KNOWLEDGE CENTRE
MATERIALS CHEMISTRY

Annual Report 2019

KNOWLEDGE CENTRE
MATERIALS CHEMISTRY

The Team

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KCMC Director

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Mike Holmes
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Angela Walsh
Business Development Manager, STFC Hartree

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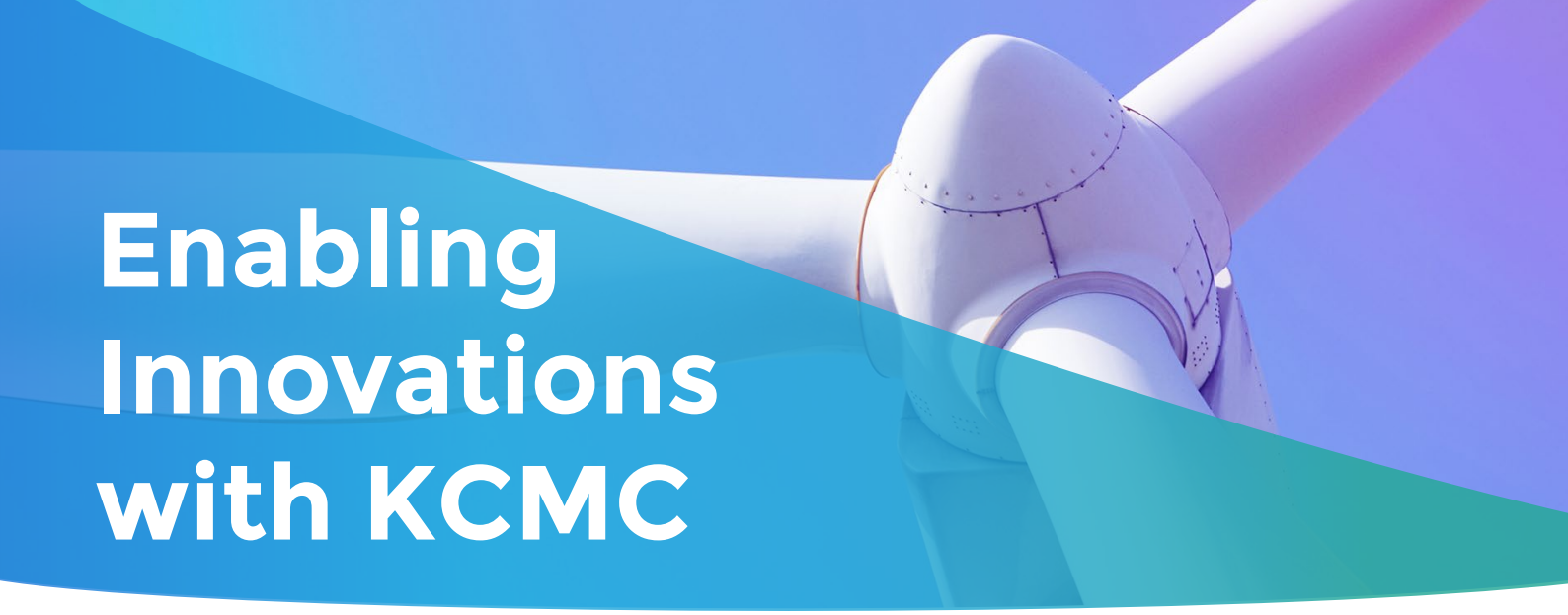
Enabling Innovations with KCMC



KCMC is at the centre of ensuring that materials chemistry in the UK is a collaborative endeavour. With an expert understanding of both the academic and industrial landscapes, it provides a unique vehicle to encourage cross-sector partnerships. Here, we can form essential linkages between the innovative strengths of academics and the product development and commercialisation aspects of industry. KCMC draws from its extensive network to unite the right partners at the right time, drive materials chemistry forward and accelerate the delivery of transformative products to market.

At CPI, we are proud to host KCMC within the UK's High Value Manufacturing Catapult. This relationship helps us to maintain a much stronger alignment and activity in the materials chemistry landscape than was previously possible. We recognise that academic-industrial collaborations are integral for ensuring that every great invention in the UK gets the best opportunity to become a successfully marketed product. Our partnership with KCMC has provided further expertise and capabilities to achieve this by joining the collaborative discussion within its network. This has provided CPI and its Catapult network with an even broader interface between universities and industry. Through this, we have crafted successful partnerships with academia in technology areas that require CPI's unique commercialisation expertise and advanced up-scaling facilities.

By aligning with KCMC, our ability to work with academia and other partners to successfully translate great ideas into commercial products is stronger than ever. This in turn helps to address major societal challenges, generate highly skilled jobs and deliver economic growth to the UK. It's a delight to work with people who truly are excited about materials chemistry and share our ambition to make it as successful as it can be. We hope to continue with the KCMC partnership and explore additional ways to extend this across academia and other organisations – making it even more effective than it currently is.

> "Here, we can form essential linkages between the innovative strengths of academics and the product development and commercialisation aspects of industry."

Dr Nick Johnson
Commercial Director, CPI

cpi

KNOWLEDGE CENTRE MATERIALS CHEMISTRY

A Governing Board Update

The current UK materials chemistry landscape is continually changing to meet its widening applications. However, with limited availability of resources from stakeholders and funding bodies, a significant emphasis is now being placed on the economic impact of materials research. At KCMC, we use our knowledge of the materials landscape to forge early R&D collaborations between research institutions and businesses. Through this partnership, investors can be confident that an innovation is supported from research in the lab through to the manufacture of a final product, and will ultimately benefit the UK economy. This confidence strengthens KCMC partners' Research Excellence Framework (REF) Scores, the assessment criteria used for funding allocation. It is for this reason our partner research institutions turn to KCMC for help with their bids, which will be submitted in 2021.

Universities play a crucial role in supplying materials chemistry innovations to UK businesses. They shape materials research during product development, rather than retrospectively influencing after. This allows challenges to be addressed and the desired characteristics of a product to be achieved much earlier in the pipeline. A standout example of this support comes from the University of Liverpool's Materials Innovation Factory (MIF) launched late 2018. KCMC has secured funding for multiple research projects in which the MIF has enabled successful collaborations between industrial and academic users through the shared use of its state-of-the-art R&D space. By enabling opportunities for training, skill development and investment in innovative projects, the MIF demonstrates the importance of a joined-up approach to the materials industry that KCMC is striving to achieve.

We'd like to take this opportunity to thank Professor Ronan McGrath, former Chair of the KCMC Governing Board and Head of the School of Physical Sciences at The University of Liverpool. Ronan played a crucial role in guiding the development of KCMC from the end of 2016 to 2018, and was particularly pivotal in securing CPI as a new hosting partner for KCMC in 2017. By helping define the advantages of the partnership and ensuring that they were clear from the outset, Ronan ensured that the potentially challenging transition was instead one of real opportunity. Ronan did a tremendous job and has certainly been a source of inspiration for the entire Governing Board. Thanks to his guidance, KCMC can continue to continue to bridge together academia and industry, accelerating the growth of a competitive and highly productive materials chemistry industry that will advance the UK economy.

> "Universities play a crucial role in supplying materials chemistry innovations to UK businesses. They shape materials research during product development, rather than retrospectively influencing after."

Professor Rick Cosstick
Chair of KCMC Governing Board, University of Liverpool

UNIVERSITY OF LIVERPOOL

KNOWLEDGE CENTRE
MATERIALS CHEMISTRY

Executive Summary

Dr John Conti-Ramsden
KCMC Director

Materials chemistry stands at the forefront of modern technology. It enables innovations in advanced materials which are essential for the development of sustainable and cost-efficient products and services with improved properties. With the current UK materials R&D landscape rapidly evolving, it is increasingly recognised that materials chemistry will contribute directly to overcoming major global challenges, including:

- **Industrial decarbonisation,**
- **Smart sustainable packaging**
- **Driving the electric revolution in transport**

To target these issues, we are now seeing an increased focus across the KCMC partners on the UK Government's Industry Strategy Challenge Fund. With it, we will cultivate future market prospects and provide an opportunity to ensure that UK materials innovation delivers long term success.

KCMC's role in accelerating R&D collaborations between business and academia is therefore vital for accelerating growth in UK materials innovation. Our work directly supports the Government's focus on facing key industry challenges, by brokering the necessary collaborations between sectors found throughout the supply chain. KCMC achieves this by leveraging its in-depth experience of materials chemistry innovation, supported by state-of-the-art facilities across the UK. A crucial benefit of working in the High Value Manufacturing Catapult is that we can enable access to innovations in academia and industry and further support their translation into commercially successful products.

In 2019, we completed the first full year of our partnership with the High Value Manufacturing Catapult network in our new home based at the Centre for Process Innovation (CPI). Here, we have striven to provide an essential bridge between thought leaders in universities and industry with the commercialisation activity of the Catapult. This connection is driving innovations that are underpinning the future of UK manufacturing, with it consolidating our competitive edge on a global scale.

After a successful partnership spanning three years, we have seen the departure of The University of Bristol from KCMC, which has shared its invaluable expertise and facilities across a number of significant opportunities during our collaboration. On behalf of KCMC we thank Bristol Chemistry Department for their contributions and are certain of their future impact to the materials chemistry industry. We are always striving to strengthen KCMC's scope for knowledge transfer between academia and industry by forging new partnerships.

The 2018-19 financial year has brought continued success for KCMC. We have once again hit our financial targets, and are delighted to continue strengthening our UK economy through innovation. We look forward to sharing with you just some of our achievements over the course of this annual review.

> "This is an exciting time for KCMC. We are currently in discussion with a number of possible new KCMC partners and expect these to continue into 2020."

Dr Mike Holmes
Academic Development Support Manager at KCMC

KCMC at a Glance

4
New case studies

£36.7 million
Cumulative research income

7
Partner research institutions

57
First time company introductions

£10.4 million
Industry income

336
Industry engagements

66%
New companies that are SMEs

4
CPI Innovation Integrator supports for KCMC spin-outs

KCMC Leadership Team

Professor Matt Rosseinsky
Professor of Inorganic Chemistry,
University of Liverpool

Professor Michael Turner
Professor Materials Chemistry,
The University of Manchester

Dr Darren Bradshaw
Associate Professor in Functional Materials,
University of Southampton

Professor Baljiner Kandlola
Professor of Materials Fire Science,
University of Bolton

Dr Andrea Walsh
Business Development Manager, STFC Hartree

Professor Andrew Hector
Professor of Inorganic Chemistry,
University of Southampton

Dr John Conti-Ramsden
Director of KCMC,
CPI

KCMC Governing Board

Professor Rick Cosstick
Chair KCMC Governing Board, University of Liverpool

Professor Martin Shroder
University of Manchester

Professor Gill Reid
University of Southampton

Professor Patrick McGhee
University of Bolton

Alison Kennedy
STFC, Hartree

Dr Nick Johnson
CPI

Dr John Grasmeder
Victrex

Dr Su Varma
NSG Pilkington

Dr John Conti-Ramsden
KCMC Director

Insights from the KCMC Industry Steering Group

The Industry Steering Group (ISG) continues to develop KCMC's role in addressing materials innovation challenges across national supply chains. This is achieved principally through working with CPI - the process industry's lead organisation within the High Value Manufacturing Catapult - and other Catapult centres as appropriate.

In the past year, the ISG has worked with this expanded KCMC partnership to improve its understanding of industry challenges in materials innovation. Under the leadership of its Chairs, John Grasmeder and Su Varma, areas of focus have included working with ISCF challenge lead programmes to identify opportunities for materials innovation, digital R&D in materials chemistry, and the development of strategies for sustainability and the circular economy. This aligns well with the recently refreshed £1Bn chemistry sector strategy announced by the Chemistry Council in late 2018, and the ISG will look to develop further opportunities for cross-sector working aligned to strategy goals in the next period.

Dr John Grasmeder
Chief Scientist, Victrex

Profile:
Dr Su Varma

Dr Su Varma co-Chairs the KCMC Industry Steering Group, is a member of the Construction Materials Board for IOM3, and an advisory board member of SPECIFIC, SUNRISE and PerTPV.

On July 2019, Dr Varma was announced as the Director of the new NSG Pilkington R&D Incubator based in Lathom, Lancashire. Dr Varma has operated at the forefront of the facilities growth, working as its Incubation Portfolio Manager since 2012. In this new role, he identifies new market opportunities for cutting-edge glass products and processes by facilitating collaborations with start-ups, universities, businesses and funding agencies.

Dr Su Varma
R&D Incubator Programme Director, NSG Pilkington

Digitisation at the STFC Hartree Centre

Chemical system and materials design has long been a process of experimentation, data collection and analysis, resulting in new breakthroughs and innovation. Indeed, multiple KCMC projects with the Hartree Centre have shown this in action. However in recent years, the wide deployment of high throughput robotics and increasingly accurate and cheap simulation has led to a huge amount of data being generated outside of specialist research groups. This is the same across all industries – the scale of data collection is astronomical.

This substantial quantity of data in the world is still growing exponentially. There has been 2.5 quintillion bytes created to date, with an incredible 90% of it having been created in just the past two years. Moreover, it is predicted that as near as 2025, the amount of data produced will pass 165 Zettabyes. Unfortunately, such extensive data generation does not necessarily result in additional insights alone – less than 1% of collected data is actually analysed for value contained within it.

Several characteristics can introduce challenges to the collection, storage, retrieval, analysis and visualisation of chemical and materials data. For example, the data may be from heterogeneous sources. Here, it will likely consist of multiple types and standards with unknown dependencies and inconsistencies possibly associated within it. The data could also constitute missing or unreliable parts as well as privacy issues, having been generated at a rate much faster than what traditional systems can handle. Nevertheless, companies that decide to embrace these challenges stand to benefit significantly.

Artificial Intelligence (AI) algorithms can help to identify patterns and trends not normally observed due to the inherent complexity surrounding multiple data sets. Perhaps the most successful example of using AI to design improved solutions is in the drug discovery industry, where it can help to identify relationships between symptoms and diseases correlated against drugs and their effect. This can then be extended to exploring which patient class is likely to respond to specific treatments. These relationships between different, diverse sets of data would not be possible with traditional methods. In this field, established corporates like GSK and digital start-ups such as Benevolent AI are leading the way.

For a company that is commencing on a journey of adopting data analytics and AI for chemical system and materials design, the road ahead can be daunting – especially in the highly fragmented and diverse advanced materials sector. Simply understanding what types of data to collect can be a challenge. Couple this to the multiple types of AI related solutions (such as neural networks, regression, decision trees, deep learning) and it is clear to see why many companies struggle to adopt a data driven discovery programme. The distinguished cross-sector learning approach of the Hartree Centre is therefore of particular help to taking the first steps on this journey at reduced risk to UK businesses.

> “There has been 2.5 quintillion bytes created to date, with an incredible 90% of it having been created in just the past two years. Moreover, it is predicted that as near as 2025, the amount of data produced will pass 165 Zettabyes.”

Dr Angela Walsh
Business Development Manager, STFC Hartree

Science and Technology Facilities Council

KCMC Metrics

Connect

KCMC industry engagements have increased substantially over the last year, with 336 having progressed during the April 2018 - March 2019 period. These engagements include both the KCMC Knowledge Transfer team's initial communications with companies and more detailed discussions on project developments. This represents a substantial increase when compared to industry engagements in the previous period (averaging about 200 industry engagements per year). Overall, this figure reflects the successful consolidation of KCMC within its host organisation CPI, and the increased resourcing within the Knowledge Transfer team to support the needs of its Research Institution partners.

The balance of support that KCMC provides across industry sectors has shifted towards chemicals and materials companies that operate over multiple downstream sectors; constituting 62% of total KCMC support in the April 2018 – March 2019 period (vs 54% the previous year). The top 4 industry sector groupings outside of this are: Engineering; Life Science, Food and Agriculture; Energy and Environment; Electronics and Photonics.

The spread of companies engaged by type shows no significant change from prior years, as demonstrated in Figure 1.

Throughout the year, 57 new companies were recorded in our customer database. The majority of these are SMEs (65%) – either early stage, start-up companies or more established SMEs seeking to expand their business capability. The second biggest category is non-UK companies (29%), constituting either overseas-based or foreign-owned UK business subsidiaries.

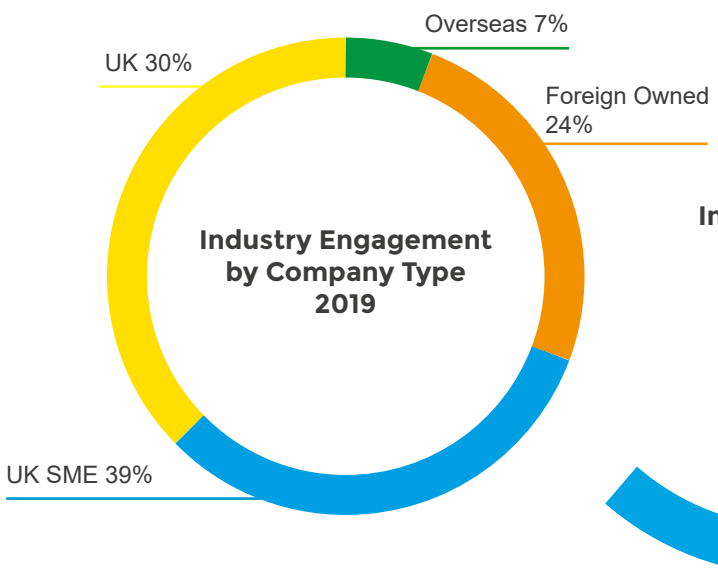


Figure 1

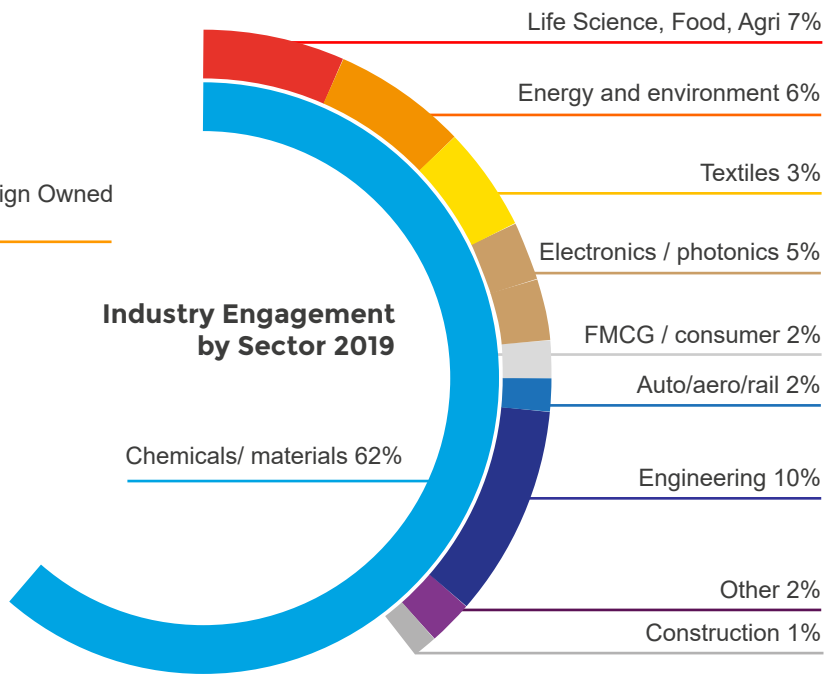


Figure 2

Facilitate

KCMC facilitates connections for a large and structured multi-sector materials network focused on materials chemistry innovation. We overcome challenges for businesses by leveraging the knowledge of our network, our partners and the wider innovation landscape.

In this reporting period, the conversion rate from initial communications to project discussions is at 21%, which is in the middle of the historic range (16% to 25%). The total number of project discussions is consistent with the previous year (71 in 2017/2018 vs 68 in 2018/2019). However, this represents a smaller proportion of total engagements, reflecting the length of time it takes to get from initial communications to project discussions. In line with long-term trends, about 22% of initial discussions with companies have led to referrals outside the KCMC Research Institution partners.

Following the transfer of KCMC from the KTN to its new hosts at CPI, it is noticeable that an increasing number of referrals are being made to access resources within the Catapult network. This relates predominantly to CPI but also includes the National Composites Centre (NCC) and Offshore Wind Energy Centre (OREC). These referrals have mainly consisted of signposting companies to access the Catapult's capabilities, but have also included engagement on cross-Catapult strategic initiatives. A key activity for KCMC has been supporting the development of industry networks in materials innovation through the KCMC Industry Steering Group. This typically involves up to 20 companies in discussion on the subject of their materials chemistry innovation challenges, and links with the UK's Industrial Strategy Challenge Fund (ISCF) led by Innovate UK.

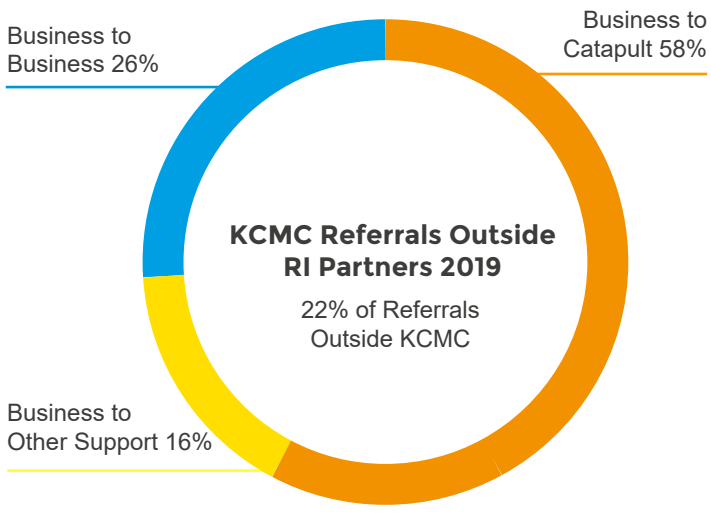


Figure 3

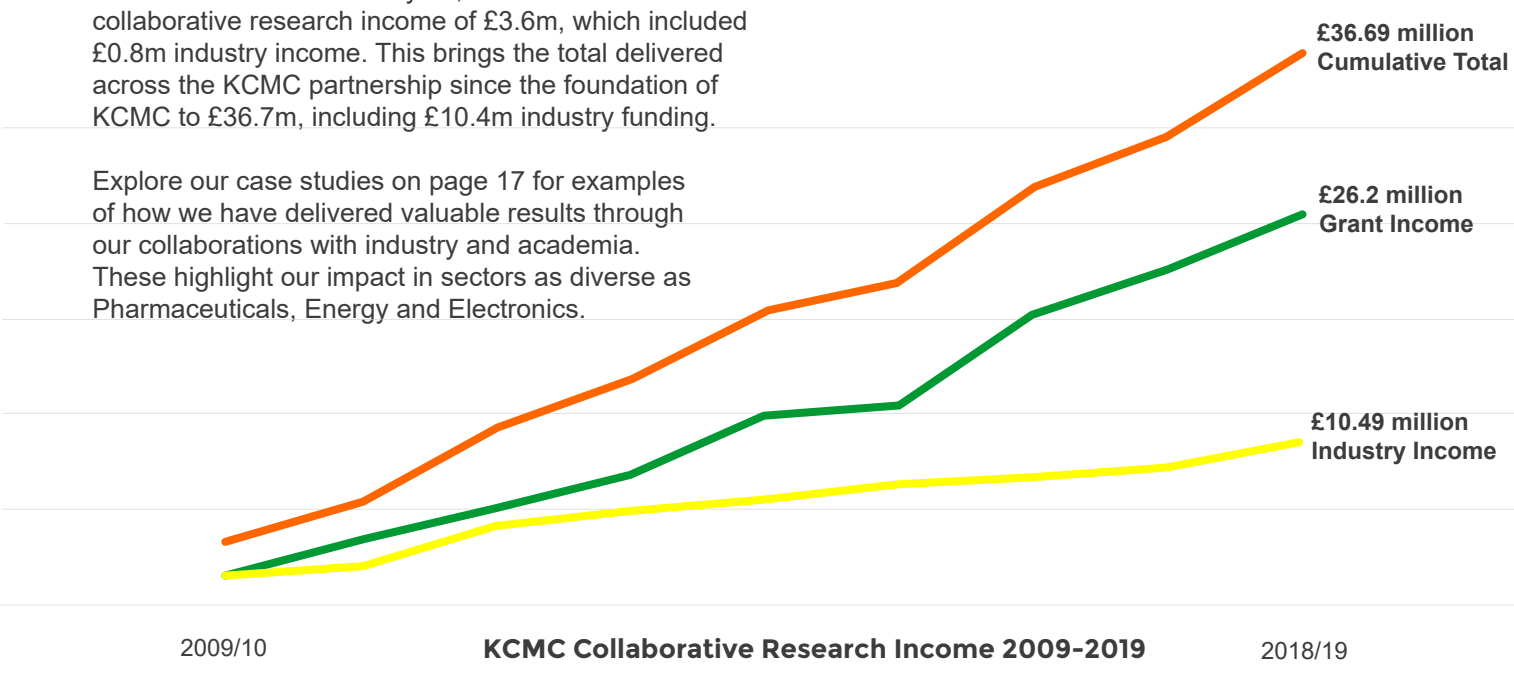
Deliver

KCMC continues to deliver research collaborations between industry and the research institution partners.

In the 2018/2019 financial year, KCMC delivered a collaborative research income of £3.6m, which included £0.8m industry income. This brings the total delivered across the KCMC partnership since the foundation of KCMC to £36.7m, including £10.4m industry funding.

Explore our case studies on page 17 for examples of how we have delivered valuable results through our collaborations with industry and academia. These highlight our impact in sectors as diverse as Pharmaceuticals, Energy and Electronics.

Figure 4



KCMC Collaborative Research Income 2009-2019

WORKING TOWARDS A PIPELINE OF OPPORTUNITY IN NEW MATERIALS

In parallel with the transition to being hosted by CPI, we are starting to see evidence of both the challenges and opportunities for delivering a pipeline of innovation in new materials. This builds on our strengths in science and technology within the UK materials chemistry industry.

In the last reporting period, Innovate UK funding laid the foundations for a number of projects across KCMC research partners and CPI. These projects have supported exciting developments in areas including materials for the battery supply chain, materials for the bio-economy and materials for composites and printable sensors. We are now using this knowledge to work with industry, research and Catapult partners to improve our ability to translate concepts on the innovation journey from initial research to market.

A key support service that we can already offer to University spin-out companies is access to CPI's innovation expertise, for example through its Innovation Integrator©. KCMC research partner spin-outs have already worked with CPI innovation experts on 4 key developments, arising from research activities at the University of Bristol, University of Southampton and University of Liverpool.

Partner Updates

University of Southampton

This year has seen a £12 million investment in our School of Chemistry, including a complete renovation of our main building and the teaching laboratories. With a new state-of-the-art teaching space and more opportunities for experimental and analysis work, we are now able to deliver an even better student experience.

The School's research excellence has also been recognised, with major grants awarded in: gel phase crystallisation; funding of Phase III of Dial-a-Molecule; the establishment of the EPSRC Physical Sciences Data-Science Service (PSDS); an ERC Synergy Grant (with the Universities of Liverpool and Rostock) on Autonomous Discovery of Advanced Materials; NMR studies on endofullerenes showing rare and sometimes enhanced signals; the establishment of a 2D gas chromatography system linked to a high-resolution mass spectrometer for analysis of highly complex mixtures.

Southampton remains at the forefront of battery development, with involvement in six key projects aimed at addressing the Faraday Battery Challenge. These range from the extension of battery life through multi-scale modelling to new routes to sodium ion battery materials. As part of the Faculty of Engineering and Physical Sciences, the School of Chemistry collaborates with the Schools of Electronics and Computer Science, Engineering, Physics & Astronomy, as well as the Optoelectronic Research Centre. The University has also recently opened its £48M National Infrastructure Laboratory which through its Testing and Structures Research Laboratory (TSRL) will facilitate the evaluation of materials and composite manufacturing.

UKRI Science and Technology Facilities Council

The STFC Hartree Centre is continuing to ensure the UK remains at the forefront of industrial innovation by accelerating the adoption of high-performance computing (HPC), big data and cognitive technologies. A particular highlight of this year was the launch of the Industrial Digitalisation Accelerator (IDA) programme, in collaboration with Siemens and Atos. It offers businesses of all sizes a practical, collaborative space to explore Industry 4.0 technologies by uniting complimentary experts in the fields of computing, analytics and the internet of things (IoT).

Through its partnership with the LCR 4.0 business support programme, the Hartree Centre has also helped generate 80 new jobs and £2.6m GVA within the SME manufacturing sector in the Liverpool City Region.

An additional success of this year was the creation of The Hartree Centre's first spin out company, Formeric Ltd. The company enables manufacturers and materials scientists to use the world leading expertise and supercomputing technologies of the Hartree Centre to accurately predict the behaviour and structure of liquid compounds. It is the exciting result of the first project under the Joint Development Agreement between IBM Research and Unilever, aiming to develop new computer software and advanced modelling capabilities that will transform the competitiveness of the UK industry.

The University of Manchester is continuing to invest in its Research Beacons (advanced materials, cancer, Energy, global inequality and industrial biotechnology). These are cross-sector partnerships that address some of the biggest questions facing our planet. Particular highlights in 2019 were the opening of the Graphene Engineering Innovation Centre (GEIC) and the rapid construction of the hub building for for the Henry Royce Institute for Advanced Materials (HRI). The GEIC focusses on speeding the development and scale up of graphene and other 2D materials, complementing the work of the National Graphene Institute at the leading edge of research into 2D Materials.

The development of sustainable materials has been identified as a major focus of the Chemical Materials Discovery research theme of the HRI and recent investment in infrastructure (£3.6M) supports the development of more sustainable materials and involves new activities in the Manchester Institute of Biotechnology, indeed developing new materials from biology is a major theme of the recently funded Future Manufacturing Hub in Biotechnology (futurebrh.com).

Finally a significant proportion of the UK Research Councils' funding for postgraduate research studentships is now awarded to institutions via Centres for Doctoral Training (CDTs), the University of Manchester, has three CDTs relevant to Materials Chemistry: one of them is focussed on Advanced Biomedical Materials, the second on Integrated Catalysis, training students in chemical catalysis, biological catalysis and process engineering. And finally, the third in the area of Nuclear Technology, which involves five universities: Lancaster, Leeds, Liverpool, Manchester and Sheffield.

During 2019, Professor Neil Berry was appointed to head of chemistry department. Neil's research focus is in molecular modelling to understand chemical systems and predict molecular properties.

Professor Matt Reed (formerly Open Innovation Director at Unilever PLC) has also been appointed to a new role as Strategy Director for the Materials Innovation Factory (MIF) and will help to deliver the vision and drive for both academic and commercial impact from the facility.

Operational since 2017, and officially opened in October 2018, the MIF provides a unique environment for both academic and industry research and collaboration, and is a core capability underpinning delivery of the University of Liverpool's priority research themes in Advanced Materials and Digital. The MIF builds off academic excellence in materials chemistry including organic materials, inorganic materials, nanomedicines, sustainability and high throughput formulation/ automation, and is a globally unique facility which enables faster and smarter innovation benefitting a wide spectrum of market sectors. The MIF also houses the Leverhulme Centre for Materials Design, created to drive a design revolution for functional materials at the atomic scale. The centre fuses leading edge synthesis concepts from the physical sciences with ideas as the forefront of computer science, alongside experts in robotics, engineering management and social science. MIF also hosts the Chemical Materials Design spoke of Henry Royce Institute, the national institute for advanced materials research and innovation. This state-of-the-art investment in equipment and facilities is available for use by both industry and academia.

The University of Bolton's Institute for Materials Research and Innovation continues to deliver applied research and deep knowledge transfer to industry partners. This has been achieved through several mechanisms such as Innovate UK's Knowledge Transfer Partnership scheme. By building from its unique capabilities in fire materials research, led by Professor Baljinder Kandola, the university is helping to solve critical issues in the supply chain arising from REACH legislation. In addition, the university is helping to develop next-generation fire retardants and fire retarded products found in everyday life, ranging from soft furnishing to laptops and composites for transport. IMRI expertise in sensors and microelectronics is also being applied in the development of medical devices.

The KCMC Materials Innovation Translator Programme

Launched in 2017, the KCMC Materials Innovation Translator (MIT) programme aims to improve the delivery of knowledge transfer between academia and industry. Supported by a £0.5 million investment from the High Value Manufacturing Catapult, the programme recruits leading early career researchers as Project Scientists to work at KCMC's partner organisations.

Each Project Scientist coordinates between industry and academia while working on R&D projects that aim to solve important materials chemistry based innovation challenges. Here, we share the journey of the Project Scientists, Chenhau Sun, Marion Specht and Aiman Rahmanudin across their time on the programme.

Chenhau Sun
University of Manchester

After completing a PhD focussing on sustainable bioplastics at the University of Manchester in 2018, Chenhau remained at the university and joined the MIT programme held there. This allowed him to pursue his interest in contributing to the industrial delivery of the research that came out of his PhD. During the programme, Chenhau collaborated with both academics and companies to help to develop and industrialise the terpenoid manufacturing process.

To achieve this, Chenhau performed a technical economic analysis, which involved testing the process at a lab scale. This was in order to evaluate its feasibility for use in industry, as well as potential bottlenecks during scale up and the potential profit margins. After the programme, Chenhau used his newfound experience and understanding of materials chemistry commercialisation to secure a Research Fellow position at the newly founded Future BioManufacturing Research Hub in Manchester.

Marion Specht
University of Southampton

Marion entered the MIT programme immediately after her PhD in Physics. She was intrigued to learn about how everything undertaken in the lab is transferred to industry, as this is not an opportunity scientists are often able to pursue. She was placed at Southampton to work on a project aiming to alter the technology of a desktop inkjet printer and enable it to print novel materials.

Due to the experimental nature of the project, Marion attended regular meetings with experts from CPI to test and troubleshoot the technology. Through this she gained an understanding of the knowledge transfer that is required to industrialise and scale-up academic research. By reflecting the KCMC collaborative ethos, Marion leveraged her new academic and industrial contacts gained through the programme, and secured a research fellow position in Southampton.

Aiman Rahmanudin
University of Manchester

Aiman, who holds a PhD in materials chemistry, learned of the MIT programme through his postdoc work with industrial and academic partners. Aiman's role within the programme was to support the use of graphene and plastic to develop a sensor platform that could be adapted for multiple applications. This work went into two industrial projects: one to create a hybrid sensor and the other to create sensors for environmental applications.

A major focus of Aiman's projects was to ensure that the platform incorporates scalable processes as it was developed. This helped him to understand how industrialisation processes influence the desired properties of the product. To achieve this, he worked with one of CPI's industrial clients to optimise the scale-up process. This highlighted the distinct stages of scaling up a product derived from academic research: from lab scale to proof of concept scale, then to pilot scale, and finally reaching the industrial scale. Since the projects involved multidisciplinary collaborations between different partners and different fields, Aiman learnt from and shared his knowledge with chemists, physicists, electrical engineers, computer scientists and business development executives. Aiman was given an 18-month contract on the MIT programme, and has been given a one-year extension thanks to promising results. Using his newly gained skills and valuable experience, he is now applying for further grants as well as a fellowship to continue his work in Manchester.

When asked if they would suggest the MIT programme to future postdocs, Chenhau, Marion and Aiman all highly recommended it. They each highlighted the importance of accounting for the requirements needed to scale up the technology under development. The programme gave each project scientist a comprehensive overview of the knowledge transfer requirements when transitioning from academic research to industrial development. It also emphasised the importance of materials chemistry research in underpinning the development of end-products across a range of applications. Initiatives such as the MIT programme help the UK to accelerate innovation and contribute to long term economic growth. The MIT programme also supports projects scientist appointments in battery research and advanced surface deposition processes at the University of Liverpool, and fire materials science at the University of Bolton.

> "The programme gave project scientists the opportunity to work closely with companies, deploying academic research capabilities to accelerate industry led innovation."

Dr Steve McBride
KCMC Knowledge Transfer Manager

Success at the Henry Royce Institute

The partnership between KCMC and the Henry Royce Institute for advanced materials has continued to drive the commercialisation of materials chemistry innovations. Operating as the UK's flagship for creating transformative new materials and systems, the Royce is tackling global challenges, enhancing industrial productivity and shaping the world around us.

The Royce has seen the appointment of its new CEO, David Knowles. He brings a wealth of experience in materials science from a number of senior academic and industrial positions. David shares his time between the Royce, working as a Professor of Nuclear Engineering at the University of Bristol, as Co-Director of the South West Nuclear Hub, and as an Atkins Fellow.

David has brought a strong focus on accelerating materials research, knowledge transfer and commercialisation to the Royce. Under David's leadership, the Institute has already collaborated with over 200 organisations to tackle major societal challenges, including sustainable plastics, decarbonisation and improving electronics efficiency. Working with KCMC's complimentary network of industry contacts, businesses looking to innovate have clocked over 90,000 hours of use with the Royce's facilities. This has helped to forge collaborations between industry and academia, and secure investments that are translating materials innovations into commercial products.

Exciting ongoing projects include SUSTAIN, the recent £35 million investment led by Swansea University to develop manufacturing hubs across the UK, including the University of Sheffield. SUSTAIN will benefit from the Institute's facilities for Advanced Metals Processing on smart, carbon neutral steel. The Royce Accelerator Tokens funding scheme has also been a great success, supporting 21 projects which have impacted SME's and start-ups by reducing the cost barriers to access equipment and facilities.

In May, the Royce announced the completion of its Advanced Materials Characterisation Suite, located in the Alan Turing building at the University of Manchester. This facility aims to drastically increase accessibility for the advanced performance testing of products. Looking forward into this year, the Henry Royce Institute Hub Building in Manchester will be completed in March 2020. This flagship building will house £150 million in lab facilities, and will act as a meeting space between academics and industry. It aims to significantly widen the reach of the Royce in materials science and increase collaborative potential in the UK.

The Royce plans to introduce its new 'Advanced Materials for Sustainable Society' strategy this year. It will identify and tackle the most pressing environmental challenges with materials research, including plastic sustainability and achieving net zero carbon emissions in the UK by 2050. To achieve this, the Royce will bring together key stakeholders and government institutions alongside research institutions and industry. This will enable long-term strategies to be developed that encompass the supply chain, helping to position the UK as a leader in the area.

Images provided by the Henry Royce Institute

David Knowles
Chief Executive Officer,
Henry Royce Institute

To keep up to date with activity at the Henry Royce Institute visit www.royce.ac.uk

Case Study:
MagnaPharm

MagnaPharm

Utilising high magnetic fields to direct polymorphism in pharmaceuticals

At a glance:

The MagnaPharm project aims to create controlled crystalline structures of pharmaceutical molecules through the use of high magnetic fields. This would have a transformative effect on almost all pharmaceutical compounds, and hence on society.

This collaborative research project is led by Dr Simon Hall, Reader in Materials Chemistry at the University of Bristol, and is funded by the European Union's Horizon 2020 Research and Innovation programme (grant No. 736899).

Challenge:

Polymorphism, the ability of solid materials to exist in two or more crystalline forms, can have a significant effect on the physicochemical properties of pharmaceuticals and therefore on therapeutic outcomes.

It is therefore crucial that research into how to reliably produce polymorphic forms of different pharmaceuticals is conducted.

Approach:

The MagnaPharm project is developing a unique and extremely promising approach based on the innovative application of magnetic fields to organic crystal growth.

Recent proof-of-principle experiments have produced an unknown polymorph of the polyaromatic hydrocarbon, coronene, in a magnetic field. The new β-coronene crystal is the lowest energy polymorph and exhibits a remarkably altered angle between the molecular planes. This provides evidence that prior to crystal growth, strong magnetic fields couple to organic molecules and enable the orientation of pre-crystallisation clusters of different polymorphs in solution.

Benefits:

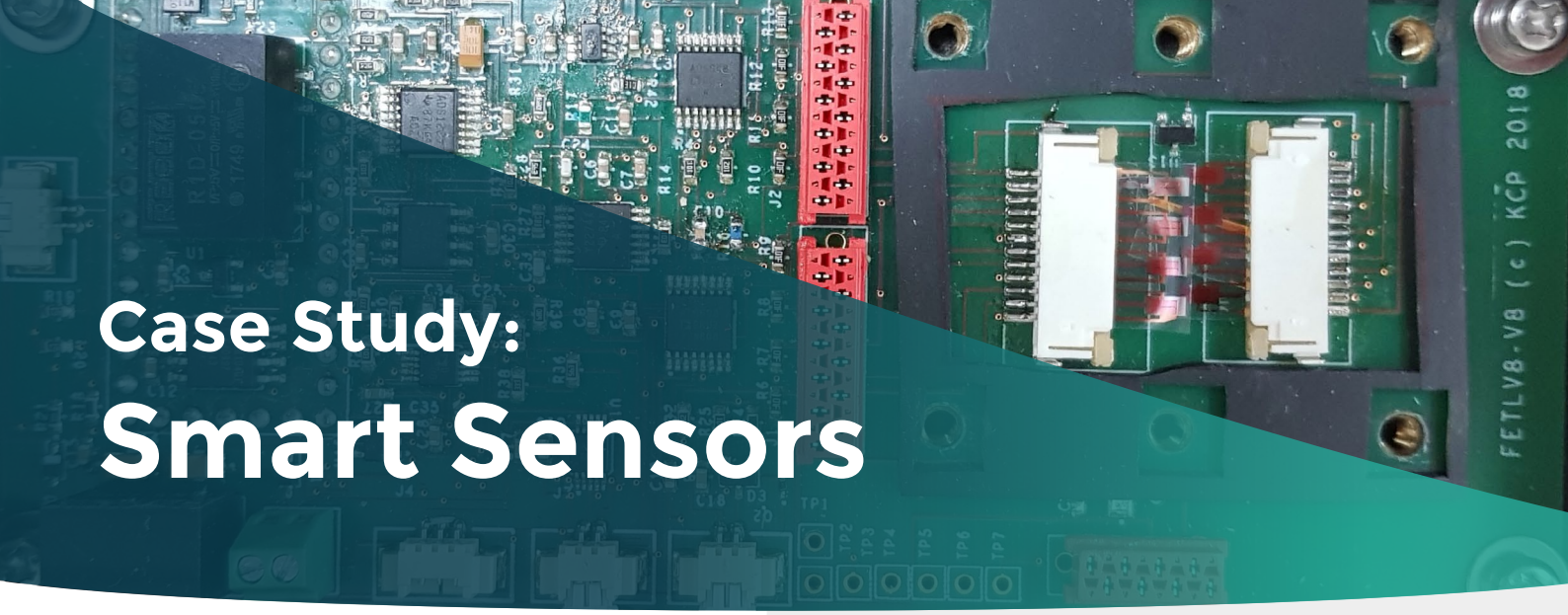
The results of this preliminary experiment are the first concrete step towards reliable production of desired polymorphs of pharmaceutical compounds. Applying this magnetic field approach to crystal growth in pharmaceuticals will transform the industry irrevocably and for the better.

KCMC support:

KCMC supported the project by helping to establish industry collaborations and secure European funding. Thanks to KCMC's established network of contacts, a partnership with AstraZeneca was set up whereby solubility testing will be performed on the materials produced as part of the project.

Timeline:

Ongoing, started in 2017. The research stage will finish in two years' time.



Case Study:
Smart Sensors

Smart Sensor Devices

Setting the foundation for future technology trends

Challenge:

Robust sensor systems that respond selectively to specific chemicals in a wide range of environments are often required to enable more sophisticated measurement and control systems or “point of use” measurements. Meeting the physical requirements of a number of these measurement challenge often means that adopting either a conformal or flexible sensor technology offers significant advantages over a planar and physically rigid technology. Combining printed and flexible electronics with conventional silicon-based electronics i.e. a hybrid technology platform, can often deliver a solution to a measurement challenge that combines the attributes of both types of electronics.

Approach:

Researchers at the University of Manchester have used polymeric semiconductors to produce flexible, organic field effect transistor (OFET) sensor arrays. These can detect a wide range of gas molecules, including those present in the environment (e.g. oxides of nitrogen, carbon monoxide), those given off by food (e.g. amines) and volatile organic molecules (e.g. esters, fatty acids) emitted by humans. Researchers at the University of Cambridge developed a printed operation amplifier (OpAmp) that can be combined with the printed OFET sensors to generated an integrated system on a flexible foil substrate.

The iPESS project combined the research of both institutions to deliver an integrated technology platform that can meet several of the measurement challenges of interest to UK based companies. The KCMC helped to facilitate the interaction between the iPESS project and several companies. This included the development & execution of the number of collaboration projects aimed at the application of the iPESS sensing technology to a number of commercially relevant measurement requirements.

At a glance:

Developing low-cost, integrated smart sensor systems to address many measurement challenges is a priority within a number of important applications in areas including the Internet of Things (IoT), agricultural monitoring, personal health monitoring and the operation of ‘smart buildings.

The iPESS project focused on developing a commercially viable smart sensor technology platform by combining novel printed flexible electronics with conventional silicon electronics. Collaboration with industry partners ensured that the technology was relevant to applications from multiple industry sectors.

This project combined the expertise of researchers from the University of Manchester and the University of Cambridge with commercially important measurement requirements from companies via the KCMC network.

Benefits:

The sensing technology platform developed by the iPESS project is flexible, thin and light and is suitable for applications across a wide range of form factors. Moreover, it was produced with processing from solution that is compatible with commercial printing processes over large areas.

The sensor provides sensitive and selective detection of gas molecules at industrially relevant concentrations, while operating at low voltage operation and low power consumption. It also can be integrated into systems utilising conventional silicon electronics to provide specific functionality.

Timeline:

The first phase of the iPESS ran from 2014 to 2017. Following from the success of the first phase a second phase of the project was funded from 2017 to mid-2019.

Case Study:
ADEPT Project

adept
Advanced Devices

Aiming to enhance the UK's manufacturing capability of nanoscale components using chalcogenides

At a glance:

The goal of the ADEPT project is to advance state-of-the-art component design and electrodeposition to operate on the nanoscale level. This could transform the technical capabilities of thermoelectric materials, infrared detectors and phase change materials.

This is a large-scale interdisciplinary research project, which is funded with over £6 million from the Engineering and Physical Sciences Research Council (EPSRC) spread across the Universities of Southampton, Warwick and Nottingham.

Challenge:

In order for the UK to meet the rapidly growing demands for more advanced thermoelectric materials, infrared detectors and phase change materials for computer memory, electronic components must become smaller, faster and more efficient. It is therefore essential to maximise industry exposure of this technology and to create greater opportunities for technology transfer.

Approach:

To support the project, a full day meeting was held at St Mary's Football Stadium in Southampton to explore the cutting edge of chalcogenides research in the UK. It was attended by academics and industry experts in energy harvesting, detector technology and phase change memory for computing applications.

The outcomes of the meeting are currently being used to formulate a bid for a new EPSRC network grant. The grant will aim to support translation of ADEPT scientific breakthroughs into the UK's capability in the manufacture of nanoscale structures and components.

Benefits:

Through the meeting, a greater exposure of the research was achieved. This was by communicating to academic and industry experts that producing structures at the nanoscale could enhance their observed effects and enable the production of smaller, faster and higher density components. Work is currently underway to form collaborations with academics and industry experts with aligned research interests.

KCMC support:

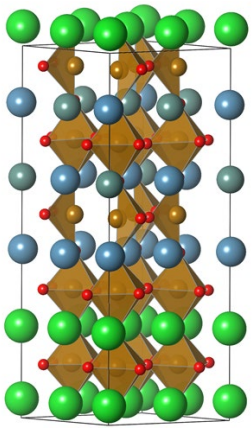
KCMC supported the project by using its established network of contacts to promote the attendance of companies with aligned interests at the meeting - facilitating industry collaborations. KCMC also provided ongoing assistance with the planning and marketing behind the meeting.

Timeline:

The project is ongoing and will be complete in Q1 2020.

Pioneering Materials Discovery – the search for Transparent Conducting Materials

NSG Pilkington are world leaders in the manufacture of glass and glazing solutions of which a critical component is the functional glass coatings that serve high value applications in markets such as automotive, architectural glass and displays. Through the KCMC partnership, NSG are collaborating with Professor Matt Rosseinsky, Dr Matthew Dyer and Dr Chris Collins at the University of Liverpool, and the Hartree Centre (part of STFC) to discover new high performance transparent conducting materials, underpinning the development of next generation market leading products.



Example crystal structure generated by MC-EMMA on Scafell Pike

The approach combines computational methods to explore structural and compositional space using MC-EMMA computational code developed by the University of Liverpool in the "Integrating Computation and Experiment to Accelerate Materials Discovery" programme grant supported by EPSRC, with super computing capabilities ("Scafell Pike" platform) based at Hartree to increase the scale of the search – the software engineering expertise of the Hartree team has been essential in optimising the codes on this platform. The University of Liverpool team has successfully used this approach to discover new materials with properties relevant to LED lighting and energy generation and storage, and are developing a suite of codes integrated with experimental approaches for functional materials discovery. Promising candidate materials arising from the programme with NSG will be evaluated by experimental synthesis and deposition followed by property evaluation.

The transfer of key discovery tools from the University of Liverpool to Hartree was enabled through the KCMC's Materials Innovation Translator funding programme providing computational scientists to optimise and port the materials discovery code. Subsequently funding was secured for a 2 year PDRA appointment of Dr Andy Zeng, who works across the three project partners with assistance from the EPSRC Impact Accelerator Account (Secondment), and access to STFC facilities via the Bridging for Innovators scheme (https://stfc.ukri.org/funding/research-grants/funding-opportunities/closing-calls/bridging-for-innovators-funding-programme/).

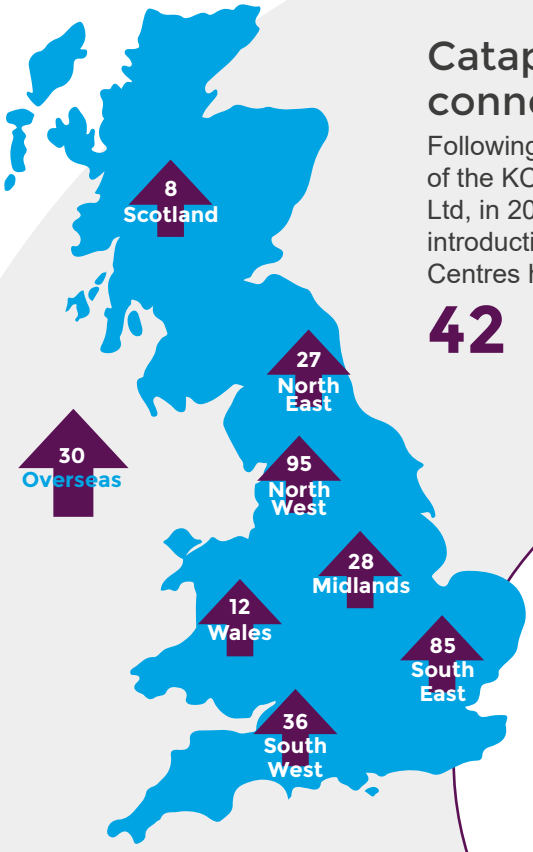
Dr Su Varma, Programme Director of the NSG Group R&D Incubator commented "This collaboration is a result of a global search for expertise in new materials discovery, which identified the University of Liverpool as world leaders, reflecting the EPSRC investment that developed the capabilities underpinning the current project. The approach represents a commitment from NSG to exploit digital methodologies to drive and expedite materials research in new product development".

We would like to thank Su Varma for his sustained contribution to KCMC activities and particularly his involvement in the KCMC's industry steering group and governing board.

> "The approach represents a commitment from NSG to exploit digital methodologies to drive and expedite materials research in new product development."
>
> **Su Varma**
> R&D Incubator Programme Director, NSG Pilkington

Connect

KCMC has made 321 business engagements across the UK and internationally



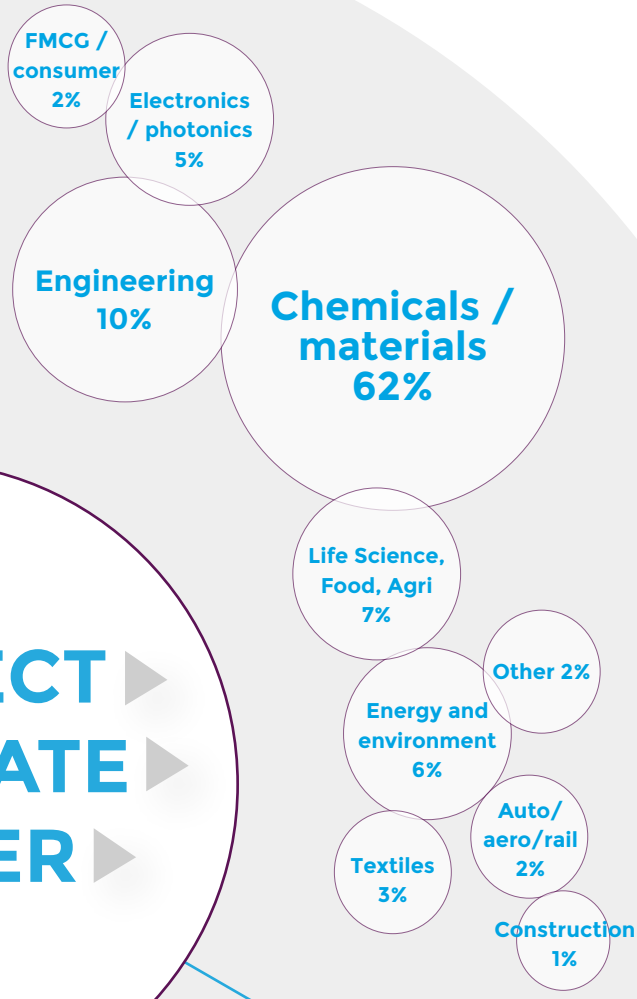
Catapult connections...

Following transfer of the KCMC to CPI Ltd, in 2019 KCMC, introductions to Catapult Centres have risen to

42

Facilitate

KCMC has facilitated projects within key Industry Sectors



CONNECT ▸ FACILITATE ▸ DELIVER ▸ 2019

£10M
Industry Cash

£8M
Core Government Grant

£26M
Competitively Won Grant

Deliver

Leveraged £36m Collaborative Research Income from £8m Core Grant

KNOWLEDGE CENTRE
MATERIALS CHEMISTRY

CONNECT ▸ FACILITATE ▸ DELIVER

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cpi

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UNIVERSITY OF Southampton

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University of Bolton

UNIVERSITY OF LIVERPOOL