Institution: The University of Salford

Unit of assessment: B13 Electrical and Electronic Engineering, Metallurgy and Materials

a. Context: Research in Electrical and Electronic Engineering, Metallurgy and Materials at the University of Salford is concerned with developing new materials for technological applications and advancing existing materials with novel and enhanced properties. Impact is demonstrated in the development of additional, improved, cost effective and competitive routes to processes, generating economic and social impacts in the North West region, the UK and internationally. The contribution electronic engineering, metallurgy and materials research at the University of Salford makes to the economy and skills base through exploitation of the technologies resulting from its research, forms core achievements of the unit's research impact. The main non-academic user groups, beneficiaries or audiences and main types of impact specifically relevant to research within Electrical and Electronic Engineering, Metallurgy and Materials include:

- International aeronautical and nuclear engineering companies, utilities providers, governments, environmental agencies and regulators, the wider public and voluntary sector, the commercial, industrial and manufacturing sector, and the communities and economies where they operate. Impact is demonstrated:
  - In the area of atmospheric pressure chemical vapour deposition, commercialising the technology and developing its application in environmental, construction, healthcare and biotechnology sectors, bringing economic benefit internationally.
  - Focused on the environmental conservation properties of photovoltaic thin films technology, through the development of cost effective and energy saving applications in the area of flexible production technologies and equipment based on atmospheric pressure plasma processing for 3D nano structured surfaces (N2P), increasing skills and bringing economic benefits to the EU.
  - Reducing the environmental impact of and risk in decommissioning nuclear weapons, through developing cost effective technologies for processing tritium, developing routes to processes, which have applicability to commercial nuclear fusion processes and to energy security.
  - Applying neutron scattering techniques to the understanding of porosity development caused by radiation damage to the graphite moderator in AGR nuclear reactors, extending reactor life until new power sources can be commissioned and focused on contributing to energy security (domestic and industrial) through the development of carbon limited nuclear graphite for the moderators of nuclear reactors.
  - Focused on the development of hydrogen storage for use with hydrogen fuel cells, via several EU Framework projects involving a number of EC academic and industrial collaborators in the international search for hydrogen storage materials for use on fuel cell vehicles in the development of environmentally efficient mobile applications.
  - In the development and licensing of zero hydrocarbon propellant spray technology to develop markets for delivering sustainable, clean solutions to our 'spray-and-go' habit internationally.
  - Focused on "Invisibility" applied optics, with the development of a concept of electromagnetic cloaking that exploits the transformation optics algorithm to create a temporal void within which events can be hidden with implications for military and security services and leading to the development and application of acoustic meta-materials.
  - Seeking opportunities to ensure that people and communities can engage with the technology through partnerships with schools, voluntary and community sector partners.

The impact described relates to the following range of research activity or research groups in the Unit:

- **Centre for Physics and Materials Research** focuses on research activity in the areas of atomistic materials modelling, neutron scattering, lasers and photonics, atomic collisions

in solids, biomaterials and structural analysis and functional materials properties. Centre for Physics and Materials research is well funded, with support from research councils, government agencies, the EU as well as excellent links with and direct funding from industry.

- **Salford Energy House** is an "old-build" traditional Salford style house (c.1920s) been constructed from reclaimed materials to represent 20% of the UK's current building stock. The house has been constructed within an environmentally controllable laboratory in which levels of heat, light, humidity and even wind can be independently adjusted and managed; enabling the development and testing of new low-carbon materials, technologies and products.
- **Salford Analytical Services (SAS):** is a specialised University commercial venture which unites research, enterprise and state-of-the-art facilities. Run by senior technical consultant managers with over 45 years industrial experience between them, SAS has an excellent comprehensive collection of key analytical instruments. Core analytical techniques include Microscopy, Spectroscopy, and X-Ray Diffraction. SAS works with many major blue chip organisations, providing expert consultancy support for problem-solving and routine analytical requirements.

b. Approach to impact:

The Unit's approach to interacting with, engaging with or developing relationships with key users, beneficiaries or audiences to develop impact from the research is as follows:

- Bringing economic benefit to the UK via a highly adaptive international operating model in the area of atmospheric pressure chemical vapour deposition by establishing a spin-off company offering strategic licensing. This company works internationally, develops new markets and supports local economies in new markets.
  - **Evidence:** *Impact Case Study*
- Reducing the environmental impact of and risk in decommissioning nuclear weapons by working with the Atomic Weapons Establishment in AWE to maintain the UK's nuclear stockpile.
  - **Evidence:** *(AWE I-CASE grant)*
- Understanding radiation limits to the use of nuclear graphite for the moderators of AGR reactors, contributing to safe life extension, contributing to energy security, domestic and industrial, through EdF.
  - **Evidence:** http://www.nuclear-graphite.org.uk/
- The development of materials for hydrogen storage for use with hydrogen fuel cells by ensuring that the project involves market leaders among the industrial collaborators, for example Daimler.
  - **Evidence:** *Impact Case Study*
- Developing and licensing of zero hydrocarbon propellant spray technology by developing an IP model for its exploitation which includes a portfolio of investment opportunities, attracting venture capitalists.
  - **Evidence:** *Impact Case Study*
- The development and application of acoustic meta-materials in partnership with Salford's experimental acoustic facilities through sponsorship by the Defence Science and Technology Laboratory to improve materials for hearing protection systems, an on-going challenge for military operations.
  - **Evidence:** *Report available on request*
- Funding of £30,000 was awarded to work in partnership with the Museum of Science and Industry, local schools and Manchester Science Festival, of which the University is a sponsor, to engage young people, their families and carers with science and making research accessible to non-experts.
  - **Evidence:** *MOSI STEM Ambassador Case Study*

Staff within the Unit, from early career researchers to established research colleagues, were specifically supported and enabled to achieve impact from their research through the following initiatives:

- Developing the physical strategic research infrastructure for capitalising upon our strong links to industry and ensuring the continuous improvement of our infrastructure to provide state of the art materials characterisation facilities, including; the high pressure hydrogen lab; Energy House; High-Performance Computing & 3D Visualisation Facilities; Intelligent Gravimetric Analysers (with Dynamic Sampling Mass Spectrometry).
- The development of Joule House, maintaining the historical resonance and heritage of Salford's track record in energy research.
- Formal collaboration with international industry and success in a range of EU Framework/ Mare Curie bids.
- Licensing products and services in collaboration with industry and commercial finance.
- Supporting researchers to progress research outputs from the fundamental theory stage, through the experimental verification stage, to their exploitation.

And linking with institutional research impact initiatives:

- Interdisciplinary integration of research and collaborating across the university in the development of the Energy Strategy;
  - Promotion and development of impact through:
  - Impact Champions Group with cross – university representation to build momentum and develop excellence in evidencing impact;
  - Impact Fund to support researchers in generating impact;
  - Celebrating impact in the Vice Chancellor's Research Excellence Awards.
- Embedding impact in funding bids;
- Training for researchers on IP and commercial exploitation;
- Early Career Researcher training in impact;
- Sabbatical scheme with a key focus on generating impact

c. Strategy and plans: With a record of generating research in partnership, the University of Salford is well-placed to articulate its impact. It has developed an institutional approach, Salford Impact, with the aim of evidencing, developing and celebrating the transformational impact of University of Salford research. Electrical and Electronic Engineering, Metallurgy and Materials research exemplifies Salford Impact through:

- Supporting the progression of research from the fundamental theory stage, through the experimental verification stage, to their exploitation, generating economic and social capital;
- Continuously improving the physical and strategic research infrastructure and maintaining state of the art materials characterisation facilities for 'always current' collaborative applicability;
- Establishing spin-offs to commercialise products and technical expertise wherever advantageous;
- Developing operating models which are conducive to meeting key challenges of the commercial, manufacturing and industrial sectors.

d. Relationship to case studies:

Case Study 1: CVD Technologies exemplifies and has informed the development of the Unit's approach to impact through its focus on taking research to market, tailored to partner priorities.

Case Study 2: Spray Technologies exemplifies and has informed the development of the Unit's approach to impact through its focus on the development of revolutionary, cost effective and environmentally sound aerosol devices.

Case Study 3: Behaviour of Hydrogen in Materials exemplifies and has informed the development of the Unit's approach to impact through its focus on the characterization of a range of different hydrogen storage materials and their commercial application.