Institution: Oxford University

Unit of Assessment: UOA13

a. Context

Research in the UOA has had impact from modelling of solar cell performance in support of a university spin-out to solving manufacturing problems for major aerospace companies and influencing industrial processing practices in the UK and internationally. Members of the UOA are active in the development of policy and strategy through membership of government and industrial advisory bodies. Our impact is based on research that is interdisciplinary and rooted in the concept of translating fundamental scientific understanding to practical deployment. The development of impact is defined as a central mission for all researchers, and enabled by dedicating infrastructure, resources and facilities to transfer science to practice, encouraging innovative partnerships with industry and seeking to influence policy in the UK and internationally.

Research in the UOA has impact on 4 main groups of non-academic beneficiaries:

- Industrial ***partners*** (multinational, SME and spin-outs) engaged with us in long term research projects or benefitting from our expertise on advisory panels
- Industrial ***customers*** commissioning our expertise for research-led, short-term services in materials characterisation and materials problem solving
- The general public through lectures, workshops and open days to demonstrate the impact of materials on the modern world and to attract new generations of Material Scientists.
- Politicians, civil servants and international decision-makers by contributing technical advice to committees and fact-finding bodies, influencing policies and their outcomes.

b. Approach to impact

The UOA approach is to provide an intellectual environment that enables and encourages academics at all stages to translate fundamental science of the highest quality into impact across as broad a range of sectors as possible, and to provide help and dedicated resources for this purpose. Generating impact is a major discussion point in appraisal meetings with academic and research staff. The impact agenda is supported by reductions in teaching and administration loads for staff undertaking major projects with industry (e.g. **Grant**) or setting up spin-out companies (e.g. **Kirkland**); secondment opportunities and generous consultancy arrangements for staff to undertake projects that the UOA identify as having the potential to lead to substantial external impact (e.g. **Wilshaw**); and establishing new posts or sub-units to work effectively with end-users (e.g. **OMCS** - see below). The UOA allocates £100k pa of discretionary funding for a dedicated schools liaison team and to support travel for staff and students as ambassadors for the Materials discipline. This enables one-to-one contact with >1000 school age students each year.

Impact on industrial partners: The UOA undertakes collaborative research with more than 50 industrial partners from blue chip multinationals to SMEs and spin out companies: 70% of the research groups are strongly engaged in industrial projects, with 10% of research income directly from industry funding, and 40% of graduate students are wholly or partly supported by industry. Senior staff members are also delegated the responsibility for managing the UOA's industrial relationships with specific research sectors or strategic partners: for instance **Reed** and **Grant** with Rolls-Royce, **Smith** with Samsung, **Robert**s for fusion technologies and with CCFE, and **Marrow** and **Lozano-Perez** with the nuclear industry. Our Research Opportunities Group plans these strategic relationships, and the UOA has in the past 6 years followed a deliberate policy to expand beyond traditional materials-intensive sectors such as aerospace, automotive and metal processing to establish collaborations with a wider range of industries from the energy storage, defence, instrument development (**Case Studies 1** and **4**), biomaterials and processing sectors, reflecting the expansion in our research activities underpinning these technologies. Recent new research initiatives in the UOA operating close to market and where impact on practice is likely in a

Example 1: *OMCS undertook due diligence for* ***E6 Ventures*** *who were considering investing in SME Diamond Hard Surfaces. Our research-based, independent review of DHS-produced material resulted in E6 Ventures investing £570k in DHS, helping the company into manufacturing for a global market.*

comparatively short time frame include contracts with major Japanese and Chinese industrial partners on spray forming and with Korean partners on energy storage and quantum devices.

Commercial services and industrial liaison:

There is strong demand from industry for expert characterisation and materials problem solving, often with tight deadlines. In 2002 the UOA set up a dedicated team, the Oxford Materials Characterisation Service (OMCS), now with 8 full time employees, and overseen by **Grovenor**. Since 2008, > 400 customers have used OMCS (some many times) because of its research-led knowledge base, drawing on the expertise of academic groups and facilities across the UOA. OMCS's turnover has risen to > £800 kpa and is a *mechanism* by which we use world class research to deliver impact e.g. **Example 1**, and to solve short-term problems for industry e.g. **Case Study 2**. The UOA also hosts an experienced team funded by the Technology Strategy Board (TSB) as part of the Materials Knowledge Transfer Network (KTN), overseen by **Grant**. This team helps the UK transport sector access materials research and innovation, and facilitates knowledge transfer across the sector by bridging the gap between academia and industry (**Example 2**). More than 15% of the projects from this unit of the UK Materials KTN have also involved substantial research activity in the UOA. **Bagot** has begun a Royal Academy of Engineering Industrial Secondment with Rolls-Royce to explore new ways to exploit Atom Probe analysis to the benefit of the company.

Example 2: *Since 2008, the* ***Materials KTN team*** *based in the UOA have initiated and managed 38 projects with a total of £28m public money and > £14 M commercial investment, involving more than 100 industrial partners (40% SMEs). Projects involving research in the UOA included* ***HIGHTECS,*** *an EU FP7 Cleanskies project led by GE Aviation to develop a high temperature engine sensor module, and where GE are now moving to prototype production.*

Public impact: UOA staff are active in a wide range of outreach and public engagement activities:

- Stands on quantum phenonena at the Royal Society Summer Exhibitions in 2010 and 2012 funded by the UOA and visited by > 3,000 people.
- > 50 public seminars and invited public talks organised by learned societies (IOP, RSC etc.) on topics ranging from nuclear materials to solar technologies.
- Popular blogs, podcasts and other digital media, for example in quantum computing.
- Since 2008, > 3,000 students at Key Stages 3 and 4 and 500 teachers have visited the UOA for open days, residential courses and activity days with funding from Gatsby and Smallpeice.

Impact on policy makers: Staff of the UOA act as members of influential advisory bodies. For instance: No 10 Round Table Discussion Meetings and Dalian World Economic Forum meetings (**Grobert, Warner**), Rolls-Royce Materials Advisory panels and Fusion Advisory Board (**Grant**), EERA advisory panels (**Marrow**), and we have given evidence to House of Lords Committees on Nuclear Energy. A specific example of an outcome of this activity (with Imperial College and Manchester University) is the £15M National Nuclear User Facility project funded by BIS in 2012 where our meetings with ministers and government chief advisors influenced the outcome.

Economic impact: The OUA has delivered direct economic impact, including enabling increased income for UK companies and establishing new spin out companies to create new jobs. For instance, during the period of assessment, OMCS undertook contract work for SMEs that resulted directly in expansion of their business (**Case Study 3**).

Exploiting intellectual property: ISIS Innovation (the wholly owned IP exploitation company of Oxford University) has 2 staff members dedicated to the UOA. Licensing and spin-out activities are facilitated by ISIS (they have spent > £120k since 2008 on patent protection for the UOA), and ISIS can also provide seedcorn funding to develop basic science towards application (**Example 3**), as well as paying a generous proportion of any IP income back to inventors. UOA staff have been involved with 24 new patent filings and 8 new licensing deals since

Example 3: *Oxford's EPSRC Impact Acceleration Award and ISIS Innovation's seedcorn fund have provided £400k for vital proof-of-principle work for* ***Prosilicon,*** *spun out from the UOA. ISIS Innovation have also filed 4 protecting patents for the company.*

2008 (**Briggs, Czernuszka, Giustino, Grobert, Kirkland, Porfyrakis, Smith, Todd, Watt, Wilshaw**). Knowledge Transfer Partnership and Secondment schemes are actively encouraged, and 4 have been completed since 2008, for example with multinational Johnson-Matthey and spin-out Oxford Advanced Surfaces.

Three new companies have been created from the UOA since 2008. **Oxtex Ltd** (**Czernuszka**) develops materials for reconstructive surgery and restorative dentistry. Incorporated in 2011, Oxtex has raised initial funding of £1.2M to establish a manufacturing facility. Trials in small animals began in September 2012 and will be followed by *in man* trials in UK hospitals, the Harvard Dental School and the University of Malaya in 2014. Oxtex has won OBN awards for Best Emerging MedTech in 2011 and the Best New Product in 2012, and with ISO13485 accreditation has already generated more than £70k in sales. **Oxford Imaging Detectors** (**Kirkland**) was spun out in 2011 and was quickly bought (£1 M) by a corporate investor to begin full commercial prototyping (**Case Study 4**). **Prosilicon** (**Wilshaw**) was incorporated in March 2013 to market the invention of high resistivity silicon. First wafer sales have been made to companies in France and the USA.

c. Strategy and plans

The UOA strategy for impact is the responsibility of the Departmental Committee supported by the Research Opportunities Group. The requirement to articulate pathways to impact when applying for research funding emphasises the importance of external impact to all staff. We make full use of the institutional support provided by Isis Innovation and the new Division Business Development team funded by the Higher Education Innovation Fund in the Maths, Physical and Life Sciences Division. Since 2008, a total of £1.3 M has been awarded to the UOA for the impact agenda from competitive bids to the EPSRC Impact Acceleration Account, HEIF and internal university resources. Examples of the strategic use of this funding include: (a) building on the success of OMCS, we are using competitively won HEIF funding to train other parts of the university to grow their industry-facing service arrangements, and (b) EPSRC Pathways to Impact funding has supported secondment of a postdoctoral researcher to transfer technology from the UOA to successful spin-out company OID.

We have ambitious plans to expand and diversify the impact we will deliver.

- We will build further on *manufacturing* research and its more immediate potential for impact by: (a) further targeted academic appointments in energy storage technologies; (b) freeing more staff time by reductions in academic load; (c) new investment in manufacturing laboratories and (d) strategic allocation of institutional funds (including studentships) to promising areas.
- UOA staff (with CCFE and STFC) lead a project on the design of a £250 M international fusion materials test facility that will have considerable impact on the UK's nuclear energy future.
- We will invest further in OMCS to strengthen the interface between our research and industry, especially the SME sector, including a new full time technology liaison manager.
- We will exploit the new resource available from MPLS Business Development team to develop long term research partnerships with selected industries, aiming for 12 new industrial partners by 2016 in the targeted areas of superconductivity, polymer electronics and energy storage.

d. Relationship to case studies

Our four Impact Case Studies are closely related to one or more of our approaches to impact. **Case Study 1** describes the development of the Atom Probe as an example of long term basic research translated effectively into a commercial product, then sold world-wide (***Impact on industrial partners)*** and also exemplifies our pragmatic approach to ***exploiting intellectual property***, in this case by the formation of a spin-out company as a route to market. Both these approaches, as well as ***impact on industrial partners,*** are also exemplified in **Case Study 4** that describes how existing partner JEOL exploited UOA inventions via purchase of intermediary company Oxford Imaging Detectors***.*** **Case Study 2** demonstrates our ability to quickly adapt new, basic-science inspired techniques developed in the UOA to solving time-critical and potentially highly costly industrial problems, in this case delivering a unique capability in analysis to Rolls-Royce that saved many £Ms. **Case Study 3** is an example of ***commercial services and industrial liaison*** leading directly to ***economic impact*** through a partnership between OMCS and Cellmark that increased substantially the company's share of the forensic services market.