Institution: University of Bath

Unit of Assessment: 8: Chemistry

a. Context

Research in Chemistry at the University of Bath delivers impact across a range of areas: ***industrial applications***, including the adoption of more sustainable chemical processes; ***wealth creation*** including commercialisation of intellectual property (IP) and capitalisation of companies; sensor development for ***diagnostic, clinical and environmental*** applications; providing ***enhanced postgraduate training***; ***engagement*** outside academia and ***influencing policy*** at senior levels.

We have industrial links, with *50 companies*, with varying levels of collaboration and funding, involving interactions through direct funding, project partnership, membership of industry advisory groups for larger projects and programmes, studentship support, consultancy, production partnerships, pre-clinical testing and direct commercialisation. Our clinical links, with *a dozen clinical partners* and collaborators, exploit the relevance of our research themes to potential clinical applications, including developing and designing new therapeutic materials and delivery systems. In terms of outreach activities, policy and strategic impacts, in addition to our extensive involvement in *public engagement and related activities*, Bath chemists are involved at high levels advising UK funding policy directions, in Research Councils, Government and industry-facing bodies. We also deliver impact in our provision of highly trained researchers for the workforce, notably in technical industrial roles and other high value areas.

b. Approach to impact

Bath Chemistry delivers impact through research excellence by identifying key targets including: the pharmaceutical, fine chemicals and chemistry-using industries; clinical treatment and diagnosis; and sustainable manufacturing and environmental applications. These are underpinned by impact in economy and wealth creation, including IP generation and exploitation. We identify and engage fully with potential beneficiaries across these areas, recognise and enhance alignment with national priorities, place our research in the context of wider societal challenges and identify those aspects of our research with potential for impact. During the REF period, this has been achieved through various means including: involvement of non-academic partners in large collaborative research initiatives; establishing problem-based interdisciplinary Research Centres; hosting user-led 'sandpits' and 'foundries'; impact-focused deployment of University research funding (e.g. PhD studentships); holding research showcase events; embracing involvement with key advisory bodies; and by means of primary publications. These activities are supported across our five research themes of Catalysis & Chemical Transformations, Energy Materials, Sensing & Healthcare, Structural Chemistry and Sustainable Chemical Technologies. Our approach can be demonstrated through various routes taken to deliver impact from our research.

- ***Establishment and exploitation of research themes with impact potential:*** A significant consideration in developing the research themes within Bath Chemistry has been the potential to build large consortia, and the consequent potential for involving major industrial or clinical partners. All five themes have succeeded in this, and the way in which they have been harnessed in delivering impact can be illustrated with two prominent examples:
  (i) The Centre for **Sustainable Chemical Technologies** (CSCT) was formed as a cross-disciplinary University Research Centre in 2008 with full industry partnership at its core leading to the securing of substantial industrial funding and an EPSRC Doctoral Training Centre (*Davidson, Scott*), with impact demonstrated for large industry (e.g. ***Johnson Matthey***) and SMEs (e.g. ***TMO Renewables***). With accumulated income of £19M+, CSCT is expected to develop further its scope and reach by developing into a broader University Research Institute in 2014.
  (ii) The **Bath Biosensor Network** was founded as a cross-University network and developed through an annual cross-disciplinary event, leading to funded EU Networks, industrial links and PDRA funding, translation into successful commercialisation and clinical outcomes (Impact Case Studies on ***Atlas Genetics*** and ***GlySure***) and to the establishment of an international ***Catalysis for Sensing and Health*** consortium, with Chinese partners (ECUST), led from Bath Chemistry.
- ***Primary publication, leading to take-up of Bath-generated chemistry in industry:*** High impact publication of breakthrough work on "Borrowing Hydrogen" (*J Williams*) led to the take-up and implementation of this synthetic research methodology in industrial contexts. Williams interacted directly with industrial collaborators in the pharmaceutical industry in sharing

the methodology, now widely adopted by major players including ***AstraZeneca*** and ***GSK***; Publication of a new catalytic route to butadiene from ethanol (*Jones*) directly led ***Synthos SA***, Poland to work with Bath, leading to demonstration applications, a joint patent, direct investment in Bath research (£250k), equipment purchase (£60k) and plant construction at Synthos (£500k).

- ***Protection and commercialisation of Bath-generated IP:*** A prime example is joint patents in metal alkoxide catalysts from industrially-funded research (*Davidson*, with ***Johnson Matthey***), the direct generation of £4.6M income from IP transfer and adoption in sustainable industrial processes for PET (for plastic bottles) and polyurethane manufacture, eliminating heavy metals.
- ***Industrial collaboration for clinical applications:*** Translation of Bath Chemistry research into clinical environments has exploited several routes, recognising the importance of close engagement with relevant experts (clinical, regulatory, charity, industry, funders) to deliver impact. Development of imaging probes for cancer cells was achieved through initial direct collaboration (*Pascu*, with ***Intrinsiq Materials Ltd*** and a range of ***clinicians*** in the UK and US), leading to TSB funding (£180k) and a dual target of device commercialisation and clinical testing.
- ***Direct academic-clinical collaboration:*** In addition to the links noted above, Bath Chemists (*Jenkins*) have harnessed strong direct clinical links with the ***South-West Children Burns Centre*** to deliver a range of impacts, including education, engagement, the founding of medical charities with funding of £1.5M, and direct engagement with clinical researchers and practising clinicians, as well as with industrial partners exploring potential commercial impact based on the development of responsive wound dressings for treating burns.
- ***Direct translation of research into therapies and diagnostics:*** Clinical devices have been developed via joint academic-industrial funding including TSB, Knowledge Transfer funding and industrial Fellowships and consultancies, for follow-on translational research to deliver economic impact (> £30M direct investment), skilled employment and clinical testing and implementation (formation and development of GlySure (*James*) and Atlas Genetics (*Frost*)).
- ***Converting research to industrial impact through sandpit outcomes:*** Key research in wastewater treatment developed through RCUK, EU and industrial funding (*Kasprzyk-Hordern*) has had direct impact in water-treatment plant processes; this was prioritised by the University for a cross-disciplinary sandpit event held in 2011 that has since resulted in direct funding of £3M from industrial partner ***Wessex Water***, whose joint development of sandpit outcomes was key.
- ***Public engagement activities:*** Extensive activities in public engagement are supported by Bath's Public Engagement Unit (funded through the ***RCUK PE with Research Catalyst*** initiative, *Davidson*). These include dissemination beyond normal disciplinary environments (e.g. to clinicians), funding and awards for outreach activities, a successful Public Millennium Lecture Series and involvement in major events including Cheltenham Science Festival, Bath Taps into Science, Goldsmiths' Company Residential Courses, Salters Festival of Chemistry.
- ***Influencing policy:*** as Coordinator of a Bath-led *EPSRC Chemistry Grand Challenge*, *Dr Jenny Woods* has developed her engagement and influencing role to become a regular speaker at national political events and an advisor on Liberal Democrat policy, authoring elements of their ***science policy*** and advising high ranking politicians including Julian Huppert and Vince Cable.

In supporting these and other impact-related activities, Bath Chemistry has a flexible and pro-active approach, encouraging academics to form and develop links, offering full support for identifying commercialisation and impact opportunities. Resources are made available through the Research Development and Support Office (RDSO) and its commercialisation arm Bath Ventures (now Enterprise, Knowledge and Exploitation Office). These include substantial pump-priming funding, e.g. from the Knowledge Transfer Account, support in forming Knowledge Transfer Partnerships (including the largest ever Bath KTP of £350k for *James, Bull*, with ***Quotient Diagnostics***), and the EPSRC-funded Impact Acceleration Account (IAA). We also encourage our academics to engage heavily with end-users, with Industrial Fellowships held by *Bull, Davidson, Frost, James* and *J Williams* and a large number of consultancies held by our academics, with *Scott* Director of a successful consulting company (***JLS ChemConsult Ltd***). We welcome incoming industrial collaborators (e.g. *Enright*, ***AmpliPhi Biosciences***, Industrial Visiting Professor). Achieving impact is explicitly recognised and rewarded on a personal level: *Knowledge Exchange activities* are an integral part of assessments within Staff Performance and Development Review and promotion processes; and the importance of achieving impact is supported through generous allocations for consultancy and advisory activities within workload models.

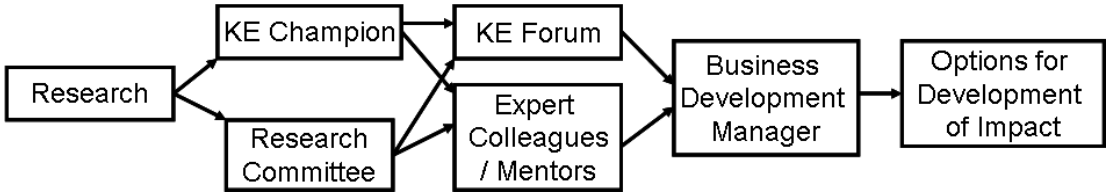
c. Strategy and plans

Strategy and plans for supporting impact

Our strategy for developing further our impact activities is to exploit the success of Bath Chemistry in forming wide-ranging critical-mass research partnerships, based on our strategic research themes, through which we have identified our key target users and potential beneficiaries. Excellent research is at the root of impact, and our successful approach has helped build a substantial and diverse funding portfolio that offers the capacity to generate underpinning research and the capability to move it towards developing impact. We will continue to develop our approach to delivering impact as part of our *Strategy and Plans*, building on mechanisms developed in the REF period and the key exemplars given in our Approach to Impact (b., above).

In addition to pursuing impact through the current diverse routes such as exploiting our interdisciplinary and stakeholder-focused collaboration, and protection of IP, we will enhance the value of our industrial and clinical links through a newly-established ***Stakeholder Advisory Board***. This Board (chaired by Dr Will Barton, TSB) advises on impact, providing a valuable external perspective on our current activities and future directions. It comprises distinguished figures with industrial, commercial, clinical and policy expertise and builds on the existing direct external involvement in steering or advisory groups for major initiatives at Bath such as CSCT, the UK Catalysis Hub and the Directed Assembly Network. To help identify and deliver routes to impact, we will also develop further our non-academic dissemination pathways (public engagement, alumni, social and national media) and drive innovative research areas with impact potential through an expanding range of mechanisms including showcase events and innovation 'sandpits', Having identified future impact priorities through such activities, we will invest in these as we have done in developing our current impact track record, through deploying pump-priming resources and harnessing critical mass efforts within our research initiatives and themes.

In addition to the Chemistry-focused approach, identifying, targeting and delivering impact will also be supported by ongoing University strategy. Full support will be given to academics in forming, maintaining and growing relevant interactions, pursuing IP protection where appropriate and in enhancing industrial links. Bath Chemistry has been influential in developing and delivering University structures and activities in Knowledge Exchange (KE) and these are well geared to maximise impact opportunities. The Department has a University-appointed ***KE Champion*** who leads in identifying and maximising KE opportunities (*Frost*, who also chairs the University KE Forum and is a member of the EPSRC Impact Acceleration Account Steering Group). Chemistry is also represented on the University *Research Impact Group* (*Wilson*). Enhanced processes and systems, including the PURE research information system, will capture impact data, including metrics. RDSO representatives sit on Departmental and Faculty Research Committees in order to assist in our impact-focused activities, and a Business Development Manager is available for Chemistry, allowing a natural pipeline approach to be adopted to develop options for impact:



This impact pipeline approach will streamline access to the substantial expert support available in the University's Professional Services, including research support, commercialisation and legal.

d. Relationship to case studies

The relationships between the unit's approach to impact and the submitted case studies

The submitted Case Studies reflect various elements of our approach, as indicated in Section b. above, which are summarised here to show the clear links and the benefits of our approach:

Case Studies: *CS1*. Atlas Genetics (*Frost, Jenkins, Marken, Peter*), *CS2*. GlySure (*James, Bull*), *CS3*. Industrial Catalysis (*Davidson, Jones*), *CS4*. Burns Treatment (*Jenkins*).
CS1 & CS2: Research themes with impact potential; Bath-generated IP; Industrial collaboration for clinical applications; Direct translation of research into therapies and diagnostics
CS3: Research themes with impact potential; Bath-generated IP; Industrial Fellowship & funding
CS4: Research themes; Academic-clinical collaboration; Public engagement