Institution: University College London

Unit of Assessment: 8 - Chemistry

a. Context

Research undertaken within UCL's Chemistry department has impacted substantially on a wide range of industry partners, delivering economic benefits from process improvements and new technologies. Research into physical organic chemistry has benefitted the pharmaceutical industry by making the drug discovery process more efficient; materials research has led to the development of new products for the construction and energy industries; computational chemistry and physical chemistry measurements have underpinned catalysis development and use in the automotive and bulk chemical industries. Spectroscopic analysis techniques developed in the department are now in widespread use in cultural and conservation sectors. A further key impact has been the provision of skilled people: the department has provided over 100 highly skilled PhDs and PDRAs to industry since 2008. Additional benefits have accrued to legislators, policy makers and public services such as politicians, government advisors, public sector workers and funding agencies through our provision of expert knowledge on topics including high performance computing and nanotechnology. We have used outreach activities to share key research findings with a broad cross-section of the British public, thereby enhancing awareness of and engagement with important scientific questions and issues relating to issues including energy, health, nanotechnology and climate change, and inspiring the next generation of scientists.

b. Approach to impact

The department takes a wide-ranging approach to fostering and maximising the extra-academic impacts of its research. That approach is underpinned by a threefold commitment to: (i) building and maintaining active and collaborative working relationships with relevant industry partners; (ii) providing expert advice to policy-making bodies; and (iii) engaging the general public with key research outcomes, particularly via the popular media.

Fostering Industry Links: Forging and maintaining strong and productive industry links are integral to the transfer of basic research from the laboratory for the ultimate benefit of the UK economy. Many industrial contacts are forged through personal interactions and involvement in national networks. Academic staff are strongly encouraged to share or refer contacts with relevant partners within the Unit. They attend relevant training courses run by UCL Advances, UCL's centre for business interaction, for example on "how to be a more effective networker" and "communicating science to business", which equip them with the skills required to network talk to business. The department has a Knowledge Transfer Champion (**Darr** 2010-14), a role supported by awards of over £60k from institutional KE funding (e.g. EPSRC Pathways to Impact Award). Darr has organised 6 UCL-industry networking events to support staff in identifying suitable industry contacts that may lead to productive partnerships, and which included themed meetings on nanomedicine, energy and energy storage, photocatalysis, electrochemical innovation and modelling for industry. Since 2006 our Industrial Doctorate Centre in Molecular Modelling and Materials Science (M3S IDC) has also held annual Industry Conventions to foster interactions between staff and existing and new industry partners, thereby strengthening our links with industry. These events typically involve representatives of between 30 and 100 external businesses, including large companies such as AWE, Accelerys, DTSL, JM, IBM, INEOS, BP and Rolls Royce. More sector-specific events organised by the IDC have included presentations, networking and "speed dating" sessions. The IDC further benefits from an industrial steering group made up of 6 industry leaders who advise the Department on its postgraduate courses and research of interest to industry. Since 2008 the IDC has developed 30 new industrial sponsors; the strong series of partnerships that have been developed have led to repeat sponsorship, in particular from Pilkington/NSG, Johnson Matthey, BP and AWE, each of which have supported 4-6 students.

To promote opportunities for knowledge exchange, the Department significantly enhanced its website in 2010 to include business-focussed pages providing advice on modes of industry engagement and on consultancies and the provision of technical support services. In addition, the site includes information for potential external partners about the range of research expertise within the department. We also transfer our expertise by delivering continued professional development and training activities for industry. Recent examples include delivery of industrial training on modelling and simulation to BP staff through the Thomas Young Centre, and **Anderson**'s provision of continuing education courses to companies including AstraZeneca, Pfizer, GSK and UCB.

Translation and Commercialisation of research: As well as its provision of informational resources and support for knowledge exchange activities, the Department encourages its researchers to apply for RCUK follow-on and developmental pathway funding. **Parkin**, for example, received a total of £750k in MRC DPFS funding between 2010 and 2013 to develop an antimicrobial catheter lock in a project co-sponsored by Ondine Biopharma (£250k); this project has already led to the granting of one new patent and three clinical trials that confirm efficacy. The department further incentivises work to deliver benefits to industry through its policy of offering reduced overhead charges for projects with demonstrable potential to deliver such benefits. **Caddick**, for instance, has secured an industrially funded PDRA at a reduced (30%) overhead rate (2013-7) for work involving the development and application of new reagents for protein modification, which is seen to have significant impact potential and which underpins the activity of 5 UCL patent filings. We often make use of the support offered by UCL Business PLC (UCLB, UCL's technology transfer company) in our engagement with industry. Further indications of the success of this approach include 32 priority IP protection filings and 64 granted IP protections, as well as 13 licensing agreements since 2008. During the same timeframe, the department has also been involved in 56 invention disclosures and 21 proof of concept projects funded by UCLB (£25-50k each), which support the pre-commercialisation development of promising technologies emerging from UCL. Furthermore, the UoA has spun out a number of companies, both staff (Canbex – now with 30 staff working on MS drug precursors) and student-led (Cella Energy – founded by 4 IDC students). We also maintain close research links with companies that evolved from UCL research prior to 2008, especially Aeroqual, where we have made and tested industrial sensors. UCL Chemistry [text removed for publication] is the only gas sensor lab in the UK to enable full preparation, characterisation and valorisation of metal oxide based sensors.

Sponsorship and secondments: The department has encouraged the transfer of skills into and out of academia through secondments and student placements. Examples of secondments include four Royal Society fellowships: Dr Glenn Jones's secondment into UCL (2010-2013) from Johnson Matthey to develop new computational codes for catalysis and **Di Tommaso**'s fellowship with AstraZeneca (2011-2015) to work on crystal polymorphism; **Sankar**'s 50% was secondment to Johnson Matthey (2008-11) to develop synchrotron methods of analysis; and **de Leeuw** (2012-16)'s 50% secondment with AWE to develop new models of radiation damage in nuclear materials. The further secondments of five early career researchers (GSK, JM, GoScience and DBIS) have been supported by awards of over £125k from institutional KE funding including the EPSRC's Knowledge Transfer Secondment scheme, Collaborative Training Account and Impact Acceleration Account. Interactions with industry have been further developed through industry-funded EngD and PhD studentship (the success of which is evidenced partly by the growth from 30 to more than 125 such fully- or partially industry-sponsored projects between 2008 and 2012) and 6 fully-funded PDRAs. We have capitalised on support in the form of UCL impact awards (a studentship scheme involving equal UCL / industry-matched funding), Industrial CASE awards and, in particular, the IDC. Impact studentships have allowed 12 new industrially funded projects since 2008.

Consultancy: Members of the Department take every opportunity to use their research expertise to provide expert advice, often on the invitation of external beneficiaries. This is supported by UCL policy allowing academic staff to undertake up to 40 days of renumerated consultancy per annum. More than 50 consultancies have been conducted during the REF period. [text removed for publication]. Many such activities are undertaken with the support of UCL Consultants Ltd, which provides contractual, tendering and administrative support to UCL staff.

Public and media engagement activities: We make similarly extensive use of appropriate central resources to ensure that we pursue the most effective possible means and forms of communicating our research to various sectors of the general public, and particularly to school children. To that end, **Rowley** has worked with UCL's Public Engagement Unit (PEU) and Widening Participation Team to ensure the efficacy of a series of lectures for year 10-13 pupils based on departmental research (2008-present). This series has included lectures on atmospheric chemistry (**Rowley**), nanomaterials (**Darr**), and materials design and structure prediction (**Catlow**), and has attracted some 400 pupils per year from more than 45 schools in London and surrounding counties; eight of those schools have attended for four years or more. Public talks based on departmental research have also been delivered through the UCL Science Centre, which provides lectures and information services for year 12 -13 students and teachers; staff presented five such talks to audiences of around 300 in 2011-12. The department received funding from the UCL PEU

(£1500) to support seven "science soirees" on topics including energy (Grau-Crespo/Goodall), nanotechnology (Waugh/Coates), CO_2 (**Rowley/Lewis**) and pattern formation (Poole/Fenner). Since May 2009, five members of the department have also participated in the PEU's Bright Club, a variety night at which researchers are tasked with using stand-up comedy to share key insights from their research with a public audience of 50-400.

As well as sharing research with the public directly, we are keen to engage public audiences via the media, wherever appropriate, and have consistently sought to develop this as an approach to impact. EPSRC Senior Media Fellowships awarded in 2007 and 2012 to **Sella** enabled him to grow his public and media engagement activities based on UCL chemistry science. As a result, in the period 2008-2012 he has contributed to more than 20 BBC television and radio programmes, given 40 public presentations, and led public discussions at the Cheltenham Science Festival. We have extended the range of media in which we engage with our non-academic audiences, particularly in terms of exploiting new online forums for engagement. A 2009 collaboration with Sciencefilms/Labreporter led to the development of eight "Lab Report" short videos posted on YouTube; to date, these have been viewed over 25,000 times. **Michaelides**' ICE group produced an exhibit on the properties of water at the nanoscale for the 2010 Royal Society Summer Science Exhibition, including a free iPhone game app which was downloaded 4,265 times by users in 73 countries. More recently, **Hirjibehedin** has instituted a citizens' science project titled "Feynman's Flowers", which uses online participatory methods to educate the public on molecular spintronics; the project webpage has received around 1800 unique visitor hits since its creation in Sept. 2012.

Our specific emphasis on these key approaches to impact is supported by a range of resources intended to encourage and facilitate the more general development of non-academic benefits from our research. These include the annual award of three to five full year staff sabbaticals to maximise the impacts of current research, particularly by developing new links with industry, the media and public policy. Individual proposals for these awards are reviewed by the Head of Department and a clear set of impact (as well as research) objectives agreed with successful applicants. This policy was initiated in 2010; since then, 13 members of staff have benefitted from a sabbatical, leading to the development of eight new funded industrial research projects with a total value of ca. £400k. Impact is also factored into workload models for core teaching, research, and administration; individuals engaged in impact-related activities are eligible for reductions in their core teaching hours. Non-academic impact is further recognised and rewarded within the Department via formal biannual appraisals and yearly performance reviews.

c. Strategy and plans

Over the next 6 years we intend both to maintain key elements of our existing approach, and to enhance and add to these as a means both of maximising the non-academic benefits of our research generally and, in particular, of achieving a number of new impact goals.

Based on success in the current REF period we expect to develop at least 20 new industry collaborations, especially in biomedicine. This will be stimulated by interactions with the Francis Crick Institute (formerly UKCMRI) through the recent appointment to the Department of two UCL Crick Fellows (**Bucar** and **Christie**) with a specific remit to build closer links with the Crick, but also by the continuation of twice-yearly industry networking events. We will also continue to develop joint industrial links with Kings, IC, QMUL, Greenwich, Kent and The Open University. We have recently started to act as a characterisation hub for these universities and for industry through the award of £3M equipment infrastructure funding from EPSRC (launched 1/7/2013).

Our leading role in UK catalysis will be consolidated through our engagement in the Harwell Campus and Diamond; UCL involvement in this centre will grow to over 20 academic staff and some 25 PDRA/PhD students in the next two years. We will use this interaction as a focal point for UK catalysis and will involve at least 20 SME as well as 10 large companies in it. Catlow is leading on this in the UK, and the EPSRC IAA funded MITE hub call has just been advertised.

We will extend the international dimensions of our research especially through two industrial research institutes, A* in Singapore and JAIST in Japan, [text removed for publication] and plan to expand our EU funding base through Horizon 2020 applications, building on our existing EU funding strengths in coordinating large scale computing for healthcare and in photocatalysis for water purification.

We further anticipate the development of at least 10 additional licensing agreements with industry and the spin-out of at least two (new) companies originating within the department. This

will start with Thiiologics, a registered company based on 5 patent filings and currently wholly based within UCL Chemistry. [text removed for publication]. Participation in schools outreach and public engagement activities, both within and beyond the Department will be increased through programmes such as the ChemNet Ambassador scheme. We intend to capitalise on Sella's increasingly prominent status as a science media personality to continue to engage new non-academic audiences in our science in the coming years.

In support of these and other impact-related activities, we will continue to facilitate 3-5 staff sabbaticals each year and to recognise such activities in our workload models. The department has been informed by EPSRC that M3S IDC has been funded for 5 more years and we will grow two other DTCs within the department. We also plan to take advantage of upcoming initiatives and programmes developed by UCL through its 2011-2015 UCL Enterprise Strategy. To that end, we will work with the staff from UCL Enterprise to support and enhance our existing knowledge transfer activities and to develop new activities. We will also encourage staff to undertake training in entrepreneurship as part of UCL's plans to train 250 staff per year by 2014-15. To support our goal of developing spin-outs and licensing, we will further promote the IP and investment support available from UCLB. We will also publicise the university's increased support for student entrepreneurship courses and businesses, and anticipate 5 new student business start-ups.

d. Relationship to case studies

The significance and success of many strands of the approach to maximising impact described above is evident in all seven of the submitted case studies. Fostering close links with industry, which was a key factor in the ESRC's decision to award us the only DTC in materials science and modelling in 2009 (renewed in 2013), features in several of the case studies. UCL08-PAR and UCL08-WIL focus on the commercialisation of research originating within the department, including work by **Williams'** group on gas sensors and **Parkin**'s work on glass. Both projects arose from long-term collaborative relationship with companies (Honeywell, NSG). UCL08-CAT relates to computational and experimental work on catalytic processes; this has had major impact on catalysis development, commercialisation and has influenced catalytic registration, originating from and facilitated by **Sankar'**s RS industrial fellowship with JM. UCL08-ABR describes the impact of **Abraham**'s work on partition functions on improvements in screening by drug companies; those impacts were facilitated by our continued provision of both lab and office support for Abraham since his formal retirement in 1998. The breadth of our research collaborations and the transfer of skilled people is exemplified by the pioneering work of **Clark** in the use of Raman spectroscopy for the identification and cataloguing of important pigments and artefacts for authentication in the museum and heritage sector (UCL08-CLA). UCL08-COV outlines impacts arising particularly from **Coveney**'s provision of expert advice to bodies including the UK High-End Computing Strategy Committee, and the UK Prime Minister's Council for Science and Technology (CST) on e-science and grid computing. Our emphasis on public engagement as a key route to impact is exemplified in UCL08-SEL, which details the use made by **Sella** and others use of departmental research to engage a broad non-academic audience, including through media and schools engagement.