BRAGG CENTRE FOR MATERIALS RESEARCH
ANNUAL REPORT

2019/2020

UNIVERSITY OF LEEDS

Contents

Welcome from the Director

Prof. Edmund Linfield,
Director of the Bragg Centre

Welcome to the first Bragg Centre Annual Report and what a year it has been!

Despite all that has happened, it has been a pleasure to see such a broad range of successes from Bragg Centre researchers, and I hope that you will enjoy reading about some of these in this annual report. Indeed, we soon found that we had too much material to include, and so you will find additional case studies spotlighted on our website alongside this report.

From the outset, the Centre has aimed to support an inclusive environment that inspires, attracts, nurtures and retains the best talent. Our community has now over **200 members**, including our new **Bragg University Academic Fellows**, and we have been delighted to welcome our first cohort of **Bragg PhD Studentships**.

We have been very busy throughout the year developing the Centre in line with our emerging vision to be an international hub of research excellence in materials science. The productivity and recognition of our community continues to go from strength to strength, with a current grant portfolio in excess of **£80 Million**, over **400 publications** generated over this reporting period, and the award of several prestigious medals and fellowships. In particular, the securing of funding to establish the Wolfson Imaging Facility will help support our expertise in *in situ*, in operando and transient measurements in the future. Furthermore, we have strengthened considerably our engagement with industry, and look forward to capitalising on several emerging partnerships in the coming year.

We have continued to develop our ongoing partnership with the Henry Royce Institute, as one of its Founding Partners. This has included development of our Royce facilities, and the provision of external access to industrial users and PhD students totalling **1500 hours** throughout the year. We have also jointly led a national roadmapping initiative to explore material solutions to achieve the UK's ambitious target of net zero carbon emissions by 2050, taking responsibility for activities associated with the development of 'low-loss electronics'.

We believe that the Bragg Centre has a very important role to play in public engagement and being advocates for materials science. It has thus been a real pleasure to be part of a new initiative this year: the Bregg Centre Creative Labs. This brings together artists with scientists and engineers to co-create new ideas, and has flourished from its inception. We look forward to capitalising on this success in the coming year, expanding our influence beyond the Bragg Centre to inspire future generations of material scientists and stimulating inclusivity from the outset.

Finally, I would personally like to extend my thanks to all those who have contributed to the success of the Bragg Centre. To our External Advisory Board, who have provided invaluable advice both formally and informally. To our Management Committee, for their careful stewardship of Bragg Centre activities. To the Bragg Research and Innovation Team (Andy, Helen, Katharina and Mike), for all the support they have provided to our membership, and for their work in putting together this report. And finally, to you, our Members – it is your diversity and successes that have created such a vibrant community, even when working on-line for much of the year. It is a true pleasure to be part of this community.

Our progress in perspective

Perspective from the External Advisory Board

Prof. Dame Julia Higgins DBE FRS FREng,

Chair of the Bragg Centre External Advisory Board

The External Advisory Board of the Bragg Centre held two meetings this year and these could not have been more different in circumstance. In January, the Board travelled to Leeds for two days of meetings and the Centre's annual research symposium. When we parted, our intention had been to visit again in the summer for a range of meetings and to see the new building. How the situation changed in the next month or so! Like so much of working life these days, we had to hold our interim meeting virtually.

However, across both meetings, we have been extremely impressed by the range of research being presented and also the rate at which the new building is being completed. The Board gained an overwhelmingly favourable impression of the Centre in these very difficult times, and with the progress it has made towards meeting our recommendations.

It is clear that there is very good quality and potential for science in the Centre. We believe that the interplay between the large number of disciplines involved with the Centre, as well as excellent access to a broad range and quality of facilities, allow us to encourage the Centre to aim high. We have been particularly impressed with the excellent spirit, enthusiasm and ideas of the University Academic Fellows and other early career researchers, who are a source of strength for the Centre, both now and in the future.

We think that the main priorities for the Centre over the next year should be to refine its focus, particularly on more challenge-led research; in getting industry and other end users involved as true partners in research; and in ensuring that the move into the new building doesn't distract from progress in establishing the Centre and realising what should be its ambitious aspirations.

The rest of the Board and I look forward to continue to participate in what should be an exciting journey ahead.

Comment from the Deputy Vice-Chancellor

Prof. Nick Plant,

Deputy Vice-Chancellor: Research and Innovation

The University's Research and Innovation Strategy aims to build a research culture and environment that places the University of Leeds at the centre of a global Research and Innovation community. Building on our strengths in disciplinary fundamental research, we will combine these in a truly transdisciplinary fashion to create research that advances knowledge and creates solutions to local, national and global challenges

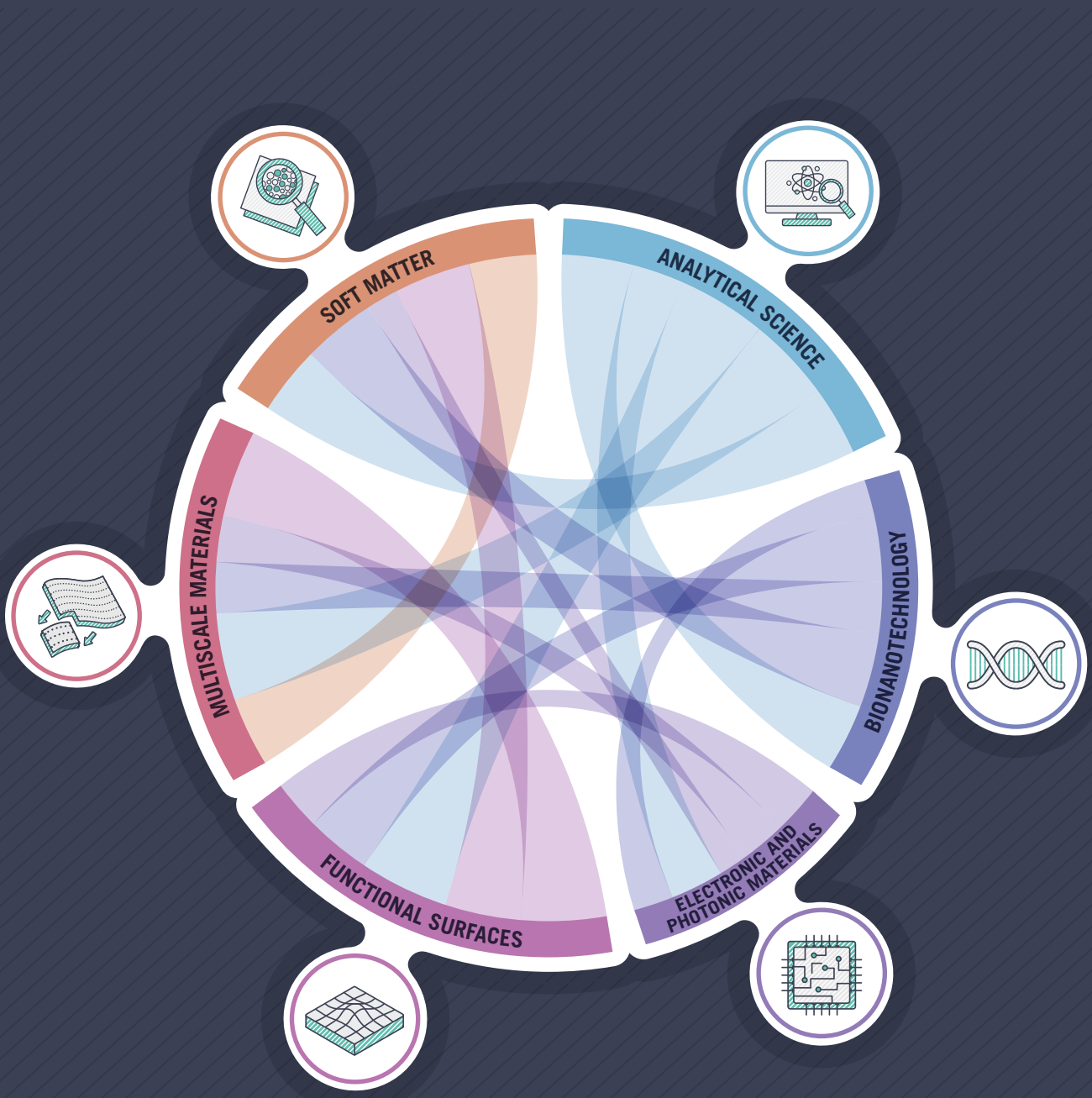
The Bragg Centre epitomises this strategy: it is a flagship activity that brings together materials researchers from across the campus, working across traditional School and Faculty boundaries, promoting our world-leading research nationally and internationally.

It is a real pleasure to see all that has been achieved by the Bragg Centre in its first full year of operation. The enthusiasm and drive of its researchers has led to major new grants, fellowships and prizes being awarded, while the wide-ranging collaborations being established with academia and industry testifies to the strength of materials research at Leeds. I greatly look forward to seeing what happens in 2021 as we move into the Sir William Henry Bragg Building.

The makeup of the Bragg Centre

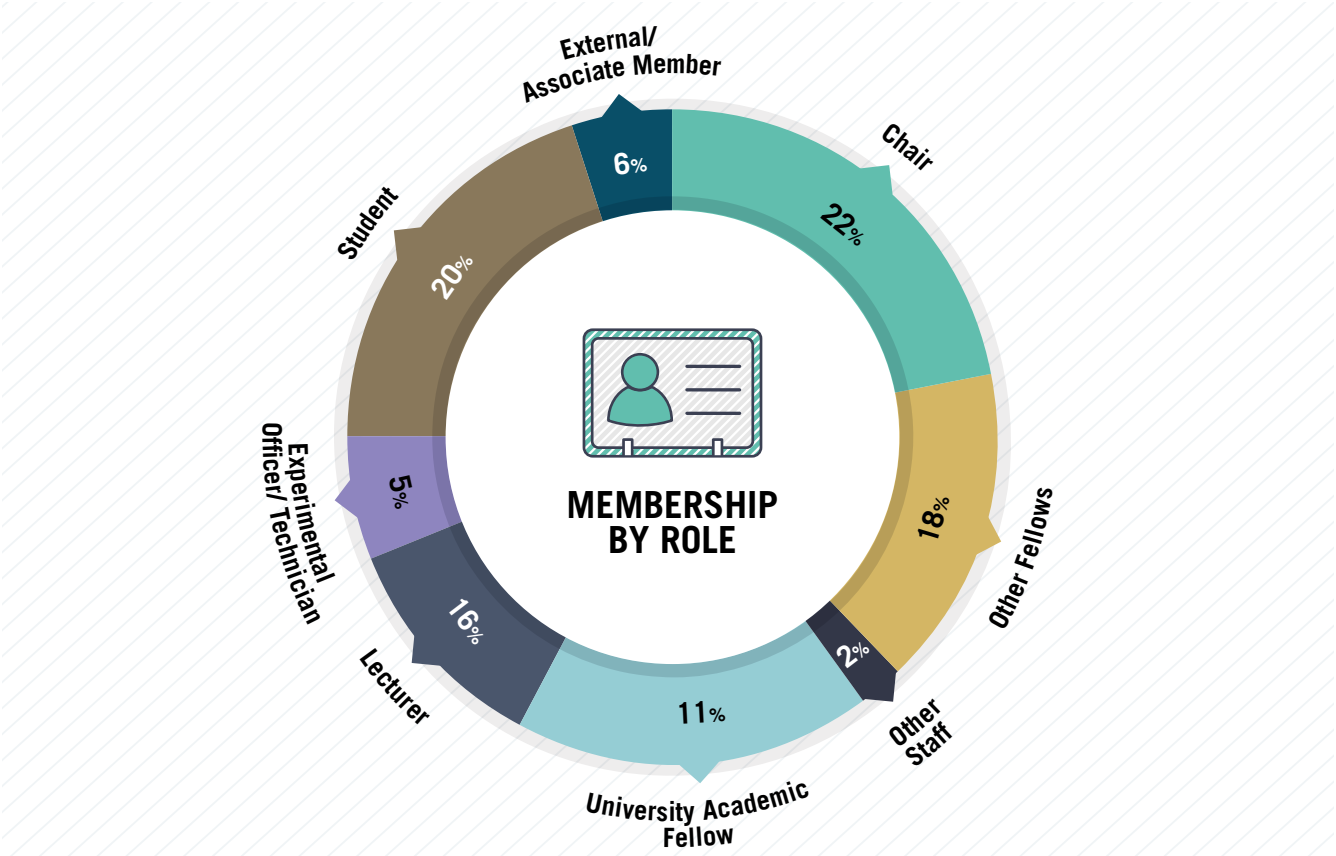
Research themes

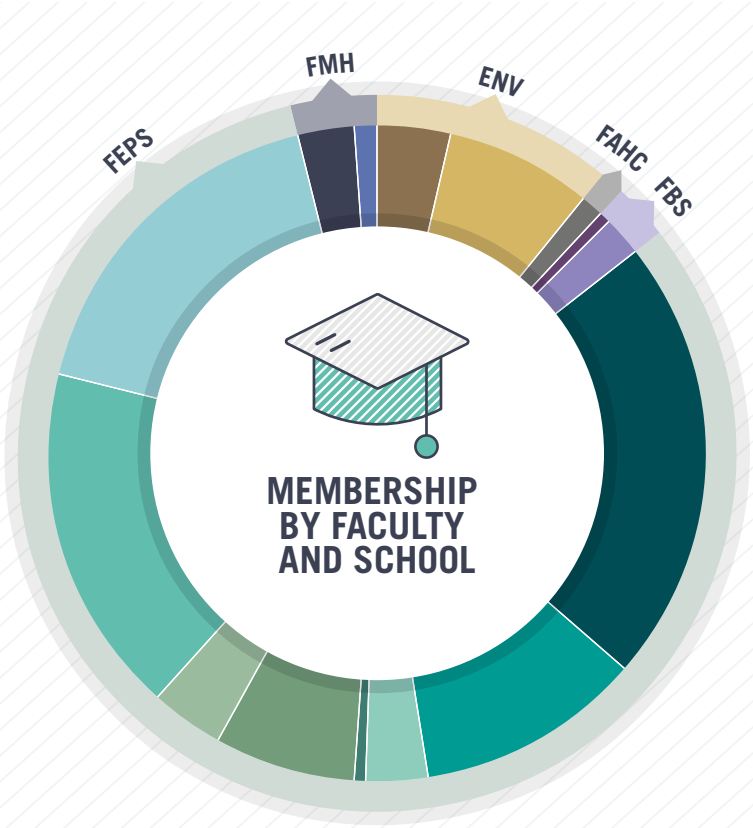
The broad range of our research activity is split into six distinct research themes, although it is notable that there remains significant interdependence with many of our community reaching across thematic areas. In particular it is clear that the Analytical Science theme (shown in blue) provides underpinning support for much of the other research activity within the Centre. The relative size of these thematic connections is clearly articulated below.



Our community

Throughout the year our membership has continued to grow, with 205 members from 15 schools, across five faculties accompanied by a host of external associate members. Our ethos remains truly interdisciplinary.





Faculty of Engineering & Physical Sciences (FEPS)
- 42 Chemical & Process Engineering
- 21 Chemistry
- 6 Civil Engineering
- 1 Computing
- 13 Electronic & Electrical Engineering
- 7 Mathematics
- 33 Mechanical Engineering
- 33 Physics & Astronomy

Faculty of Medicine & Health (FMH)
- 5 Dentistry
- 2 Medicine

Faculty of Environment (ENV)
- 7 Earth & Environment
- 14 Food Science & Nutrition

Faculty of Arts, Humanities & Cultures (FAHC)
- 2 Design

Faculty of Biological Sciences (FBS)
- 1 Biology
- 4 Biomedical Sciences

Our governance

Research Theme Leads

Prof. Rik Drummond-Brydson
Analytical Science

Prof. Christoph Wälti
Bionanotechnology

Prof. Christopher Marrows
Electronic & Photonic Materials

Prof. Ardian Morina
Functional Surfaces

Prof. Fiona Meldrum
Multiscale Materials

Prof. Brent Murray
Soft Matter

Prof. Edmund Linfield
Bragg Centre Director

Bragg Centre Support Team

Dr Andrew Lee
Centre Manager

Mr Mike Daw
Senior Research & Innovation Development Manager

Dr Katharina Zeissler
Research & Innovation Development Officer

Mrs Helen Walters
Research & Events Administrator

Ex Officio Members

- **Dr Oliver Harlen,** Pro Dean for Research & Innovation
- **Prof. Giles Davies,** Pro Dean for Research & Innovation
- **Dr Ceri Williams,** Director of Research & Innovation Development

Management Committee Members by Application

To ensure that the management committee continues to represent a balanced view of the community, members are appointed by application to sit for a two year term alongside the standing members.

Elected 2019

- Dr Joseph Barker
- Prof. Susan Bernal-Lopez
- Dr Steve Fitzgerald
- Dr Robert Menzel
- Dr Helen Freeman
- Dr Elena Simone

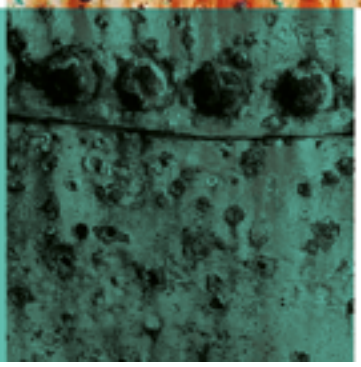
Elected 2020

- Dr Maisoon Al-Jawad
- Dr Sean Collins
- Dr Adam Sweetman

External Advisory Board

Our external advisory board helps to shape the strategic direction of the Bragg Centre. Drawn from academia and industry, they continue to drive the growth of the Centre and its international reputation for materials research.

- **Chair: Prof. Dame Julia Higgins DBE FRS FREng**, Imperial College London
- **Prof. Jeremy Baumberg FRS**, University of Cambridge
- **Prof. Peter Dowding**, Infineum UK
- **Dr Mark Hampden-Smith**, Saint-Gobain Innovative Materials
- **Dr Sheetal Handa**, BP International Centre for Advanced Materials
- **Dr Rob Hardeman MBE**, Independent Technology Consultant
- **Prof. Mary Ryan FREng**, Imperial College London
- **Prof. Adrian Sutton FRS**, Imperial College London
- **Dr Alan Turnbill OBE FRS FREng**, National Physical Laboratory
- **Prof. Jim De Yoreo**, Pacific Northwest National Laboratory



A year of investment

Securing the best expertise

As part of the Bragg Centre's commitment to research excellence, the Centre continues to invest in its people, with three prestigious University Academic Fellowships appointed to the Centre in 2019 following a highly competitive international process to secure the best talent.

Dr Sean Collins

Global climate change has prompted the UK to announce a net zero emissions target for 2050 and undoubtedly Materials Science has a central role to play in creating viable solutions for achieving these targets.

Towards this aim, Dr Sean Collins is exploring how an understanding of the relationship between structure and function at the atomic level can help boost the efficiency and reduce the degradation of next-generation photovoltaics and catalysts.

One of Sean's active research areas focusses on lead halide perovskites, which have emerged as a rising star of innovative solar energy but suffer from rapid degradation. However, where these crystals are combined in a metal-organic frameworks to form a crystal-glass composite they can be stabilised.

Sean, who was appointed as one of the prestigious **Bragg Centre University Academic Fellows**, brings expertise in advanced electron microscopy, crystallography and spectroscopy to the Bragg Centre's **Analytical Sciences** theme. His research also intersects with the **Electronic & Photonic Materials** theme and the **Soft Matter** theme to uncover the optoelectronic and catalytic properties of these metal-organic and hybrid materials.

With the Bragg Centre's **Leeds Electron Microscopy and Spectroscopy (LEMAS)** facility underpinning his work, Sean's research is also supported by the Bragg Centre's strong partnership with the electron Physical Sciences Imaging Centre at the Diamond Light Source and SuperSTEM, the EPSRC National Research Facility for Advanced Electron Microscopy.

In describing the impact of his work, Sean highlighted that:

> ***"Over the next ten to twenty years, fundamental materials science insights for these materials will develop new knowledge that will lead to manufacturing devices, catalysts, and products that last longer, have increased re-usability, create less waste, and reduce carbon emissions for improved human and environmental health and economic prosperity."***

Sean's work is enhanced by the Bragg Centre's engagement with **the Henry Royce Institute**, where his research intersects several of the recently announced Materials for the Energy Transition roadmaps. This partnership has provided tangible benefits this year, with Royce having sponsored an undergraduate summer research project focussing on the diffraction analysis of lead halide perovskite materials.

When commenting on why he joined the Bragg Centre, Sean said:

> ***"The fusion of multiple measurements that can be brought to bear to tackle advanced materials characterisation challenges is a standout feature of the Bragg Centre."***

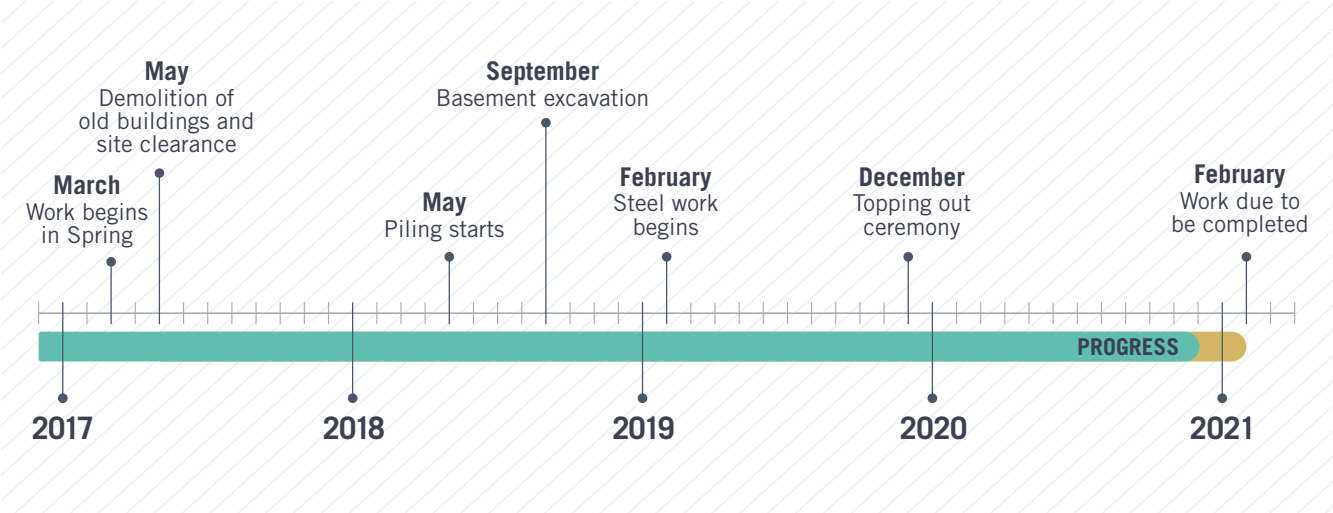
Sean's first experience of electron microscopy was during his undergraduate degree at the National Institute of Standards and Technology in Gaithersburg, Maryland (USA). Inspired by the notion of discovering entire worlds within a grain of sand, his expertise has developed throughout his career to connect structural and chemical information with optical properties at the nanoscale.

Putting our stake in the ground

Despite the pandemic and associated social distancing measures, construction work on the **Sir William Henry Bragg building** has faced only minor delay. Due to be handed over in February 2021 for occupation, this **£96 Million** flagship building is the centrepiece to an integrated campus for Engineering and Physical Sciences at the University of Leeds and will be the tangible home of the Bragg Centre.

The building has been designed to change the way people work and to encourage collaboration across disciplines and specialisms, supported by open plan office and laboratory space alongside expansive breakout areas which surround a feature four storey atrium. The Bragg Centre's physical presence will be anchored within the building through its specialised facilities, including the **Royce Deposition system**, a significantly upgraded **Leeds Nanotechnology Cleanroom**, the relocation of our **Atomic Force Microscopy** and **Electron Microscopy** capabilities, as well as the new **Wolfson Imaging Facility**.

Status of construction



Developing world-leading capabilities: The Wolfson Imaging Facility

The new Wolfson imaging facility being developed at the heart of the Bragg Centre, will be the first in the UK capable of observing dynamic molecular interactions in real time. Underpinned by two advanced technologies - high-speed atomic force microscopy and a bespoke light-sheet microscope capable of new real-time super-resolution fluorescence techniques – this world leading facility will enable deeper insight into how molecules move in cells or undergo structural changes in response to drugs, allowing for innovative research in medicine and materials science.

As a joint venture between the Bragg and Astbury Centres, representing a **£2.6 million** investment from the University of Leeds and **£750,000 from the Wolfson Foundation**, the Wolfson Imaging facility will undoubtedly promote and enable collaboration between Leeds and other leading universities in the UK and overseas. A further donation has been made by a Leeds alumni, Dr Chris Pointon, which will provide for an experimental officer to oversee the facility.

This investment will directly support the activities of two recently appointed Bragg Centre University Academic Fellows, whose combined research and instrument development expertise will enable insight into new ways of combating disease under the Bragg Centre's **analytical science** thematic.

When describing the impact of the new investment, **Dr George Heath** said:

> ***"a new generation of high-speed atomic force microscopes can capture data very rapidly, almost every one millionth of a second. The collection of data is so fast, we can generate videos of molecules in action."***

Whilst, **Dr Aleks Ponjavic** highlighted that:

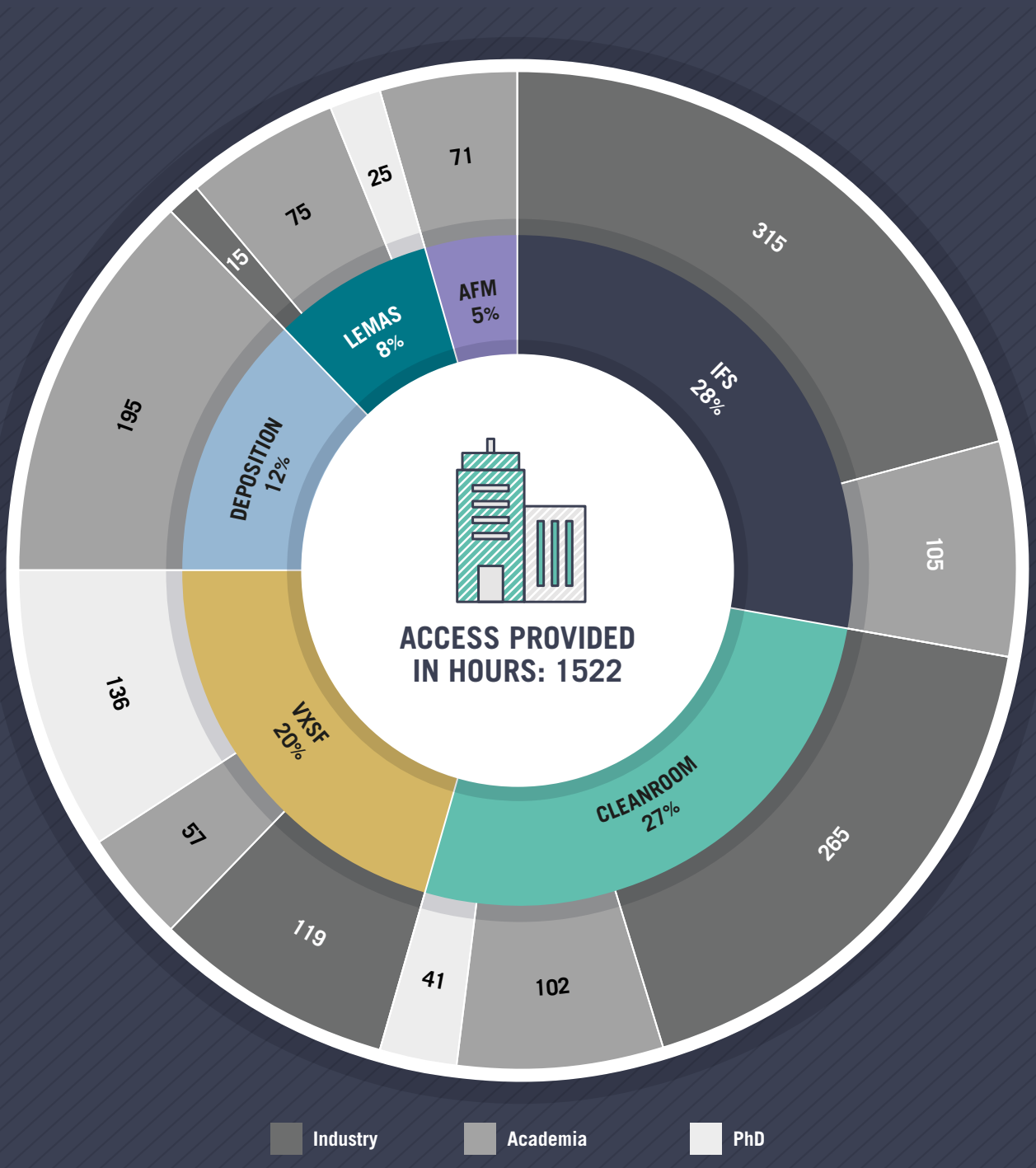
> ***"Under the light-sheet microscope, we will be able to observe how the molecule behaves in a cell – and how it interacts with neighbouring molecules and structures, which are required for the cell to carry out its functions."***

Open for business

Usage of our facilities

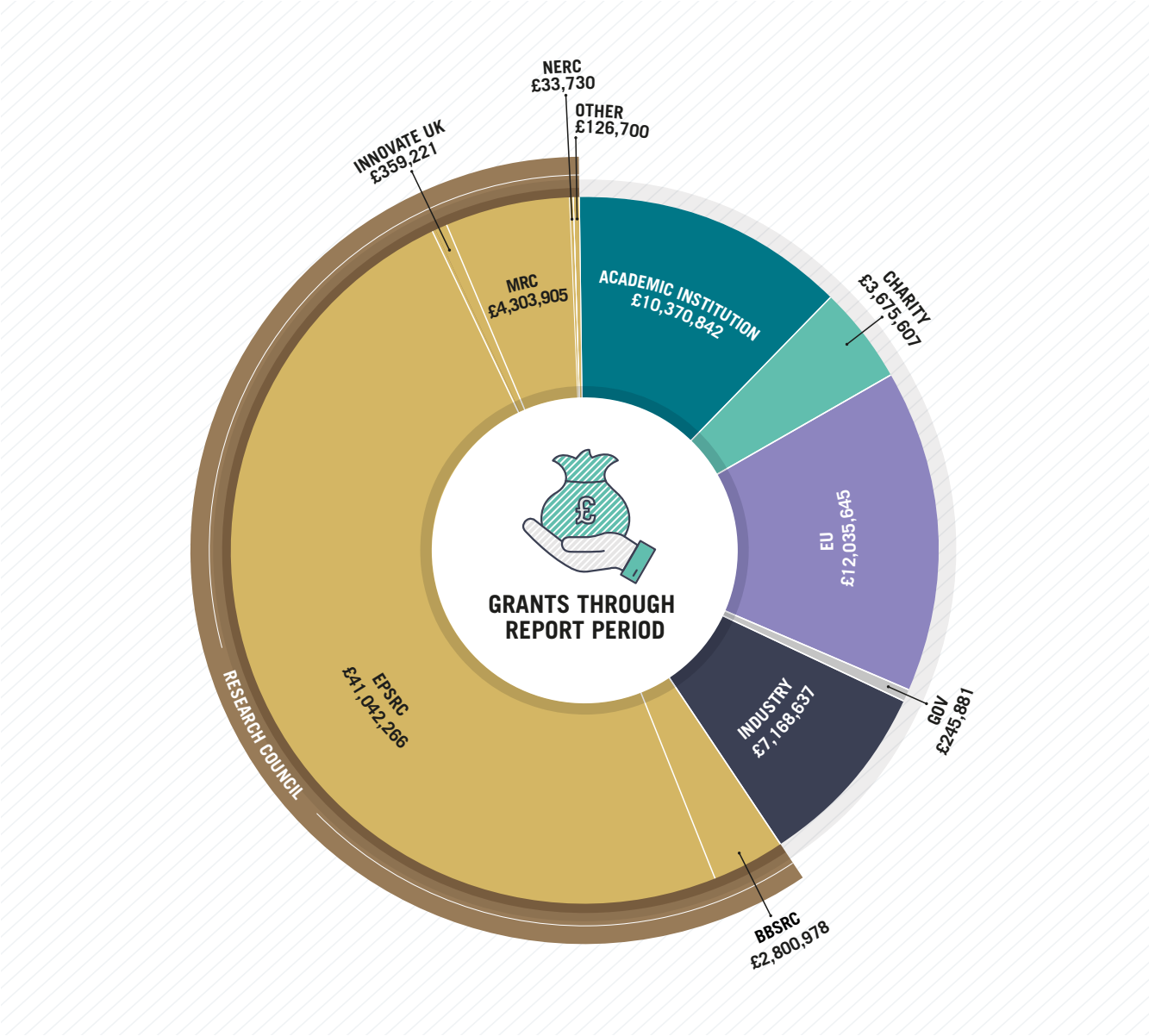
Over the course of this year, the Bragg Centre has continued to support external users to access our facilities, many arranged through the **Henry Royce Institute funded access schemes**. We have provided **more than 200 hours** of usage to external PhD students, alongside access to academics from 25 other Universities. This is in addition to extensive usage by our internal users.

Throughout the same time period, we have provided **in excess of 700 hours** of access to 14 different companies, totalling **£45,242 of income**. Alongside smaller SMEs, we have seen large corporations, including **Syngenta** and **Infineum** making extensive usage of our nanotechnology cleanroom, versatile X-ray spectroscopy, and electron microscopy facilities.



Grant portfolio

Despite the uncertainty of the global pandemic in 2020, the Centre has bolstered its portfolio of active research grants to a total of **£82.2 Million** across a mixture of sources, with **£11.3 Million** being awarded within the current reporting period 1st September 2019 – 1st September 2020. This is in addition to the reported facilities income, the award from the Wolfson Foundation and the recurrent funding coming into the Centre from the Henry Royce Institute.



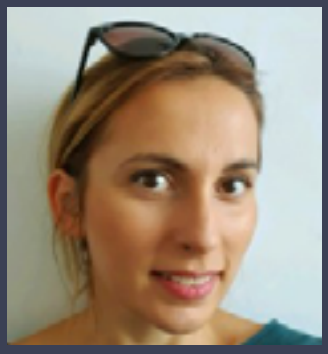
Grant highlights

- Flow-XI: A New UK Facility for Analysis of Crystallisation in Flow Systems, *Meldrum, F.* EPSRC, **£1,129,049**
- Self-induced transparency modelocking of terahertz quantum cascade lasers, *Dean, P.* EPSRC, **£1,127,383**
- Crystal engineering the new generation of sustainable, biocompatible and stimuli responsive formulations for the delivery of drugs and nutraceuticals, *Simone, E.* European Union, **£1,531,578**
- GreenTRIBOS, *Nevile, A.* European Union, **£701,842**
- Quantum spin Hall effect spintronics, *Marrows, C.* EPSRC, **£861,846**
- Synthetic Antiferromagnetic Skyrmions, *Marrows, C.* EPSRC, **£815,629**
- Model membranes for quantitative analysis of light harvesting, *Adams, P.* EPSRC, **£475,101**
- Multi-layered interconnected networks of hybrid polymer-lipid membranes for bioelectrocatalysis, *Jeuken, L.* BBSRC, **£448,854**
- Porous 3D Superstructures as Implants for Brain Cancer Drug Delivery, *Ong, Z. Y.* EPSRC, **£393,881**
- The Physics of 3D Printed Liquid Crystal Elastomer Composites, *Gleeson, H.* Leverhulme Trust, **£316,985**
- Understanding and optimising crystallographic and structural changes during enamel remineralisation, *Al-Jawad M.* GlaxoSmithKline, **£141,700**

Collaborating with industry

Within the Bragg Centre, Mike Daw leads the development of our strategic industrial engagement to deepen our connection with industry as equal partners in challenge-led research.

Much of our research is informed by working closely with industry, and thereby maximising the potential for economic and social impact. As of September 2020, the Centre's portfolio of active grants involved **109 industrial partners**. Of these industrial interactions **over £18 Million** was supported by research council, Innovate UK and the EU funding, and over **£7 Million was direct industry-funded** research. This year, emerging partnerships at the Centre level have been initiated with a number of companies, including **BT**, **Victrex**, and **QinetiQ**, with a number of other new relationships under discussion alongside continued interactions with **AstraZeneca** and **Syngenta**.



Ms Natalia Koniuch

Within the pharmaceutical industry, there is an increasing need to link the structure of a drug formulation to its performance in order to realise the full potential of a medicine.

To this end, PhD student Ms Natalia Koniuch is using electron microscopy to provide a complete physical description of complex pharmaceutical materials in order to investigate the key interfaces and defects at atomic resolution.

Natalia's project, which sits under the Bragg Centre's **Analytical Science** research theme, is funded by an EPSRC iCASE award with **AstraZeneca**. Working closely with the AstraZeneca Product Development Group, Natalia is developing new low-dose transmission electron microscopy methods to increase the application of these analytical techniques directly within the pharmaceutical industry and in response to real world problems.

Natalia's project draws heavily on the Leeds Electron Microscopy and Spectroscopy (LEMAS) facility within the Bragg Centre and the wider connections with the SuperSTEM facility at STFC Daresbury Laboratories in Cheshire.

Having discovered a passion for electron microscopy during her Masters degree, Natalia pursued a PhD within LEMAS and immediately became a Bragg Centre member. In describing the community, Natalia said that she felt that the Bragg Centre:

> ***"…always offered invaluable network opportunities and collaboration with other researchers in my own and related fields."***

The Bragg Centre continues to support the development of Natalia's career through the provision of regular training events and focused workshops across the community.

Dr Elena Simone

Academia traditionally generates new knowledge and innovative technologies using simple models in isolation. Subsequent input from industry then seeks to translate these novel technologies to solve complex real world problems.

Through the award of a Royal Academy of Engineering Industrial Fellowship, with a 15% contribution from **Syngenta**, Dr Elena Simone aims to change this paradigm by developing a more efficient approach to translational research that directly answers the complex problems of her industrial partner.

Working with Dr John Hone and Prof. Neil George of Syngenta – one of the world's leading agrochemicals manufacturers – Elena's project focuses on understanding, designing and controlling some of Syngenta's most challenging crystallisation processes.

Describing the partnership, Neil remarked that:

> ***"Elena's secondment to Syngenta will be key in translating the challenges to the University and the practical developments back to Syngenta."***

Featuring within the Bragg Centre's **Multiscale Materials research theme**, crystallisation processes are widely used as separation techniques in industrial settings. This often involves multiple liquid and solid phases and the inclusion of sample impurities which cannot be fully characterised by traditional analytical techniques.

In order to overcome this issue, Elena is using a novel multi-sensor approach to characterise and monitor the crystallisation processes of complex multiphase and multicomponent systems.

Insights from Elena's work will aid Syngenta in optimising the design and control of their crystallisation processes enabling consistent crystal properties, for example uniform size and purity, to be delivered. The results of this research will also be broadly applicable in many industrial sectors that require crystallisation processes, including pharmaceuticals and food manufacturing.

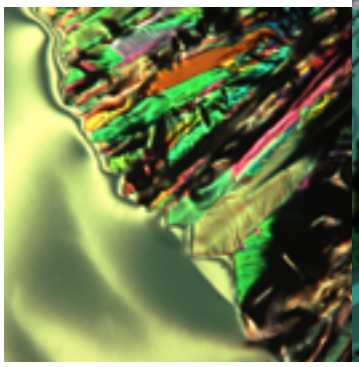
When considering the partnership, Neil described his enthusiasm to build a stronger connection directly with the Bragg Centre:

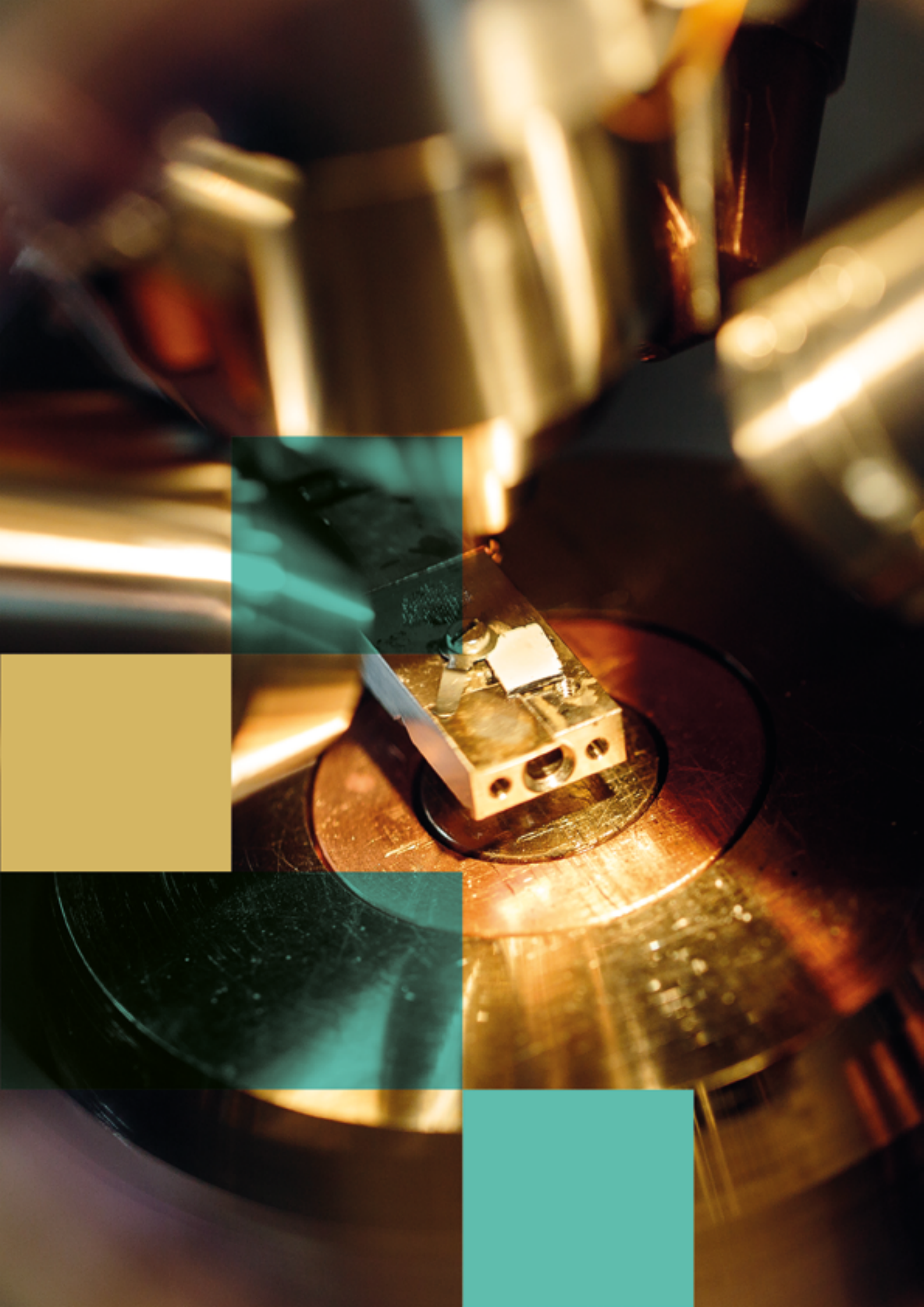
"Syngenta has set-up a strategic research collaboration with the School of Chemical and Process Engineering at Leeds and has developed a cluster of studentships, contract research projects and cross company consortia, that are addressing multiple challenges.

Most of these projects have accessed the Bragg Centre's materials characterisation capabilities including XPS, LEMAS, AFM, and X-Ray Tomography…

…and of course, accessed the considerable expertise of the staff.

I think there are great opportunities to utilise the Bragg capability further by closer, direct engagement and highlighting the importance of material science in manufacturability and the biology-materials interface in the fine chemical sector."





Partnership with the Henry Royce Institute

The University of Leeds is a partner of the Henry Royce Institute for Advanced Materials (Royce) alongside eight other leading UK research institutions. Funded by the Engineering & Physical Sciences Research Council, Royce supports world-recognised excellence in UK materials research, accelerating commercial exploitation of innovations and delivering positive economic and societal impact for the UK.

Through Royce, the Bragg Centre has established state-of-the-art Deposition and X-ray Photoelectron Spectroscopy capabilities, and are making other facilities available (AFM, Leeds Nanotechnology Cleanroom, Electron Microscopy, PVD) for access to the national academic and industrial communities.

This year, in conjunction with Royce, and the Institute of Physics, the Bragg Centre has been involved in the development of a **technology roadmap for low-loss electronics**. Coordinated by **Dr Katharina Zeissler** and **Dr Oscar Cespedes**, the roadmap sets out the priorities, as identified by the UK research communities, to achieve more efficient power and computing electronics in support of the UK's transition to net-zero carbon emissions.

Published in September 2020, the full report is publicly available, here: *'Materials for the Energy Transition roadmap: Materials for Low Loss Electronics', Henry Royce Institute, September 2020*
https://www.royce.ac.uk/content/uploads/2020/09/M4ET-Low-Loss-Electronics-roadmap.pdf

ADVANCED MATERIALS RESEARCH & INNOVATION

ROYCE

Education & training

The Bragg Centre is committed to developing the expertise of our community and inspiring future generations of material scientists. In support of this goal, the Centre has conducted a Winter School and an Undergraduate Summer Internship programme in association with the Henry Royce Institute. Alongside this, the Centre has inducted its first cohort of Bragg PhD Studentships and continues to support its vibrant community of postgraduate researchers with training opportunities and events.

Undergraduate Summer Internships

Throughout the summer of 2020, Royce launched a new funded research internship scheme targeted at final year undergraduates. The Bragg Centre supported four internships which ran for several months throughout the summer break and culminated in a day-long virtual event on the 9th September – attended by the larger Royce cohort of interns, supervisors, and Royce staff – in which each intern had the opportunity to deliver a poster presentation about their work. The predominantly remote internship project included developing machine learning for extracting nanoscale properties of metal-organic framework glasses as a candidate for LED phosphors, investigation of low dose transmission electron microscopy and spectroscopy for the analysis of electron beam sensitive materials at nanometre resolution, the development of a terahertz spectroscopic imaging system for materials analysis and atmospheric research, and designing a prototype liquid flow-cell for X-ray photoelectron spectroscopy on formulated materials.

Referring to the scheme University of Leeds intern, Xinyan Li commented:

> ***"The Henry Royce Institute Summer Internship provided me with a precious opportunity to take my first taste of academic research, giving me a broad platform to get access to the state-of-the-art technologies."***

Royce Winter School

In January, the Bragg Centre hosted a three-day Royce Winter School for 17 PhD students from 9 universities to experience our facilities first-hand. The event covered functional surfaces, thin film growth, cleanroom nanofabrication, scanning probe microscopy, electron microscopy, and X-ray photoelectron spectroscopy using a combination of lectures and practical demonstrations. Culminating in a networking session, the organisers encouraged the attendees to discuss their PhD experiences and their own research. The event was well received, with several attendees highlighting the usefulness and enjoyable nature of the experience and that they would recommend it to other PhD students for future events.

Studying a PhD in the Bragg Centre

Ms Huayang Yu

My research interest lies in synthesising biomedical polymers for drug delivery applications. Now in the final stages of my PhD, my work has used Reversible Addition Fragmentation chain Transfer (RAFT) polymerisation to create bio-compatiable polymers that can self-assemble into nanoparticles that can be loaded with anti-cancer drugs.

The size and shape of these nanoparticles must be carefully controlled to ensure uptake by the target cancer cells and this is directly related to the chain length of my synthesised polymers. I have made extensive use of the nuclear magnetic resonance and scanning electron microscopy capabilities of the Bragg Centre to thoroughly characterise my polymers and their nanoparticles. Cytotoxicity studies were also undertaken in collaboration with St James Hospital to explore the clinical implications of my drug loaded nanoparticles.

The Bragg Centre has provided me with a platform for collaboration in this Soft Matter research with many professional researchers, relevant community meetings, access to analysis instrumentation and the support of dedicated technicians. I have been able to meet professional people in the polymer field where I can share and discuss my ideas which has benefited my studies.

Bragg PhD Studentship Programme

This year the Bragg Centre inducted its first cohort to the new Bragg PhD Studentship Programme. With up to five EPSRC funded positions each year, this competitive scheme funds cross disciplinary projects which tackle both fundamental and applied problems. The studentships are supported by a bespoke training programme and a series of cohort-based activities including a monthly PhD forum and an annual summer PhD colloquium. At the time of writing, a further 13 projects representing the breadth of the Bragg Centre's research activity are being advertised for the 2021 intake.

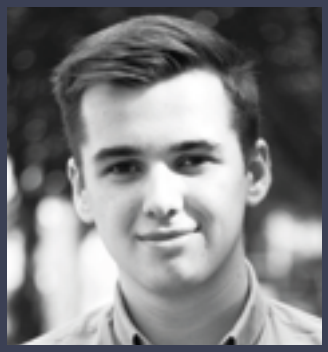
Ms Nina Miklos

I have an interdisciplinary background having just completed an undergraduate degree in the School of Food Science and Nutrition at the University of Leeds, which touched on several of the Bragg Centre's research themes, including: **bionanotechnology, soft matter and analytical science**.

I was interested in the Bragg Centre because of its clear vision and multi-disciplinary community. Having been awarded a Bragg PhD Studentship, I am able to pursue my PhD within the Bragg community, where not only is the project incredibly interesting and unique, but it also allows me to develop skills that aren't limited to one branch of science.

I'm working on the development of a sensitive method for ctDNA mutation detection through a highly accurate nanopore readout. The aim is to create ease of tumour analysis through patient liquid samples instead of through invasive tissue biopsies.

It is extremely exciting to contribute to the advancement of cancer diagnosis through increased understanding of tumour development and I hope that my work will eventually lead to improvements in prognosis for patients.



Mr Robert Elkington

After finishing my mechanical engineering degree and having worked in a series of tribological research internships, I was eager to start building a research career that combined my knowledge of tribology with my passion for medical engineering.

The interdisciplinary nature of the Bragg Centre appealed to me as it provides a supportive environment within which I can collaborate effectively with other researchers outside my own field. The access to a broad range of state-of-the-art facilities within the centre will create opportunities for me to develop a broader skill set with a wide range of equipment new to me, and this cross discipline thinking at the core of the Bragg Centre will allow me to develop novelty with in my PhD project.

My project aims to develop and characterise new types of gel-like surface grafted polymers that closely mimic the material properties, robustness, and ultra-lubricity of articular cartilage with the view to develop a new type of partial joint replacement for early arthritis intervention.

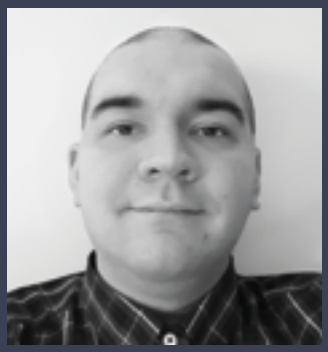
Ms Rachel Bocking

Having graduated in 2020 with an Integrated Master's in Chemistry from the University of Leeds, I immediately joined the Bragg Centre with the award of a Bragg PhD Studentship. My cross disciplinary PhD, entitled "Graphene-Modified Nanoelectrode Sensors for In-Situ Sensing in Regenerative Medicine and Electro-Catalysis", will involve work across the schools of Chemistry, Electronic & Electrical Engineering and Medicine.

This topic greatly appealed to me as it aligns with my interest in researching materials that can have an impact in real-world applications, such as conception treatment and sustainable energy research.

Prior to this, I have investigated the use of catalytic copper/nanocarbon hybrid materials and spent a year in industry at Lubrizol acquiring skills in materials characterisation whilst developing sustainable marine engine oil formulations.

The Bragg Centre environment will help me to collaborate with people from across multiple departments, drawing on a breadth of expertise in order to further my own research experience.



Mr Robert Mackay

During my time as an Undergraduate at the University of Glasgow I became heavily interested in magnetic materials, pursuing this area of physics during my Masters studies with a focus on the magnetic skyrmion textures in multi-layer synthetic antiferromagnets.

When considering the continuation of my career path in this field, I quickly identified the Bragg Centre and its Studentship scheme as the perfect opportunity to pursue my interests within a dynamic environment. The philosophy and objectives of the Bragg Centre stood out to me and made it something that I wanted to become a part of.

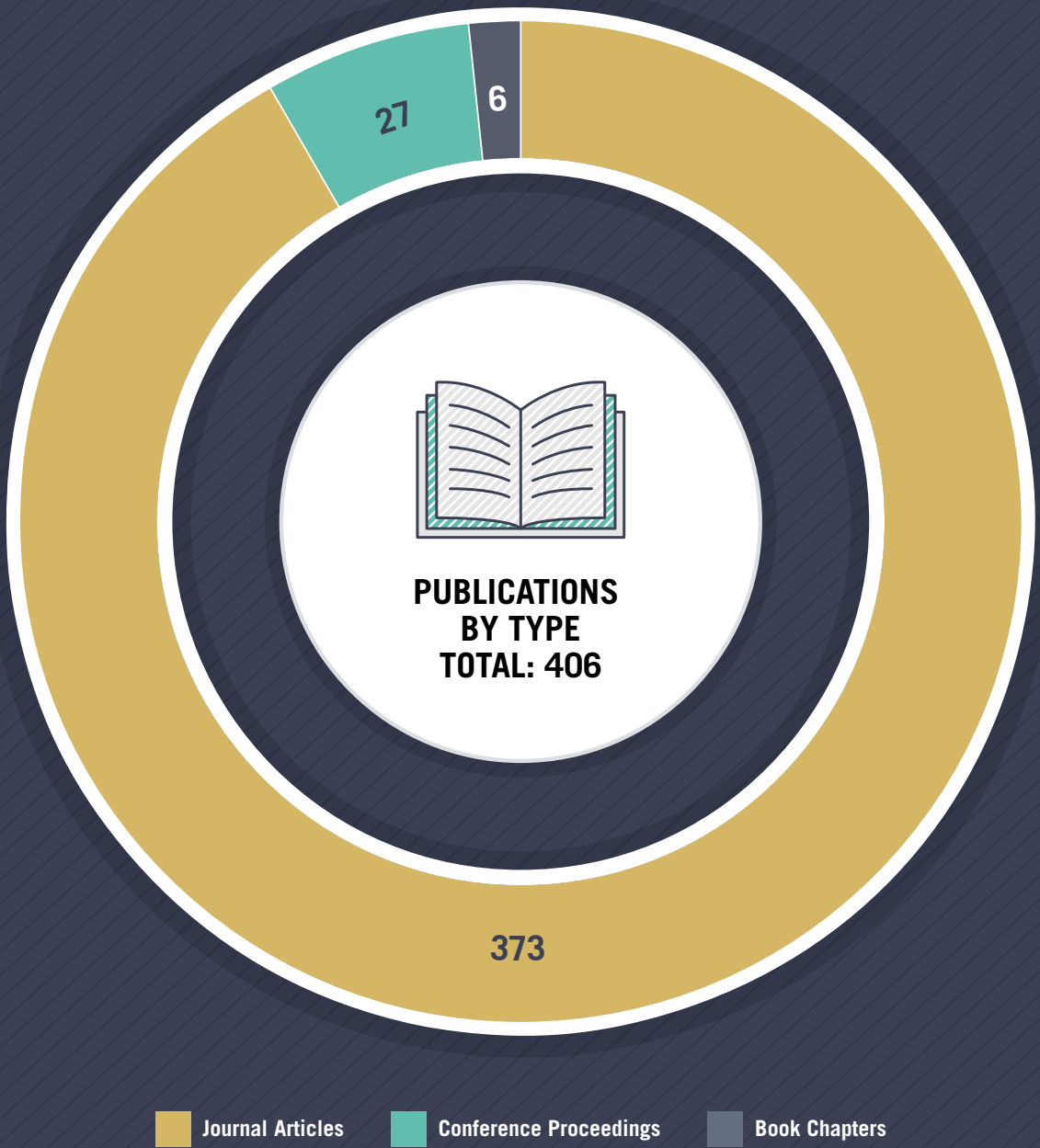
My current research project under the Bragg Centre is a computational study into the effect of mechanical strain in antiferromagnetic materials. Such materials are currently viewed as great candidates for applications of high-density spintronic data storage of the future.

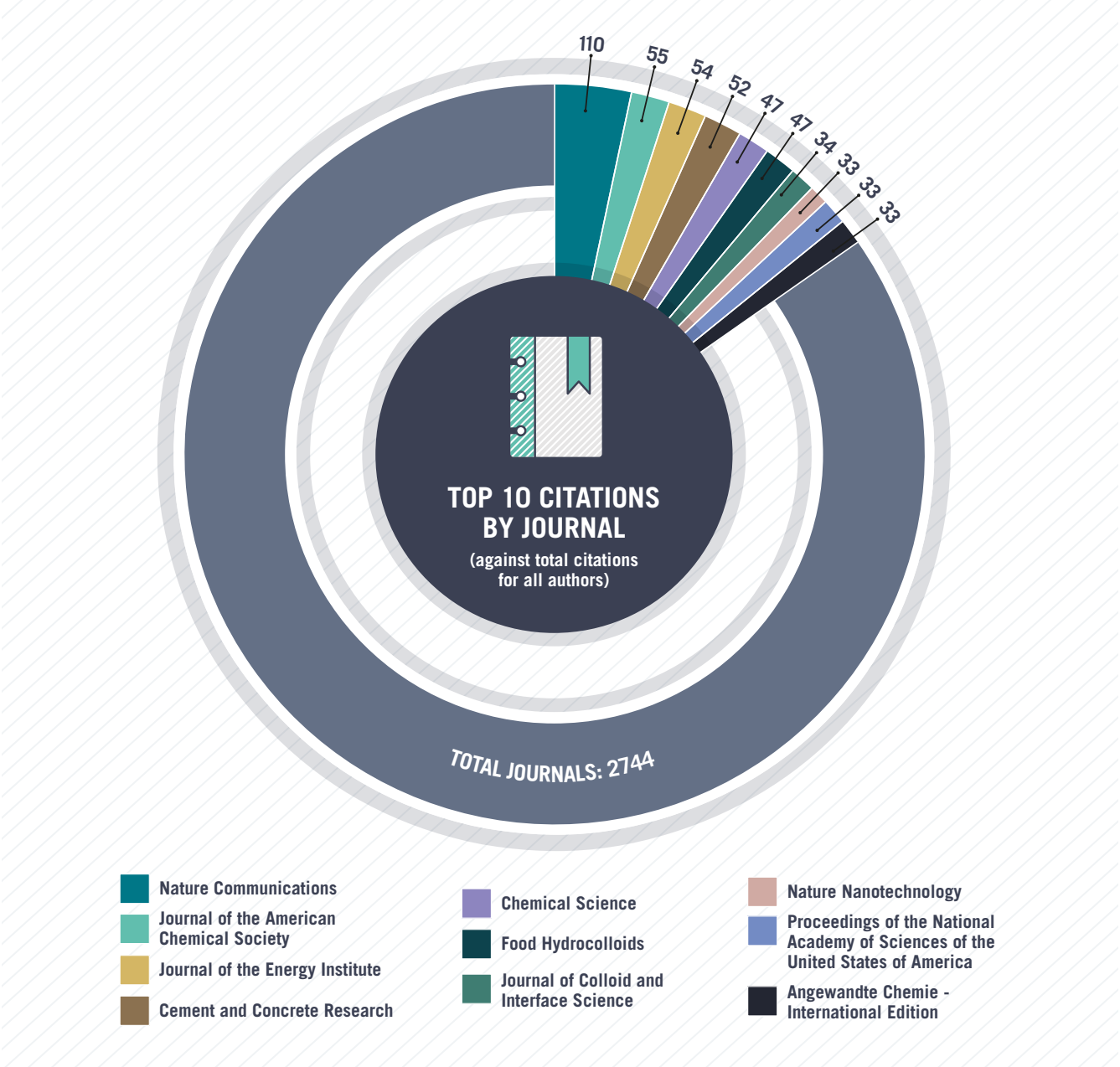
Our impact

Despite the circumstances in the latter part of this year, the Bragg Centre has continued to reach a wide audience with the bredth of its publications and the creativity of its public interactions. Whilst our members have also been recognised for significant contributions to their respective fields.

Publications

Across the year, the Bragg Centre community has authored **406 publications** covering the breadth of material science. With **373 articles** published across **238 different journals**, 13 of which are part of the Nature publishing group. The influence of our community continues to grow, with a **cumulative citation count of 2744** this year.

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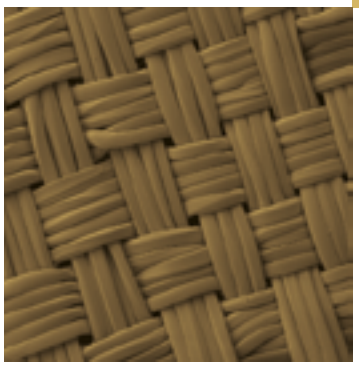
TOP 10 CITATIONS BY JOURNAL
(against total citations for all authors)
TOTAL JOURNALS: 2744
Nature Communications
Journal of the American Chemical Society
Journal of the Energy Institute
Cement and Concrete Research
Chemical Science
Food Hydrocolloids
Journal of Colloid and Interface Science
Nature Nanotechnology
Proceedings of the National Academy of Sciences of the United States of America
Angewandte Chemie - International Edition



Recognition of our community

The Bragg Centre is proud to celebrate the achievements of our community, as the outstanding work and influence of our members this year continues to be recognised.

Honouring achievements

The global use of concrete as a construction material is responsible for around 8% of all CO_2 emissions annually. As part of the effort to combat this, research led by a member of the Bragg Centre community, **Prof. Susan Bernal Lopez**, is exploring new low-carbon cements with the aim of developing sustainable alternatives that can be produced from recycled industrial waste or by-products.

This year, in recognition of her distinguished achievements in her chosen area of materials science, Susan was awarded the **Institute of Materials, Minerals & Mining's (IoM3) most prestigious award, the Rosenhain Medal and Prize**.

The Bragg Centre is pleased to celebrate the achievements of its community and hopes to support Susan to continue developing her research at the highest of standards through access to facilities, expertise and by identifying opportunities for national and international impact.

Influencing national policy

This year, Bragg Centre member **Dr. Helen Freeman** successfully secured a **Parliamentary Academic Fellowship**. This will enable her to work directly with the Parliamentary Office for Science and Technology throughout 2021 to produce a research briefing on embodied carbon in the built environment with a special focus on building materials. Her work aims to underpin evidence-based policy making to support the construction sector in achieving net zero by 2050.

Supporting future leaders

Dr Yoselin Benitez-Alfonso

Dr Yoselin Benitez-Alfonso is an Associate Professor in Plant Sciences at the University of Leeds and a member of the Bragg Centre, where her research activity contributes to the **Soft Matter** theme. Recently the recipient of a prestigious **UKRI future leader fellowship**, Yoselin's research explores the structure and mechanical properties of plant cell walls surrounding cell-to-cell communication channels, known as plasmodesmata. Complementary to furthering fundamental biological knowledge, her work seeks to exploit the material properties of cell walls at these regions in order to design novel biomaterial products. From Yoselin's previous work, it is known that the accumulation of β-1,3 glucan polysaccharide callose in these regions gives rise to tuneable mechanical properties and, expanding on this, her future leader fellowship seeks to determine how plant waste resources can be repurposed to create novel hydrogel materials from these biopolymers to produce sustainable bioplastics.

This strongly aligns with one of the Bragg Centre's emerging priority areas, Materials for Resilient Infrastructure, with a focus on the circular economy and sustainable or recoverable materials.

> ***"The bioplastic sector is predicted to contribute £1.92 billion to the UK economy in the next decade."***

As part of this work, the Bragg Centre's Atomic force microscopy and a custom rheometer capabilities will be instrumental in characterising the nanomechnical properties and viscoelasticity of these novel hydrogel formulations. Alongside which, structural determination of these biological polymers will continue to strengthening the collaborations between the University of Leeds' flagship Astbury & Bragg research centres.

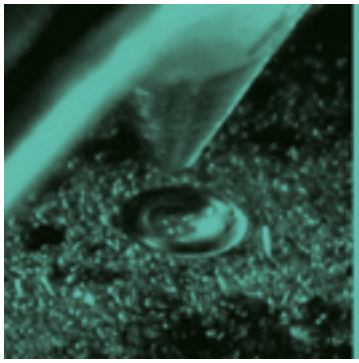
In describing her research, Yoselin said:

"My research is interdisciplinary, involving Plant Sciences, structural determinations, mathematical models, biophysics and material sciences."

Beyond the Bragg Centre, Yoselin's research interacts with a host of European academic institutions and has strong connections with industrial partners, providing excellent opportunities for translational impact:

"I have close interactions with the cellulose industry Futamura for the development of new cellulosic materials and with GrowMed Tech to obtain novel beta-1,3 glucan diagnostic platforms."

Originally from Cuba, Yoselin's auspicious career began in Chemistry before transitioning into plant biochemistry and molecular biology at the University of Cordoba, Spain, followed by several international postdoctoral research stints. She established her cross disciplinary research group at the University of Leeds in 2017 with a focus on the biophysical and biomechanical properties of cell walls and biomaterial development, joining the Bragg Centre community in 2019.



Engaging beyond the Bragg Centre

As a Research Centre, we recognise that it is our responsibility to provide a platform for the communication of knowledge and innovation to the wider world. The Bragg Centre strongly promotes the development of Public Engagement, Science communication and Schools Outreach across its community. Sadly, due to the unforeseen circumstances throughout the year, many of the planned events were either cancelled or unable to continue in their original form.

Looking ahead, the centre will reinvigorate its engagement programme and capitalise on its partnership with the **Discover Materials Network** – a national network of material science departments created with the express purpose of promoting material science within the national school curriculum – and new collaborations with the **Institute for Research In Schools** – a charitable organisation connecting A level students with Academics for the co-production of research. These efforts will be championed by **Dr Andrew Lee** on behalf of the Bragg Centre, with the award of an **Engagement Excellence Fellowship** and will underpin the Bragg Centre's emerging equality, diversity and inclusion framework in 2021.

Innovation through Collaboration

Prof. Lorna Dougan

In 2019 a pioneering cross-disciplinary programme was established between the Bragg Centre and the Leeds Cultural Institute which paired Materials scientists and engineers with professionals from the cultural and creative industries.

The project, known as the **"Bragg Centre Creative Labs"** was led by the Bragg Centre's Prof. Lorna Dougan and Dr Scott McLaughlin from the school of Music, alongside Steve Manthorp and Sue Hayton from the Cultural Institute.

With the aim of sparking innovative materials design through enriched cross-disciplinary collaboration, the Creative Labs programme formed 10 partnerships across a range of disciplines such as visual art, theatre, literature, craft and sonic art. The artists met with their Bragg Centre academic partners – who represent diverse academic fields including Physics and Astronomy, Biology, Chemistry, Mathematics, Engineering and Design – for the first time in November 2019.

Each pairing - many of which included whole research groups – developed their unique outputs, facilitated by exchange visits throughout a 12 week period, culminating in an open showcase event in January 2020. The Creative Lab partners shared their experiences and explored how the creative arts can challenge and inspire materials research.

Watch the Creative Labs Bragg Centre Alumni webinar ›

Read about sparking innovation in materials research through creative collaborations ›

Initially funded through the University of Leeds Interdisciplinary Pump Priming fund, additional funding was secured by Lorna through an **EPSRC engineering public engagement champion award** with an approximate value of £125k – **one of only five awarded nationally**. This outstanding achievement has enabled the partnerships to continue, building and developing the ideas that emerged beyond the original three month programme.

Speaking about the initiative, Lorna said:

> ***"By bringing together cutting-edge materials research with artists and scholars in the humanities, we are creating rich ground for exploratory research and new perspectives."***

It is hoped that the development of a cohort of "Creative academics" within the Bragg Centre will fuel follow on projects, achieve wider impact in public engagement and showcase the Bragg Centre externally as being pioneers in such activities.

Get in touch

To find out more about the Bragg Centre for Materials Research, please contact us:

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