discipline. Now, the UK Government has committed £113m further investment into the Hartree Centre for expansion of the organisation's capabilities into data-centric research and cognitive computing technologies. In addition to this, IBM has committed a further £200m worth of technology and expertise, including 24 IBM researchers coming to Daresbury to work alongside Hartree researchers, enabling access to the latest data-centric and cognitive computing capabilities, such as the world-famous IBM Watson.

This investment will bring these technologies to a host of UK companies for the first time.

Cognitive computing stretches far beyond what is possible even with the best computers today. These systems 'learn' in similar ways to human development. For example, Watson can read and understand natural language, making it easier for humans to interact with even the most complex web of data, and to develop a solution in a more instinctive way having assessed all the information available. This will become increasingly important as manufacturing processes become more data-driven with risk-based Quality by Design (QbD) approaches and sophisticated Process Analytical Technology (PAT) control. The interface has to be manageable and accessible to human operators with a range of skill sets and capabilities. By ingesting a corpus of literature on a particular topic, for example materials science, the system can help to target new areas for research & development with the potential to accelerate step-change innovation in next-generation advanced materials. The Hartree Centre is a key contributor to the network of state-of-the-art science facilities through which the KCMC is supporting materials chemistry innovation in companies.



IBM Watson at The Hartree Centre, UK (Photo: IBM)



Adrian Toland
Business Development Manager,
The Hartree Centre

IBM Watson: The Hartree Centre will have access to the latest cognitive computing capabilities from IBM, such as the world-famous IBM Watson



The Hartree Centre: modelling and simulation for materials chemistry applications (Photo: STFC)

Profile of a KCMC project scientist

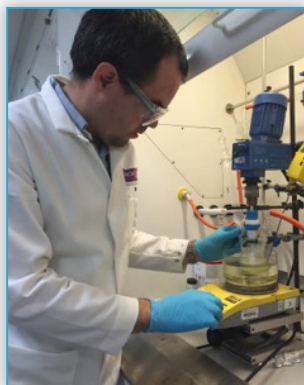
Dr Andrew Foster, University of Manchester

Dr Andrew Foster, KCMC project scientist at the University of Manchester, grew up in Northern Ireland and completed both his undergraduate and postgraduate studies at Queen's University Belfast, finishing in 2001. His PhD was funded by DuPont Dow Elastomers LLC, which at that time had a neoprene plant in Maydown, Londonderry. Between 2001 and 2004, he worked as a postdoc at the University of Sheffield on two projects funded by ICI Paints and dstl, respectively. Then in late 2004, he moved to the University of Manchester to take up a postdoc position working on a EU Framework Programme 6 funded consortium project on the optimisation of pressure-sensitive adhesives.

In 2008, he took a break from research and completed a teacher training course (PGCE) at the University of Manchester. "This was a positive experience developing new skills but I found that I missed research and thus sought a return to it," he says.

In 2010, he was appointed as a project scientist for the Knowledge Centre for Materials Chemistry (KCMC) based in the University of Manchester attached to Prof. Michael Turner's group. "This involved working with a range of companies on short-term projects relating to materials and polymer science," he explains. "My career in research has always involved working in close collaboration with industry, so I have developed an awareness of the focus and requirements this brings. I have completed projects for Melford Labs, Cambridge Display Technology (CDT), Victrex, Akzo Nobel, BWA Water Additives and University of Manchester Intellectual Property (UMIP) during my five years with the KCMC. Highlights have been producing a scalable synthetic route to a polymer for Melford Laboratories Ltd, exemplification of the use of novel monomers in Suzuki cross-coupling polymerisations for CDT, and contributions to a UMIP project to develop the synthesis of conjugated polymers in emulsion conditions. I also contribute to ongoing work on

conjugated polymer nanoparticles in Prof. Turner's group. I enjoy the balance of working on focused projects for industry and still being involved with novel research whilst attached to a research group."



Dr Andrew Foster, KCMC project scientist at the University of Manchester: enjoying working on focussed projects for industry while also being involved in novel research

Dr Rick Anderson, STFC

Dr Rick Anderson grew up in the North West of England and completed both his undergraduate and postgraduate studies at Bangor University, North Wales, finishing in 2006. His PhD looked at the emergence of the classical world from the quantum world in a chemistry setting. Following his PhD, he worked at the Centre for Applied Marine Sciences at Menai Bridge, where he used modelling and simulation in the design of marine-based composite materials with potential for packaging applications, and served as Industry Liaison Officer. In 2008, he joined Durham University as a research associate to work on a multidisciplinary project designing clay-swelling inhibitors for oilfield applications with M-I SWACO, UCL, Glyndwr University and the Centre for Advanced Software Technology Limited.

In 2009, he was appointed as a project scientist for KCMC based at STFC's Daresbury site as part of the computational chemistry group. This involved working with a number of companies on short-

and long-term projects in the fields of formulation, chemistry and materials.

"I worked out early on in my PhD that my real passion in work was not in the pursuit of theory but rather in connecting with others and working collaboratively," he says. "The science I do needs to have an immediate application. Whilst I have been working with the KCMC I have had the pleasure of carrying out research with a number of companies, including Unilever, Infineum, Syngenta, Akzo Nobel, Sun Chemicals, IBM and

Datalase, in addition to working with a number of academic groups. My biggest highlight to date has been in producing a framework to enable formulation chemists to use modelling and simulation to help in the design of new and sustainable products such as oil and fuel additives, and home and personal care products."

Dr Rick Anderson, a KCMC project scientist based at STFC's facility in Daresbury, is researching how modelling and simulation help in the design of sustainable new products



Baltex and Bolton: Long-term successful collaboration

Industry-academic collaborations are a hot topic, and technical textiles company Baltex has been proving their value for over 15 years.

In 2000 Charles Wood, Baltex's MD, was moving his company into developing three-dimensional (3D) knitted fabrics, and was advised that the leading authority on this was Professor Subhash Anand MBE at the University of Bolton, which is a founding partner of the KCMC.

The two immediately identified mutual interests and began working on a project to develop shielding electromagnetic materials to prevent mobile phones interfering with avionic systems. Wood said the collaboration, which ended in a patent, "went like a dream".

The success led the pair to look at further projects. Over the years these have included stretch fabrics for orthopaedic support bandages for compression therapy and hypertrophic scarring from burns; the world's first single-layer 3D fabric for Venus leg ulcers (a £700m UK market); an award-winning pad for cycling and triathlon to protect the crotch area from the saddle, reducing medical risks including erectile dysfunction; and a knife-proof smart material for police and military applications.

Perhaps their biggest success has been the patented Airospring cushion which helps prevent pressure sores, a medical condition that can affect people confined to a single position, such as wheelchair

users or those in hospital beds. The treatment of pressure sores costs the NHS up to £2.6bn a year.

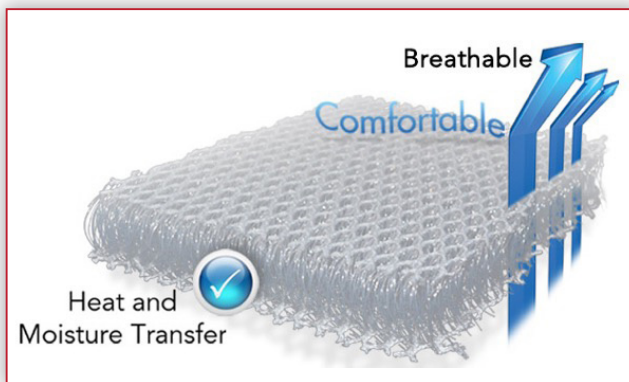
Airospring was a revolution in technical textiles. Made from three to five layers of spacer fabric, each with different compression properties, it distributes pressure and allows maximum airflow to create a microclimate, which dissipates perspiration and promotes healthy skin.

Wood says: "We have benefitted hugely from the expertise and facilities available over the past few years, which have been critical to our product development. Professor Anand in particular has contributed unparalleled expertise and we are lucky to have his experience available locally.

"We have also benefitted from the collaborative environment within Bolton, and Subhash has opened doors to other departments, for example we have been able to access equipment intended for testing concrete, which proved to be exactly what we needed for testing wheelchair cushion technology."

The 15-year partnership has led to at least six projects which have delivered valuable outcomes, including three granted patents.

The UK textile industry is worth £9bn, according to The Alliance Project, part of the New Economy think tank. Collaborations like Baltex and Bolton's can help the UK take advantage of this opportunity and enhance the repatriation of textiles manufacturing to the UK.



Teaching Intensive Research Informed



Materials Chemistry SIG: focussed on building UK capability in key areas

The Materials Chemistry Special Interest Group (SIG) has focussed on building UK capability in key priority areas agreed with its industry group and Innovate UK.

The main activity has been on making new connections and bringing together new groups of companies to help address the major societal and industrial challenges of today. The Group's delivery focus is acceleration of innovation and support for companies to compete in global markets.

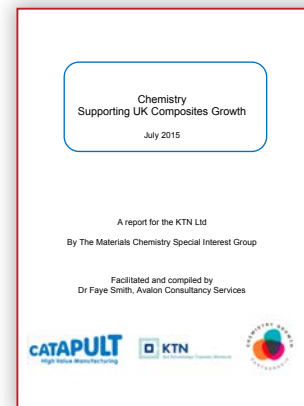
Meetings have been held to deepen understanding of chemistry challenges in the growth of the UK composites industry, and to address the energy trilemma of sustainability, security and affordability. A report 'Chemistry in Composites' is in process on opportunities for chemistry to support growth of the UK composites industry. A major achievement has also been the

engagement with KCMC of the University of Bristol, which has been welcomed to the KCMC formally with effect from 1st October 2015.

In addition to sector-specific activity, the broader challenges of new materials-driven innovation have been highlighted by the Group's industry partners and include:

- 1) scale-up and supply chain positioning: the UK value-capture challenge
- 2) technology adoption in the marketplace: accelerated validation and testing needed for new materials
- 3) the role of computational modelling in accelerated innovation
- 4) getting better at making the right connections across disciplines and multidisciplinary working
- 5) fragmented knowledge base and lack of skills in interface/joining engineering

These challenges have been considered in the Innovate UK High Value Manufacturing strategy review process in 2015.



"Powerful societal challenges are driving the need for new materials innovation in many industry sectors and the opportunity for materials chemistry innovators to compete in global markets. Our KCMC vision is to be on the leading edge through innovative collaboration between science leaders in the knowledge base and industry and so help support and accelerate the achievement of UK goals for increased productivity and economic growth."

John Grasmeder
Chair, KCMC Industry Steering Group and Technical Director, Victrex Polymer Solutions



University of Bristol joins KCMC

The University of Bristol is highly active in materials chemistry research, with several relevant EPSRC Centres for Doctoral Training (CDTs) located on campus, providing flagship national research, training and collaboration opportunities in Chemical Synthesis, Advanced Composites, Functional Nanomaterials, Catalysis, Diamond Science and Technology, and Theory and Modeling. The University's particular focus is on advanced composites science and technology, materials for energy, and soft matter.

Advanced composite materials research is led by the Advanced Composites Centre for Innovation and Science (ACCIS). The Centre combines the activities of several University of Bristol faculties, led by the Faculty of Engineering with links to the Faculties of Science and Medicine, and especially the School of Chemistry. A close association with the National Composites Centre (NCC) in Bristol facilitates

these links. Specific research areas of interest include structural materials with added functionality, eg for sensing or self-repair, and new material architectures incorporating novel fibres and nanomaterials.

Materials for energy is a broad theme that covers many topical areas of research, including materials for electrochemical solar energy conversion and storage, hydrogen storage materials, new catalysts for methane, bioalcohol and carbon dioxide conversion, and fundamental research into materials of interest to the nuclear industry (led out of the Interface Analysis Centre and South West Nuclear Hub).

Soft matter and colloids has long been an area of expertise within the School of Chemistry, and the School continues to have interests in both the fundamental and applied aspects of these materials.



Duncan Wass

Professor of Catalysis, School of Chemistry, Faculty of Science, University of Bristol

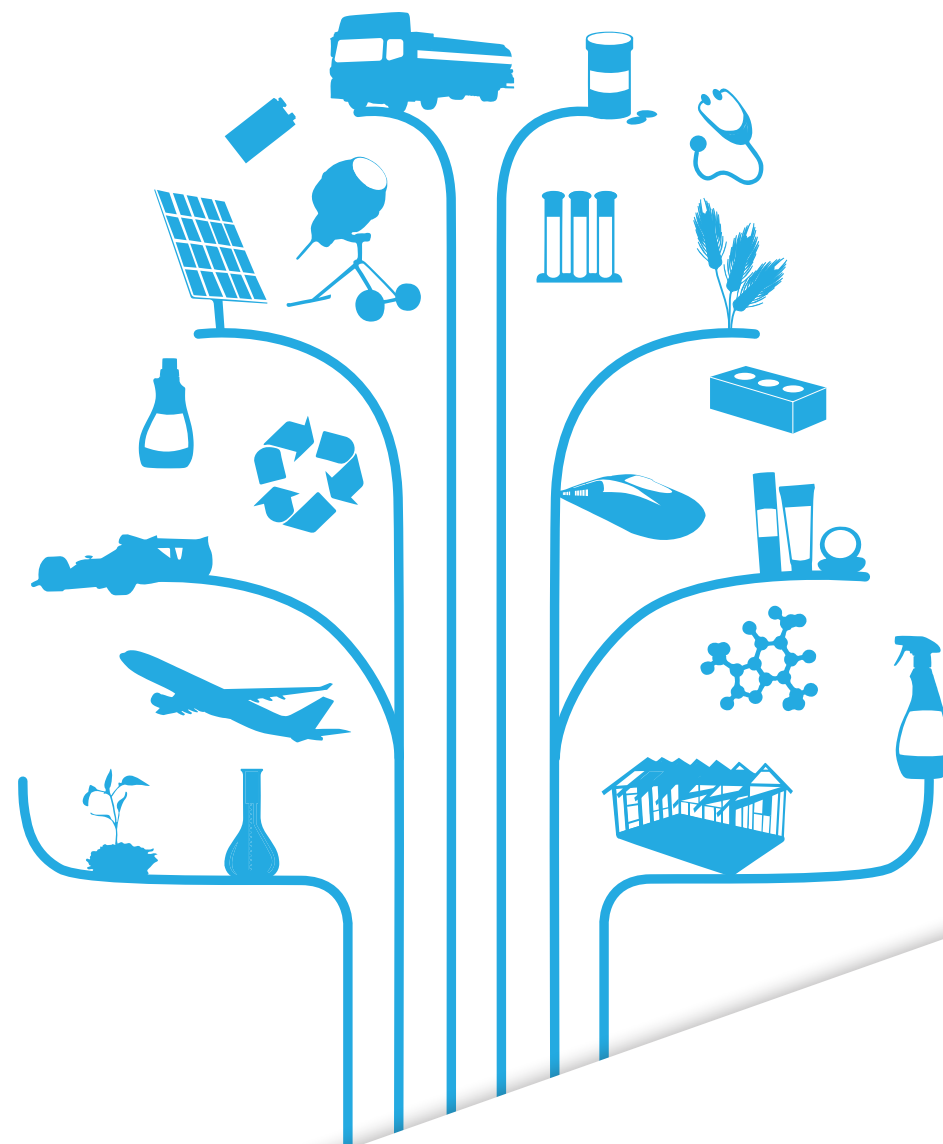


KCMC Metrics

Key goals for KCMC in partnership with Innovate UK reflect priorities for supporting growth in UK high-value manufacturing. These include strategic growth in materials chemistry capability, robust financial performance, SME engagement, collaboration with Catapults and publication of case studies to highlight economic impact.

Key metrics to support delivery of these goals are:

Metric	2014/2015 Actual	Comment from Business Plan
Strategic growth in capability	University of Bristol accession	-
Financials: collaborative research income	£1,635,979 (Industry income £905,981)	90% of plan
SME Engagement	76 (total engagements 220)	On plan
Meetings held with Catapult	3	On plan
Case Studies	5	Ahead of target





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