

Institution: Loughborough University

Unit of Assessment: B8

Section 1. Unit context and structure, research and impact strategy

Overview

The period since 2014 has been transformative for Chemistry at Loughborough. Firstly, we have recruited 17 new academic staff into priority areas of research, expanding the Unit by 20% to 31FTE for this return. Secondly, the entire Department of Chemistry moved to new facilities, as part of a £59M investment in STEM on our “West Park”; every single laboratory has been designed and purpose-built from scratch. In combination, we have totally re-energised Chemistry research and impact.

1.1 Research Structure

This Unit comprises 31 staff including all staff (26FTE) from the Department of Chemistry, with additional chemistry researchers from the Departments of Materials and Mathematics and the School of Sport, Exercise and Health Sciences (SSEHS).

Chemistry is a Department within the School of Science (SSci), which also includes computer science, maths, maths education and physics. Materials is a Department within the School of Aeronautical, Automotive and Materials Engineering (SAACME).

SSci, SAACME and SSEHS are 3 of the University’s 9 autonomous Schools. Each is led by a Dean and their Senior Management Team (SMT), whose membership includes Associates Deans for Research (ADR) and Enterprise (ADE) and leads of constituent Departments. For example, in SSci, the Head of Chemistry has vital responsibilities on SMT in representing the interests of Chemistry and facilitating opportunities for cross-disciplinary research within the School. In parallel, the Department Research Coordinator sits on the School Research Committee led by the Associate Dean (Research). The current Head of Chemistry (S. Christie) has previously held the posts of both Associate Dean (Enterprise) and Associate Dean (Research) for SSci, demonstrating how the Unit offers significant leadership at institutional level.

1.1.1 Research Groups

Unit staff work across the traditional organic, inorganic, physical and analytical chemistry areas, which have been bolstered by expertise in biological/supramolecular, polymer and computational chemistry through strategic recruitment. Current research groups are:

- **Energy:** New chemistry for energy-generation, harvesting, demand reduction and storage.
- **Health:** Development of therapeutically useful compounds, imaging and synthetic methods.
- **Security:** New methods and technologies to confront criminality
- **Sustainability:** Novel techniques and technologies for sustainable chemistry and net zero targets.

Colleagues from SAACME and SSEHS work in Sustainability (polymer technology and solid-state computation) and Health (bioanalysis).

1.1.2 Interdisciplinary Research

All 3 Schools are interdisciplinary in their structures. SSci has a very clear strategy of building on its core research strengths by supporting Research Centres with a defined focus on interdisciplinary research. Unit staff contribute significantly to leadership roles for three (of six) SSci Research Centres:

- **Centre for Analytical Science** (CAS, Thomas leads) led the €12M Toxi-Triage project which developed new approaches within rescue efforts for Chemical, Biological, Radiological and Nuclear (CBRN) incidents.
- **Centre for Sensing and Imaging** (CSIS, Zanda/Butler lead) looks at all aspects of imaging

including biomedical, quantum and materials imaging for applications such as Alzheimer's, Huntington's and Parkinson's disease, collaborating also with sports science and engineering.

- **Interdisciplinary Centre from Laboratory to Fabrication** (Roach leads) is organised into three main themes: biology-on-a-chip, chemical reactors and nano-materials/devices.

In addition, Unit staff involved in solid state chemistry, catalysis and theoretical chemistry engage with the **Centre for Science of Materials**, led by Physics; for example, Dann's work on a sustainable fuel supply through controlled synthesis of low-dimensional catalysts (SlowCat) was borne out of this Centre.

Unit staff work regularly on diverse projects across Schools. For example, the Unit and the School of Arts perfected formulations for the use of platinum in photographic processes in one of our more unusual collaborations. More generally, the institutional 'CALIBRE' strategic research framework drives interdisciplinary activity across all Schools. The Unit engages with CALIBRE's programmes, particularly in the Beacons for High Value Manufacturing (3D printing of chemical reactors), Sport and Exercise (volatile metabolomics), the Global Challenges for Energy (Hydrogen economy), and Health and Wellbeing (chemical and bio-surface engineering and its application to healthcare technologies). Under CALIBRE, workshops are held on topics of interest across disciplines such as Artificial Intelligence.

1.2 Review of Objectives from REF2014

In REF2014, we outlined our ambition to renew the Unit infrastructure and invest in new staff. We have now completed (2018) the move of the entire Department of Chemistry across campus to new facilities as part of a £59M redevelopment of the University's West Park, which also saw major redevelopments for chemistry researchers in the Department of Materials. Unit staff led the design of new laboratories and purchase of new equipment, and researchers now occupy nine completely new, state-of-the-art laboratories spanning all the chemical science disciplines. For example, an objective from REF2014 was to extend our characterisation facilities that underpin synthesis-based research, delivered via an EPSRC underpinning equipment grant that provided a new NMR spectrometer and internal School funding that provided new LC and GC-MS equipment; £500k+ investment.

Equally significant (see section 2.1), we delivered on REF2014 aims by recruiting 17 new academic staff in areas of strategic priority and created the interdisciplinary SSci research centres. This delivered significant achievements in our four research groups:

- **Energy:** Goddard was part of consortium that modelled solid electrolytes to Li and Na ion batteries which has been translated to the industrial phase with Johnson Matthey
- **Health:** CAS has delivered a broad research portfolio in volatile metabolite analysis which has been applied to a number of areas of health interest including the East Midlands Breathonomics Pathology Node, and the development of cutting-edge breath analysis instrumentation including non-invasive COVID-19 detection.
- **Security:** Kelly has delivered an impact agenda based around his novel fingerprint research; which has been commercialised and is an Impact Case Study.
- **Sustainability:** Buckley has received international acclaim for his work on the activation of atmospheric carbon dioxide for the development of circular routes to platform molecules.

In REF2014, we also outlined our aim to be a research partner of choice for multi-disciplinary collaborations and Unit staff have been PI or Col on major UKRI/EU grants totalling in excess of £35M. Many of the above achievements have been made possible by this funding, which has sustained and enriched our international networks. For example, the €12M H2020 Toxi-Triage project brought together 17 European partners to deliver a new global 'gold standard' for how emergency and health services, defence, and industry should tackle chemical, biological, radioactive, or nuclear (CBRN) incidents and produced recommendations for the European Commission on CBRN protocols.

Moving the Department of Chemistry has not only delivered completely new lab space but also brought co-location with Departments of Materials and Chemical Engineering. This enhanced collaboration and led to award of the UKRI National Interdisciplinary Centre for Chemical Circular Economy, (NiC3E, Chemical Engineering leads, Buckley and Wijayantha as Co-Is, £4.4M). Our lab space now includes a clean room facility for the first time, which was essential for the EU NEU-ChiP award to Roach (€3.5M, €0.5M to LU). Upgrading our lab space has also sustained world-leading activity in the CAS, recently attracting Turner to a CAMS lectureship. CAMS is an industrially-led community dedicated to world class analytical measurement science (AMS).

1.3 Enabling and Facilitating the Achievement of Impact

For all research-active staff, engagement with enterprise (impact) is actively encouraged. We also recognise that the origins of the research delivering impact can vary greatly and our Case Studies below show how opportunities can arise equally well from serendipitous observations, direct approaches from business for applied research support or high-quality fundamental science research originated within the University.

SSci operate a 5-part impact strategy: (a) IS1-Investing in Staff Training; (b) IS2-Establishing & Nurturing Partnerships; (c) IS3-Maximising Organisational Support; (d) IS4-Resourcing Impact Generation; and (e) IS5-Recognition & Reward of Impact.

A comprehensive programme of Staff Training Workshops is held annually for SSci which Unit staff are encouraged to attend (IS1). The Research and Enterprise Office (REO) assisted us with specialist support in partnership development (contract research, consultancy, CPD, recruitment), contracts, intellectual property, commercialisation and marketing – REO staff regularly embed themselves in the Department to foster these activities (IS2). Chemistry also appointed an Impact Coordinator (Kelly) to coordinate activities and develop action plans for each Impact Case Study (ICS) based on IS3-IS5.

Under IS4, Unit staff have access to the EPSRC Impact Acceleration Account (IAA) and Higher Education Innovation Fund (HEIF) through the University's Enterprise Projects Group (EPG). Unit staff have received 12 awards worth £0.5M and these have led to a number of research-to-impact jumps. For example, Managh received £100k IAA funding for her project on single cell metallomics developing patient specific drug dosage for platinum anticancer drugs; Butler and Willcock received £85k EPSRC IAA funding to develop hydrogel sensors for point of use diagnostics, which is currently being commercialised with High Force Research.

Proximity of the Charnwood Campus for Life Sciences (in Loughborough) and, in particular, co-location with the University's Science and Enterprise Park (LUSEP) allow staff easy access to local companies. Under IS2, a distinctive feature of our approach has been to host employees of industrial partners (Plastic Energy and Foster and Freeman) in Unit laboratories. Under IS5, the projects with both companies were shortlisted for University Enterprise Awards (Plastic Energy in 2015 and Foster and Freeman in 2019).

Our work has significant societal value. For example, a revolutionary Laser Ablation Inductively Coupled Plasma Mass Spectrometry interface, which increases both imaging speed and sensitivity (Managh) and has implications for medical imaging and nuclear forensics, is now commercialised. The same is true of systems described in the Case Study that look at breath analysis (Reynolds, Thomas) and which are now part of clinical environments for rapid medical diagnosis. Platt, with Izon Science, has developed important new approaches to biological assays and sensors, while the development of an instrument that adds on to a normal mass spectrometer and allows the separation of isomers and conformers will significantly extend research capacity within life sciences and the pharmaceutical industry (Reynolds). This system is now commercially available.

1.3.1 How the Selected Impact Case Studies Relate to our Approach to Achieving Impact

In the Forensics ICS, Kelly identified a means to significantly increase fingerprint recovery rates from previously problematic crime scene exhibits. This was supported internally through Enterprise Projects Group (HEIF) and then, with REO support, taken to end-user partners (police and security services, then Foster and Freeman).

The Plastic Energy ICS is an example of a more direct industry/academic engagement. Through REO, Plastic Energy discussed with the Unit the possibility of collaborating on reactor design and detection of volatile chemicals, to help them optimise their chemical process for the conversion of waste plastics to energy and chemical recycling. Initially this was a research collaboration, leading quickly to embedding Plastic Energy staff directly within our labs. The programme has grown from one postdoctoral researcher to 4 company staff now based in Chemistry's labs.

The Biomarkers ICS demonstrates our ability to develop high quality science, identify the right partners with REO support and co-develop enterprise activity. Advion was the perfect partner with which to develop the mass spectrometry interface because they are the global leader in the area. Reynolds received £104k EPG funding to develop this portable mass spectrometer which Advion has commercialised and sold around the world, delivering impact at NASA and elsewhere.

1.4 Research and Impact Objectives and Plans for the Next Five Years

The Unit vision for the next 5 years is focussed on taking full advantage of our new world-class research facilities. We will build a leadership position in the research areas noted here:

- **Energy:** battery development and optimisation through computation and application, and hydrogen production, storage and utilisation technologies. (recent success: SusHy EPSRC CDT)
- **Health:** volatiles including breath analysis and applications to personalised medicine; device development for chemical-biological interface studies (recent success: NEU-ChiP EU Award)
- **Security:** translate our current forensic ability from laboratory to on-site crime scene and environmental incidents (recent success: KTP in *in situ* crime scene analysis)
- **Sustainability:** plastic recycling, carbon dioxide utilisation and catalysis and application to the Circular Economy (recent success: NiC3E UKRI Centre)

These Unit priority areas will gain from SSci expertise:

- developing our underpinning strengths in computational chemistry including new collaborations with Maths
- increasing emphasis on application of AI and automation including new collaborations with Computer Science on fundamental AI and other departments, including Chemical Engineering, on applications.
- working with the SSci Research Centres and institution-wide programmes to exploit additional interdisciplinary opportunities.

Concurrently, we have the following organisational aims:

- Build upon the recent recruitment of excellent early career researchers by supporting their development towards international recognition in their areas of research and to capitalise on their early successes in UKRI funding e.g. successes in New Horizons (Wright) and New Investigator Awards (Butler and Wright).
- Support and encourage staff to transcend from Col to PI status more regularly to build their national and international profile and thus the Unit's.
- Increase international and industrial collaborations based around laboratory facilities by hosting international collaborators (e.g., Eiceman, New Mexico State) and industrial partners (e.g., Advion, Plastic Energy) and by greater engagement with CALIBRE's Institute of Advanced Studies which brings world-leading researchers to Loughborough.

1.5 Open Research Environment

The University has been a pioneer of the 'Open Agenda', actively supporting Repositories for text-based outputs (since 2005) and data (since 2015), working beyond funder (including REF2021) open access requirements. Our landmark Open Research Position Statement committed to depositing the full-text of 100% of our primary research outputs in our now unified (2019) Research Repository (including on closed access where unavoidable) from 2020. We have met this target by depositing 100% of our 2020 journal outputs in the Repository.

The last year has seen 46k downloads and 120k views of Unit research including experimental procedures, spectral data, crystal structure data, and 3D Computer Aided Design files. Unit staff increasingly use open access journals (e.g., *RSC Chemical Science*, *Nature Communications*) and have also started to engage with ChemRxiv for pre-prints (18 so far). For example, Buckley and co-workers deposited their work on carbon dioxide utilisation which was later published in *J. Am. Chem. Soc.* These commitments are seen by the Unit as critical to the democratisation of science research.

1.6 A Culture of Research Integrity

Loughborough is committed to maintaining the highest standards of research integrity. Our Code of Practice for Research is underpinned by the five principles of the UUK's Concordat to Support Research Integrity. Policies and procedures on Research Misconduct and Whistle-Blowing Policy enable staff and students to report issues of research misconduct without fear of recrimination, and these are integral to our Ethical Policy Framework which steers the work of the University Ethics Committee (EC). EC considers all ethical matters arising in the conduct of the University's business, with specific processes in place for areas of relevance to Chemistry such as the Toxi-Triage's breath analysis experiments with human participants, and work falling under the Human Tissues Act. All new staff and students undergo training as part of their induction programme on ethics issues and all projects, from UG research to multi-million-pound research grants, are required to complete an ethical checklist before a project can be authorised.

Section 2. People

2.1 Staffing and Recruitment policy

All academic staff contribute to teaching, research and enterprise activities. We expect and incentivise collegiality from the earliest career stages. Academic staff have open-ended contracts, while research staff (32 new starters since 2014) are on fixed-term contracts related to projects in line with sector norms. Part-time working is welcome.

Since REF2014, the University approach to recruiting excellent staff at all career stages, from postdoctoral and early career researchers (ECRs) through mid-career and senior roles, has radically changed, driven by the University Strategy and beginning with the Excellence100 campaign. Building on this, recruitment to established posts is now conducted through biannual recruitment rounds, managed centrally but with significant School input, rather than piecemeal replacement hires. With excellence as the primary criterion, these rounds deliver better international recruitment and improved diversity.

The Unit regularly assesses its succession needs and uses new appointments strategically to ensure critical mass and leadership in the research groups. All appointments, including replacements, have to be justified by strategic planning.

The particular and significant recruitment challenge during this REF period has been to manage significant turnover from retirements to develop strategic research areas, in line with the University strategy commitment to excellence and focus on strengths. Specifically, we have ensured that new appointments protect the Unit's basic science, align with new laboratory provision and support the SSci Research Centres. We have made appointments at all levels (1 Prof, 2 SL, 14 L). Of the 17 new appointments, four were female and one BAME.

The Unit needed to embrace computational chemistry to complement SSci strengths in Mathematics, resulting in recruitment of ECRs Goddard, Plasser, Jolley, J.Christie (in Materials) and Toth (in Maths). Fernandez-Mato and Zanda were appointed under Excellence100, the latter to lead the Centre for Sensing and Imaging, joined by ECR Butler. Roach and Cousins were recruited as mid-career researchers in bio-organic chemistry to start the Centre for Laboratory to Fabrication. ECRs Managh and Turner strengthened the Centre for Analytical Science. Turner (*Community for Analytical Measurement Science*) and Jolley (EDF) were both externally-funded lectureships.

Succession planning for research leadership positions is embedded in our structures. Department responsibilities such as Head, Research Coordinator and Impact Coordinator are vital roles in their own right but also developmental posts from which holders might progress to Associate / Dean roles. Heads of Departments and Centres usually have deputies for the same reason. The demographic profile of the Unit has changed significantly since 2014 and some are already beginning to take first research leadership positions. Butler is Deputy Lead of the Centre for Imaging Science, Roach is Co-I and Operational Lead for the EPSRC/MRC CDT in Regenerative Medicine.

2.2 Staff Development Strategy

Loughborough's Organisational Development offers a wide spectrum of training opportunities and support for Unit staff at all career stages. Courses range from earliest stages (Welcome to Loughborough) through essential training (Information security training, Unconscious Bias) to training for staff becoming senior managers (Coaching conversations for managers, Recruitment and selection).

All academics are expected to obtain Fellowship of the Higher Education Academy (HEA). For new lecturers, this is integral to their dedicated development programme. More experienced colleagues are supported through our 'Recognition of Experienced Practitioners' scheme which requires preparation of a dossier of evidence to support their application.

Unit staff can access travel budgets to allow conference attendance or to develop their research network. Each academic is entitled to £2000 within every two-year period with the priority given to staff without external funding to support dissemination of their research.

Following the principles of the *Concordat to Support the Career Development of Researchers*, the University provides structured support to Unit postdoctoral researchers (currently 15) for career progression and development, including preparation of applications for funding. Our influential Research Staff Association (LURSA) runs a mentoring programme and introduced (2017) the Fellowship Inaugural Lectures to promote Research Fellows' work. Postdoctoral researchers receive formal induction to their School and agree a training schedule with their line manager including leadership of the research laboratories. They are encouraged to undertake Continuing Professional Development activities, at the University or externally at, for example, RSC. These include communication skills, research grant application and, for those who wish to, development of their teaching skills through lectures, workshops and lab practice. They are also encouraged to present their work in Loughborough seminars and at national and international conferences. Mindful of the fixed-term nature of appointments, postdoctoral researchers have dedicated support in the Careers Network and priority on the university redeployment register in the month leading up to the end of their contract. Several former postdoctoral researchers are now working in the Unit or on LUSEP with collaborating companies, Foster and Freeman and Plastic Energy. Managh was a postdoctoral researcher in the Unit before securing her lectureship.

Under the **New Lecturers' Programme (NLP)**, all new lecturers are guided by an experienced and trained academic colleague from the Unit who acts as Adviser. NLP (formerly academic probation) was substantially revised in 2017 and includes the full spectrum of research and impact activity (publication, funding applications, collaboration, public engagement, non-

academic partnerships). New lecturers have a reduced workload in teaching and administration (33, 50 and 67% of departmental norms in consecutive years), which enables the establishment of a full academic profile in research, teaching and impact at a manageable pace. In addition to an extensive training programme leading to FHEA, the New Lecturer meets four times annually with their Adviser though many more informal meetings are the norm. New Lecturers are allocated a University-funded PhD studentship within their first two years, for co-supervision with an experienced colleague. Supervision is a requirement to pass the programme, alongside a minimum expectation on research output production, and the submission of at least one substantial grant application. The Unit particularly supports EPSRC New Investigator proposals (or equivalent) providing extensive feedback (e.g., Butler's successful NIA grant and Wellcome Trust Seed Award). During the assessment period, 8 Unit staff competed NLP and four have subsequently been promoted. 6 Unit staff are currently completing NLP.

In addition to support through NLP, new staff are assigned their own research space in shared facilities and assigned a minor administration role, for example seminar organiser, to support their integration into the research environment and their departments.

Beyond NLP, any member of Unit staff can ask a senior colleague to become their mentor. As careers develop, we expect broader leadership contributions from **mid-career and senior staff**. Since 2014, one colleague served on University Council and four on Senate. Biggs served as SSci Dean, S.Christie was Associate Dean (Enterprise) and then Associate Dean (Research) while Dann was Associate Dean (Teaching). Workload model allocations ensure appropriate research activity is maintained.

Technical staff are critical to the functioning of the Unit. Chemistry has an Experimental Officer for NMR and ten technicians, three of whom are dedicated to research. Loughborough is proud to be a founding signatory of the Technician Commitment in 2017 and Chemistry has a track record of supporting technical talent: both Turner and Reynolds (now Senior Lecturer) were appointed to lectureships from Experimental Officer roles.

All members of post-probationary staff in the Unit have an **annual Performance and Development Review (PDR)**. This University scheme was totally updated in 2017. A supportive one-to-one discussion between the reviewee and a trained reviewer reflects on achievements over the past year and agrees objectives across the full range of activities including CALIBRE-aligned goals for research and impact activity. New PDR is a transparent way to recognise excellent performance with financial **reward** and allows much fairer identification of candidates for promotion. The new scheme has particularly benefitted our research staff for whom a rigorous developmental discussion was previously sporadic and consideration for reward a rarity.

The University has also revised the criteria for **academic promotion** (Senior Lecturer and Reader / Professor), to ensure that the research components align with the University Strategy and CALIBRE. Evidence for cases can be based on research, teaching, enterprise (impact) or any combination to encourage balanced portfolios of work. We judge 'Excellence and International Reputation' and 'Academic Leadership and Influence' rather than traditional metrics based on quantity and not quality. This focus allows panels to take into account statements from promotion applicants describing how personal circumstances, such as caring responsibilities, may have affected their profile.

Effective recruitment and staff development processes have underpinned 12 promotions during this REF period: S. Christie, Dann and Wijayantha to Professor, Buckley to Senior Lecturer then Reader, Kimber, Reynolds and Platt to Senior Lecturer; Goddard (née Panchmatia), Butler, Willcock and J. Christie to Senior Lecturer (after appointment as Lecturers within this REF period). Wijayantha and Buckley were originally appointed as RCUK Fellows and have developed within the Unit to their current senior posts.

Research and impact leave is available in the form of School and University Fellowships. School Fellowships, titled "*Maria Agnesi Fellowships*" in SSci, typically last 4-6 months. In 2016, the University introduced prestigious University Fellowships of up to 12 months duration with £5k funded support. Fellowships provide focused time outside regular workload to pursue an programme of academic work. Buckley used his Fellowship to take up a Visiting Professor appointment (2014-15) in the Sigman group at the University of Utah leading to publications in leading journals (e.g., *J. Am. Chem. Soc.*), new Co-I EPSRC awards in excess of £6M and industrial funding (e.g., >£250k as PI Lubrizol and EffecTech Ltd.). After periods in leadership roles, staff can apply for Fellowship to recover ground in research. Dann received a 6-month *Maria Agnesi Fellowship* in which she transitioned from a senior school role (AD-T) to leadership of the LU funded "SlowCat" mini-Centre for Doctoral Training and subsequent promotion to Professor S. Christie benefited similarly after his Associate Dean roles, gaining promotion to Professor in 2020.

2.3 Research Students

Research students are key to the research of the Unit. Over 100 PhD students have graduated in the REF period, over 50% more than in REF2014. Of these, 34% were female and 25% BAME.

The Unit attracts **funding** to maintain its PGR population (c.65) via University scholarships, industry funding, UKRI funding including Centres for Doctoral Training (CDTs), and high-quality self-funded students. The funding mix is approximately: 30% internal, 40% UKRI, 15% industry, 15% self-funders.

The Doctoral College allocates scholarships to Schools with the aim of maximising the intake of high calibre, capable and ambitious candidates. Unit members are encouraged to match internal funding with third-party funding. University scholarships can also be used to cover international tuition fees, with specific schemes currently in place for China, Kazakhstan and Turkey. There is also a special scholarship scheme for elite athletes to carry out a PhD in Loughborough and a Unit student (Webb) was one of the first recipients.

Additional University scholarships are available in the form of **mini Centres for Doctoral Training** (cohorts of 5 students) under the competitive CALIBRE Adventure Programme, a programme disseminated as Good Practice via UKCGE. The Unit has fared well in this, winning five mini-CDTs during the REF period (3D printed chemical reactors, plasma interactions with organic liquids, brain-on-a-chip, forensic applications, and sustainable fuel supply), as well as partnering in a mini-CDT led by Maths (Designed self-assembly of nanoparticles within fluids and at interfaces). As intended, the mini-CDTs have been exploited to gain further external funding, including an EPSRC Platform Grant (S. Christie), an EPSRC Centre grant (Buckley/Wijyantha) and EPSRC New Investigator and BBSRC awards (Butler).

During the REF period, the Unit participated in 6 **EPSRC Centres for Doctoral Training**: Carbon Capture and Storage and Cleaner Fossil Energy (2013-17), Embedded Intelligence (2015-2019), Fuel Cells and Their Fuels (2015-2019), EPSRC/MRC CDT in Regenerative Medicine (2011-2021) and the newly funded "SusHy" EPSRC CDT in Sustainable Hydrogen (2019-2027, Wijyantha is Co-I Director) which will provide 17 PhD studentships to Loughborough. The Unit has also supported the NERC CENTA DTP (2014-2020, two studentships).

Unit staff have also secured studentships from STFC and Diamond as well as from UK industry (e.g., Owlstone, Solvay, Diageo). Studentship funding is encouraged for collaborations with industry; the Unit will match industry funding with internal or UKRI funding, and we also hold fully-funded, industrially focussed studentships. We have good relationships with these partners with two from Lubrizol and three from EffecTech in the REF period.

All potential supervisors have to undertake training on Bullying and Harassment, Recruitment

and Selection, Respecting Diversity, and Mental Health Awareness. Supervisors are then required to develop PhD **recruitment plans** that include approaching underrepresented groups (special mailing lists, diversity-related web-resources, conferences). All funded and non-funded projects are posted on the School website and the highly visible FindAPhD website. Studentships are allocated and advertised early in the cycle to ensure high calibre candidates are attracted to fill the positions. We arrange remote or in-person interviews with shortlisted candidates to ensure high quality students are recruited. Decisions are taken by two members of staff.

The Doctoral College runs an **induction** event for new starters, complemented by School specific inductions. All students have at least two **supervisors** with recommended split around 70:30 to ensure productive involvement of the second supervisor. They meet at least monthly and usually more frequently, with minutes recorded in the University's online Co-Tutor tool. During the first year of PhD studies, an initial 6-month review is followed by annual reviews, based on a report and viva with an independent examiner, at which student **progression** is decided.

Within Schools, quality assurance of research degree programmes is provided by the ADR. Schools also have a Director of Doctoral Programmes, who **monitors progression** and arranges subject specific training. Further specialist **support** is available from the Mathematics Learning Support Centre, the English Language Support Unit, the Student Advice Centre, and the Student Wellbeing and Inclusivity Service. Schools have elected PGR student representatives from departments who are members of the Staff-Student Liaison Committee. This offers a direct dialogue by which issues can be acted upon efficiently.

The Doctoral College offers over 200 **skills development** events annually, including the Annual Conference, Summer Showcase, Three Minute Thesis competition and the 'Diversity in Research' workshops at which several Chemistry PGRs have showcased their work. In their Schools, students attend seminars in their group, providing interaction with world-renowned researchers and industry leaders, and giving opportunities to present. Further discipline specific training covers safety matters, journal clubs, and presentations by Library and the Careers Network. Students are encouraged to publish and are also supported by grants to attend conferences (£2k across their PhD). All students have an opportunity (c.90% take-up) to gain teaching experience by assisting in labs and tutorials, after completing the University's Teaching Skills course designed for PhD students. Participation in outreach activities with the public is also encouraged. One measure of the efficacy of this training comes in the success PhD students have enjoyed in gaining national awards during the last REF period. Examples include the RSC Inclusivity and Diversity fund £5k (Howard, 2020), the Haque and Bose Award (McMurchie 2019) and the British Mass Spectrometry Prize (Rankin-Turner 2018).

2.4 Equality, Diversity and Inclusion (EDI)

EDI matters are led by Schools and all make strong commitments. For example, Chemistry actively participates in a range of SSci-led EDI activities, including Women in Science lecture series, Pride in STEM research showcase (talks by LGBT+ scientists), Black Excellence in STEM events, panel discussions about experiences of Black students and staff in STEM, and the Diversity Allies Campaign (encouraging staff and students to be better allies to underrepresented groups). The university has staff groups e.g. BAME and LGBT+ groups and a women's network (MAIA), which is also a member of the Women in HE network. Wijayantha has been active in developing the university's Race Equality Charter and is also a member of the SSci EDI committee. Goddard is active within the MAIA and BAME networks and a mentor to postgraduates and ECRs through schemes in these networks. Goddard also secured an RSC Inclusion and Diversity award to gather data and enhance the experience of underrepresented student and staff within Chemistry.

All colleagues complete a Respecting Diversity mandatory course and pass an online Unconscious Bias course. School SMTs receive bespoke Unconscious Bias training. SSci and

SAACME hold Bronze Athena SWAN Awards and SSEHS holds silver.

Formal **flexible working** requests are submitted and approved by HR, supported by the School. Staff teaching may request up to one hour each day free from timetabled teaching to accommodate e.g. school runs. School meetings are restricted to core hours of 10am-4pm. Academic staff also have the ability to work flexibly or remotely on an informal basis so long as their responsibilities are fulfilled. For other circumstances, such as family caring duties, staff can request compassionate leave for immediate issues or longer term flexible working for ongoing responsibilities.

Remote working is facilitated via the VPN (with secure multifactor authentication) that provides access to all University online resources, as well as choice of device (desktop/laptop). These policies and supporting infrastructure have eased the transition to effective home working during the COVID-19 pandemic from March 2020.

Staff and research students with caring responsibilities are supported by a **carer's fund** each year to support additional costs associated with conference attendance. An annual equality analysis of staff conference attendance is undertaken each year, and action plans drawn up if required. The Schools fund mid-career female staff to attend the Aurora Leadership Programme.

In addition to University-level support, the **Unit supports staff returning from parental, maternity, adoption, caring responsibility, sick or other long-term leave** by giving them phased workload reintroduction extending over two years. Two Unit staff have used Shared Parental Leave, one took a year's maternity leave, and several students have returned from caring responsibilities. Staff are further supported by Occupational Health to determine accommodations to allow them to continue in their role, including staff with disabilities.

Wellbeing support: The Unit has Mental Health First Aiders with externally accredited training, who provide immediate support to staff and research students. The **Wellbeing Advisor** provides support to staff and research students. The **University Counselling Service** is available for emergency meetings and long-term treatment. The University also subscribes to the **Employee Assistance Programme** providing 24-hour telephone counselling and repeated sessions for staff with complex issues.

2.5 EDI in submission construction

Following the University's REF Code of Practice (CoP), the Unit created a REF Submission Team (25% female, 25% BAME) covering all research groups. The submission team completed EDI and unconscious bias training. All colleagues were asked to nominate and self-assess potential outputs for inclusion. In line with our Responsible Metrics Policy, these were peer assessed for originality, significance and rigour by a team of reviewers representing all research groups and covering different career stages, age, gender, race, and ethnicity. Output selection was based solely on excellence and did not set out to ensure even distribution across individuals or groups, as set out in the CoP. Throughout our REF preparations, equality impact assessments (EIAs) were carried out to assess both institutional processes and our draft return, including outputs selected, against protected characteristics, and to monitor whether further action was required. EIAs confirmed no issues required attention. 16% of outputs selected are attributed to staff identifying as female (16% of Unit staff identify as female).

Section 3. Income, infrastructure and facilities

3.1 Research Funding and Strategy

In this REF period, the primary strategic aims have been the design and commissioning of new research facilities, and recruitment of staff. On funding, the aim has been to maintain our grant income during a disruptive period of staff turnover and the moving phase (2017-2019), so that we can look to leverage this investment in both staff and facilities towards the end of this REF period, and over the next 5+ years. From 2018, we have seen this strategy come to fruition,

evidenced by leading 4 EPSRC and 1 BBSRC awards. These include several ECRs, confirming the success of our recruitment strategy.

Strategic alignment between research priority areas, including the interdisciplinary research centres in SSci, and the new physical infrastructure has been fundamental in the transformation of Chemistry. Now the Unit is attracting **funded research to take full advantage of the laboratory investment**. For example, the clean room in Chemistry aligns with needs of the Centre for Laboratory to Fabrication, which recently attracted new EU grant to Roach (NEU-Chip). NEU-Chip aims to revolutionise computing power by augmenting brain cells with silicon chips. This Centre, the new bio-lab and clean room facility are the home of the Unit's role in the EPSRC Platform Grant on Hybrid Manufacturing Process Research. Further evidence of the success associated with the SSci Research Centres comes from the Centre for Analytical Science whose laboratories delivered two **major and prestigious grant awards**: the East Midlands Breathomics Pathology Node (MRC, £2.4M total, £385k to Loughborough, 2015-19) for and the Toxi-Triage project (Thomas leads, EUH2020, €12M, 2015-19). The Unit is now a world-leading centre for volatile compound analysis with bespoke lab facilities and equipment plus outstanding leadership in the field.

Since REF2014, all grant applications are subject to formal **internal peer review** and, depending on size, will go to expert and non-experts for feedback including research support reviewers. **ECRs have high priority** for this support and this group has seen successful PI bids to UKRI: Jolley will investigate mechanisms of retention and transport of fission products in virgin and irradiated nuclear graphite (EPSRC, £320k, 2018-21) in collaboration with a team at Manchester; Butler is investigating luminescent host molecules for multisite recognition of polyphosphate anions (EPSRC, £250k, 2019-21), high-throughput luminescence assays (BBSRC, £150k, 2020-21) and for luminescent host molecules (BBSRC, £247k, awarded 2020, in collaboration with Liverpool University); Wright is investigating three dimensionally defined non-fullerene acceptors (EPSRC, £270k, awarded 2020) and from the New Horizons scheme to investigate three-dimensionally delocalised nano-graphenes (EPSRC, £200k, awarded 2020).

Additional significant grants from our ECRs include Goddard (InnovateUK, 2 x £100k, 2016-19) in collaboration with Johnson Matthey to investigate energy storage in relation to solid state electrolyte materials and interfaces; Kondrat secured PhD funding from Diamond (£50k, 2018-22) to look at potassium XAFS of batteries and catalysts and ISIS (£60k, 2019-23) to investigate neutron spectroscopy of surface intermediates on nanoporous metal catalysts for hydrogen storage technologies; both Butler and Kondrat received Royal Society Research Grants (£15k, 2016-17 and £20k, 2018-19) to purchase a fluorescence spectrometer and an autoclave reactor respectively. In addition, ECRs are assisted to develop collaborations across campus and beyond. For example, Butler has developed collaborations with colleagues in Materials and this led to joint PhD studentships and EPSRC Impact Acceleration funding (£100k); Kondrat has developed international collaboration with the Institute of Science and Technology for Ceramics (CNR, Italy) funded through the Royal Society International Exchanges programme to investigate layered perovskite photoelectron-catalysts for carbon dioxide reduction (£12k, 2018-20).

CALIBRE encourages staff to **collaborate across disciplines** and the Unit has attracted funding through joint projects such as:

- Kelly's collaboration with the School of Design and Creative Arts which formulated new processes for the use of platinum in photography (Anglo-American Platinum, £250k, 2014-17).
- Unit engagement in two Loughborough-led EPSRC CDTs (in Embedded Intelligence and Regenerative Medicine)
- S. Christie worked with the School of Mechanical, Electrical and Manufacturing Engineering (EPSRC, £0.8M, 2014-16) on the Towards Bespoke Bio-Hybrid Prosthesis - Manufacturing bio-inductive interfaces in 3D grant under the High Value Manufacturing Beacon.
- Kimber worked with Chemical Engineering (EPSRC, £0.5M, 2015-18) on Tackling

Antimicrobial Resistance: An Interdisciplinary Approach grant under the Health and Wellbeing Global Challenge.

- Wijayantha is part of the Physics-led Neuromemristive Systems grant (EPSRC, £1M, 2020-23)

Such relationships are productive and mutually beneficial and we will continue to collaborate in this way; for example, Buckley and Wijayantha are co-investigators on Loughborough's UKRI Centre for Circular Chemical Economy (EPSRC, £4.4M, 2021-24).

The Unit has engaged in **Research Consortia** with the intention to "link with the best" to enhance funding track record before, in the next cycle, taking the lead more often in larger grant applications. This has been facilitated by a budget available to fund travel so that Unit staff developing national and international collaborative proposals can attend initial meetings. SSci Research Centres were also provided with a budget to run workshops and attract potential partners into our networks. This has resulted in a 59% increase in UKRI funding in this REF period:

- Wijayantha is part of the UCL led £1.8M JUICED Hub consortium with Southampton and Birmingham (2017-2021) and was part of the UCL led £2.2M Sustainable Manufacturing of Transparent Conducting Oxide Inks and Thin Films (2014-2019).
- Goddard is part of the Sheffield University led £1.2M Design and high throughput microwave synthesis of Li-ion battery materials grant (2015-2021) including Glasgow, Oxford, UCL and the STFC.
- Evans was part of the Leeds University led £5M Decommissioning, Immobilisation and Storage solutions for Nuclear waste Inventories (DISTINCTIVE, 2014-2019) including Strathclyde, Sheffield, Birmingham, Bangor, Lancaster, Bristol and Manchester.
- Fletcher was part of the Loughborough Aeronautical and Automotive Engineering led £3.3M ELEVATE (ELECTROCHEMICAL VEHICLE ADVANCED TECHNOLOGY, 2015-2019) including Oxford, Warwick, Southampton, Coventry, UCL and 6 industrial partners.

Finally, a growing area (19% increase in this REF period) is **funding from or with industry**. Over £1.9M has been secured, including the EDF lectureship (a joint 5-year appointment, £0.5M, 2016-21) several InnovateUK awards (Goddard, Worrall, S. Christie, Kelly/Reynolds totalling £0.6M, with industries such as Glass Technology Services, Lubrizol Ltd, Johnson Matthey) and through industrial CASE type awards (£0.3M).

3.2 Organisational and Infrastructure supporting Research and Impact

Unit staff work through their School, specifically the ADR, to link with colleagues in the Research and Enterprise Office (REO). REO provides specialist support from costings all the way to Research Development Manager (RDM) support for facilitating large, multi-partner grant applications, EU grants and Fellowships for example, Butler received specialist mentoring for his ECR Wellcome Trust seedcorn funding application, and all EPSRC New Investigator Awards receive allocated time from the REO team.

Fellowship applicants are mentored from early stages to ensure the Fellowship is correct route for the individual. Care is taken with Early Career Fellowships to ensure the correct level of professional development is included to complement the science in the application. University and School resources are also added to the Fellowship "package" in the form of equipment, space and studentships, to ensure the whole grant is at a level to be both competitive and able to deliver cutting edge science.

The KTP Office within the REO provides full life cycle support for KTP projects from meeting with industrial partners with the KTP advisor and writing proposals to supporting delivery of the projects, including finance, data support and KTP associate training. All our InnovateUK, KTP and consultancy projects, where there are close collaborations with industrial partners, require contractual agreements, especially relating to intellectual property. Some of our projects have international partners, making the agreements more complicated. The University's Contracts Team provides the required specialist legal service support, negotiating with our partners,

developing agreements and monitoring commercialisation opportunities.

3.3 Operational and Scholarly Infrastructure Supporting Research and Impact

The REF period has seen a paradigm shift in the facilities and operational infrastructure of the Department of Chemistry. In 2014, Chemistry was housed in a standalone 1960s building with out-dated laboratory space. Chemistry is now in expansive, modern facilities, that project our forward-looking attitude to research and impact. This evidences Loughborough's substantial and sustained commitment to maintaining experimental facilities in support of world-class research activities.

The redevelopment was part of a strategic investment in STEM infrastructure on our "West Park", which, at £59M, was the biggest single estates investment in the University's history. Chemistry benefited from relocation, refurbishment, and new build to deliver state-of-the-art laboratory facilities. This comprised a £17M development of "STEMLab", housing teaching laboratory facilities, and the complete refurbishment of W Building to relocate Chemistry onto West Park. This placed Chemistry adjacent to Physics, Chemical Engineering and Materials, and the teaching facilities in STEMLab. This was a planned move to leverage research overlaps with complementary Departments, to facilitate new collaborations and working practices in the short to medium term. Undertaken in partnership with Chemistry staff themselves, the new laboratories cover every element of Chemistry with facility for synthetic chemistry, biological facilities, advanced analytical techniques, high pressure/temperature reactions, physical chemistry and characterisation. Researchers are located directly adjacent to their laboratory space. All Chemistry research was successfully moved over to this new facility between April and September 2018.

To maximise operational effectiveness, laboratory spaces are now organised by function rather than research group. This has resulted in enhancements through critical co-locations:

- a suite of advanced analytical laboratories with NMR instruments adjacent to x-ray diffraction;
- advanced analytical equipment includes inductively coupled plasma-mass spectrometry, and an array of mass spectrometry, ion mobility and differential mobility spectrometry housed in bespoke labs with their own data repository.
- large synthesis lab houses the synthetic methodologies, including their own analytical capabilities (thermo-gravimetric analysis, infra-red spectrometers, high performance liquid chromatography-mass spectrometry, gas chromatography-mass spectrometry).
- a laser lab adjacent to the main physical chemistry space and a bespoke material preparation lab for high pressure/temperature work.

In addition, new strategic investments have provided:

- a bio-sciences laboratory to Category 2 standard;
- a class 1000 clean room and lithography facility for work at the forefront of micro-manufacture; we produce devices with micro-scale features for organ-on-a-chip devices, chemical patterning of cells, preparation of magnetic and electronic structures and investigation of new layered materials.

In the REF period, University investment has been complemented by external grants: EPSRC multi-user equipment grant for a new solids/liquids 500MHz NMR spectrometer (£2M total, 2017, £277k to Buckley), chemisorption analyser (£675k total, 2020, £60k to Kondrat) and Wolfson Foundation (£200k, Thomas) for new analytical science equipment. Over £500k internal funding has been invested to support underpinning equipment including a new 400MHz liquids NMR, two benchtop 45MHz NMRs (with flow capacity), two new reverse phase HPLCs, GCMS and LCMS for routine analysis and a semi-prep HPLC, two fluorescence spectrometers, a glove box and ICPMS.

Space is open to all to encourage collaboration. For example, Physics make full use of the Material Preparation lab, collaboration is increasing with Chemical Engineering and Materials in

carbon capture and utilization, and in fluorescent probes for materials design.

A formal framework for sharing research facilities across the department/university/region has been established. Loughborough is a pioneer of the equipment sharing agenda, developing the open-source equipment database system Kit-Catalogue™ (www.kit-catalogue.com) to facilitate efficient use of equipment internally and externally.

The computational facilities available to researchers have also advanced considerably during the REF period. We have recruited five specialist computational chemists and have built a computational suite within the new Chemistry facilities. Within SSci, there is a higher specification computer facility (SCI_GRID), and, within the University, a high-performance computer (Lovelace) and an EPSRC funded Regional Tier 2 facility (HPC Midlands+), with Goddard on the Stakeholder Advisory Board for both.

J.Christie and Goddard are members of the Materials Chemistry Consortium and the Materials Molecular Modelling hub, giving them access to ARCHER/ARCHER2 and Tier 2 machines; for example, THOMAS/YOUNG (hosted at UCL) allowing rapid computational analysis of battery optimisation. Wijayantha, Dann, Elsegood, Kondrat, Worrall have frequent access to Diamond, ISIS and the national crystallography, NMR and laser facilities through various competitive calls, for beam time at Diamond and access to the national NMR Centre based at Warwick.

Section 4. Collaboration and contribution to the research base, economy and society

4.1 Research Collaborations, Networks and Partnerships

Collaboration is key to many of our most successful projects and in-line with the REF2014 strategy aim to be a research partner of choice for multi-disciplinary collaborations. The Unit supports the building of external links with travel budgets for academic staff, and through dedicated support staff in Schools and the REO. We encourage research collaborations through, for example, Midlands Innovation (including the Energy Research Accelerator) at a regional level, through UKRI initiatives at national level (EPSRC Grand Challenges and Early Career Fora), and internationally through travel awards. Where significant periods of time are required, Fellowships (study leave) are deployed; for example, Buckley used his Fellowship to take up a Visiting Professor appointment (2014-15) at the University of Utah.

Successful collaborations with UK partners are associated with interdisciplinary work under the Unit's research groups, for example:

- Energy: Wijayantha's work with UCL in EPSRC funded research into Transparent Conducting Oxide Inks and Thin Films and with their Joint University Industry Consortium for Energy (Materials) and Devices (JUICED Hub) is based on our distinctive contribution of expertise in fabrication of energy devices for next generation batteries. He is a board member of the JUICED Hub.
- Sustainability: S. Christie's collaboration with Leeds University, currently under EPSRC platform grant on Hybrid Manufacturing Processes, is based on our distinctive contribution of expertise in 3D printing of chemical and biological reactors, enabling real time analysis of chemical and biological processes, now being applied to industrial problems.
- Health: Thomas's EMBER project in collaboration with Leicester University (and hospitals) is based on our distinctive contribution of expertise in volatile compound and complex mixture analysis which makes breath sampling and disease detection possible. Its effectiveness is evident in very recent work on non-invasive COVID-19 diagnosis.
- Health: Weaver's work with De Montfort University has been supported by the British Society of Antimicrobial Chemotherapy and is based on our distinctive contribution in unusual polyfluorinated heterocycle formation for anti-parasitic properties.
- Health: Loughborough's EUH2020 PET3D project led by Zanda involved eight academic partners from across Europe including Amsterdam, Munster and Bergen. This project tackled the European shortage of specialist scientists in imaging.

Participation in EPSRC Centres for Doctoral Training in Energy and Sustainability has been an important driver for collaboration and has supported over 15 PhD students during the REF period:

- Carbon Capture and Storage and Cleaner Fossil Energy CDT led by Nottingham, with Birmingham, Sheffield and the British Geological Society. Buckley and Wijayantha investigated carbon dioxide utilisation technologies.
- Fuel Cells and Their Fuels CDT led by Birmingham, with Nottingham and Imperial College. Wijayantha investigated novel materials for hydrogen generation.
- Sustainable Hydrogen CDT: Wijayantha is CoI in the consortium which includes Nottingham (lead), Birmingham and Ulster. Wijayantha, Buckley supervise students through this CDT with industrial co-funding regarding hydrogen storage, Wright is investigating novel materials for hydrogen applications and Kimber is developing new odour agents for use in hydrogen storage.

As part of the University's position in Midlands Innovation (the partnership of the Midlands eight research intensive universities), Unit staff are engaged in the Energy Research Accelerator. Wijayantha has been member of its Research Committee and has been a leader in the fields of energy storage and conservation, particularly for renewable energy sources.

The Unit's international academic collaborations have led to >250 journal papers with international co-authors during the REF period. For example, Buckley has co-authored papers with the Sigman group at University of Utah, one of the world's leading groups in Physical Organic Chemistry; Thomas has collaborated with Eiceman at New Mexico State University, a world leader in ion mobility spectrometry, through the Toxi-Triage project, and Platt worked with UC Irvine on modelling and application of multifunctional aptamer-nanopore sensors.

4.1.1 Interaction with Key Research Users, Beneficiaries or Audiences

Collaboration with industry partners is pervasive in the Unit and embedded in strategy (IS2). We do this through our research groups and our interdisciplinary Centres. The two main mechanisms we use are joint working by allowing key partners full access to our lab facilities and sponsoring of PhD studentships.

Examples of co-working in laboratories include:

- Sustainability: Plastic Energy utilise our lab and analytical facilities to determine polymer pyrolysis and monomer regeneration protocols.
- Security: Kelly's work on fingerprint detection with Foster and Freeman also benefits through knowledge exchange and equipment sharing, as well as project supervision.
- Centre for Analytical Science (CAS): Industry can be embedded in CAS for extended periods to facilitate knowledge transfer. Advion and Owlstone have developed bespoke mass spectrometry interfaces for breath analysis in this way.
- Centre for Laboratory to Fabrication: an AstraZeneca chemist was hosted for 18 months to develop expertise in 3D printed photochemical reactors, applying this to industrial problems on returning to AstraZeneca.

Over the REF period we have leveraged our contacts with UG placement companies to grow the relationships into PhD sponsored programmes. Examples include:

- Industrially funded studentships from Solvay, InnoSpec, and HK Wentworth who were attracted to Unit expertise in phosphorus ligand design.
- Lubrizol who approached Loughborough specifically to address efficient cleaning at lower temperatures due to Buckley's expertise in oxidation chemistry. This relationship continues with further studentship funding for 2021-2024.
- EffectTech who have co-funded studentships during the REF period accessing expertise in novel materials and carbon dioxide utilisation to aid succession planning within their business.

- Funding for PhD studentships with Owlstone and Diageo who secured access to expertise in volatiles analysis

4.1.2 Engaging with Diverse Communities and Public

Staff have engaged with popular science programmes such as Fake Britain on BBC, and with the Bank of England and Historic England on counterfeit merchandise. Around 50% of staff are active on social media to engage the wider community and general public. In addition, research students are very actively involved in online activities that deliberately portray their research in an accessible manner to wider and diverse audiences. Postgraduate researchers at Loughborough have been award winners at the RSC Twitter Poster competition on three occasions; twice in Section sub-panels (Materials and Analytical), and one overall winner with Special Commendation. The Unit strongly endorses and encourages this activity in order to promote the discipline widely, in a contemporary and accessible format.

4.2 Contribution to the Sustainability of the Discipline

Many Unit staff hold leadership roles within the chemistry community. ECRs are particularly encouraged to take leadership roles in important national bodies, both to sustain the discipline and also to increase their profile. Unit staff have been particularly active in the Royal Society of Chemistry (RSC):

- Treasurer of the RSC / Society of Chemical Industry (SCI) joint colloids group and committee member of the RSC Biomaterials Chemistry group (Hatton, 2017-)
- Chair and former Secretary of RSC Electrochemistry Group (Wijayantha, 2011-19)
- Chair of RSC Photochemistry Group (Worrall, 2006-15)
- Kimber: RSC Organic Division Council (2018-), Organising Committee and judge for RSC-SCI Retrosynthesis Competition (2019-), including setting the target molecule and Session Chair for the final.
- Goddard: RSC Dalton Division Council (2017-), RSC Pan African Chemistry Network (2016-present), Elected member of RSC Science, Education and Industry Board (2015-18) and RSC Solid State Chemistry Group Committee (2014-17)
- Council member of RSC biomaterials chemistry group (Roach, 2015-)

Unit staff have also given service to significant organisations in Chemistry:

- President of the European Photochemistry Association (Worrall, 2014-16)
- Secretary of the International Association of Breath Research (Thomas, 2019-21)
- President of the UK Society for Biomaterials (Roach, 2019-).
- Executive Committee Member of British Society of Mass Spectrometry (Heaney, 2019-).
- Chair of SCI Young Chemists Panel (Buckley, 2014-15) and Panel Members (Butler, Kimber 2015-19)
- International Union of Pure and Applied Chemistry (IUPAC) Sub-Committee on Photochemistry (Worrall, 2008-)
- Member of CAMS Measurement Science Research Institute (Turner, 2020-).

Unit staff have been **responsive to national and international priorities**. Buckley and Wijayantha (UKRI National Centre for Circular Chemical Economy) and Hatton (UKRI Sustainable Plastics, researching circular business models for food packaging) engaged with partners across the UK in response to the UK's Clean Growth Strategy. CAS has been at the centre of collaboration with industry and clinical partners in the rapid detection of COVID-19 via breath analysis. CAS coordinated independent clinical research in UK, Sri Lanka, Germany and Canada which resulted in rapid tests for discriminating COVID-19 from other respiratory diseases. Thomas was also an evaluator for the 'Sniffphone' (Smartphone for disease detection from exhaled breath) and scientific advisor to the MRC Bravo project (defining the volatile organic signature of ventilator associated pneumonia).

4.3 Indicators of Wider Influence

We encourage staff to undertake roles that influence future research in their chemistry

disciplines.

Engagement with funders

The majority of Unit staff act as reviewers across all major chemical science funding bodies in the UK/EU e.g. UKRI, RSC, H2020 (including EU COST and Marie Skłodowska-Curie actions), Heart Research UK, British Heart Foundation and Medical Research Scotland.

The Unit encourages engagement with EPSRC; 25% of Unit staff are members of the EPSRC Peer Review College, with an additional 15% actively reviewing proposals. Goddard was appointed to the EPSRC's e-Infrastructure Strategic Advisory Team (2020) and Roach was instrumental in establishing the EPSRC Early Career Forum in Manufacturing Research (2016-present).

Invited keynotes and lectures

Unit staff delivered over 100 invited research lectures worldwide including such diverse keynotes and plenaries as: the International Congress on Heterocyclic Chemistry (Malkov, 2015); the 3rd & 4th EuCheMS Congress on Green and Sustainable Chemistry (Buckley, 2017/19); UK Automated Synthesis Forum (S. Christie, 2019); European Society of Vascular Surgery (Cousins, 2019); International Conference on Applied Chemistry (Goddard, 2020).

As ECRs, Managh has delivered a keynote to North American Workshop on Laser Ablation (2019) and Kondrat was invited to the Faraday Discussion on Nanoparticle Systems for Catalysis (2016). Butler was invited to present at the International Conference on Bioinorganic Chemistry in 2019; this led directly to new collaborations with leading biological chemistry groups in Oxford, Berkeley and Brussels, and to two high profile publications.

Staff also chaired numerous conference sessions, for example the Hydrogen Networks session at the Supergen Energy Networks conference (Wijayantha, 2020), World Biomaterials Conference (Roach, 2020), Breath Summit (Thomas, 2019), and Historic England: Theft of Heritage Metals (Kelly, 2016).

Journal Editorship

Unit staff regularly act as reviewers for all major international journals. Zanda is an Editorial Board Member for Thieme Chemistry Journals (2009-). Four staff act as Editor-in-Chief (growth from one in REF2014): Synform (Zanda, 2009-), International Journal of Ion Mobility Spectrometry (Thomas, 2009-19), Cogent Chemistry (Weaver, 2020-), Progress in Reaction Kinetics and Mechanism (Worrall, 2020-). Staff are also Associate Editors for Review Journal of Chemistry (Malkov, 2019-), RSC Advances (Buckley, 2015-17), Frontiers in Chemistry (Butler, 2019-) as well as an editorial board member of Journal of Breath Research (Thomas, 2018-). We are pleased that our emerging leaders such as Buckley (Reader since 2020) and Butler (SL since 2020) are already influencing their research communities by being active in editorial roles.

National and international committees

Unit staff are increasingly active in influential committee roles. ECR Kondrat sits on the Catalysis Hub Steering Committee shaping the future landscape of catalysis technologies. Kelly was an influential witness providing written evidence to the House of Lord's Science and Technology Select Committee's report: "Forensic Science and the criminal justice system: a blueprint for change" (2019). Buckley sat on the Management Board of the "CO2Chem" Grand Challenge Network, an international network that works across disciplines and across academia, industry, and government. He shaped the Grand Challenge through the core activities of Connectivity (networking, conferences, research funding and development), Information (news, media, publishing) and Learning (summer schools and professional development). S. Christie sat on the EPSRC Grand Challenge Dial-a-Molecule Steering Group and led its Enabling Technologies Theme; he hosted its flagship annual Summer School for PGR and industrial chemists, at Loughborough since 2018.