

Institution: Glyndŵr University
Unit of Assessment: 13: Electrical and Electronic Engineering, Metallurgy and Materials
a. Context

The University's vision is to 'become indispensable as a significant, relevant and expert partner in regional and national economic and social development'. This is reflected in the research activity across the University and in particular within UoA13. The focus is on applied research, the results of which can produce benefits for research users. Researchers engage with collaborators and clients in the UK, Europe and across the world. Non-academic collaborators and clients are usually commercial manufacturing companies such as, Unilever, Glaxo Smith Kline, San Ei Gen FFI Inc., BP, Sharp Solar, Tata, and there are also non-commercial collaborators and sponsors such as the European Southern Observatory. Fields of commercial activity which benefit from the research include agriculture, food production, oil exploration, aircraft manufacture, optoelectronics, PV cell manufacture, ultra-high precision large optics, wearable electronics, holographic imaging. Research users benefit through the licensing or assignment of IP arising from collaborative and commercial research projects.

b. Approach to impact

Engagement with non-academic research users to enable fruitful research relationships is effected through a variety of means. Academic staff engage in a wide range of professional and business networks (for example. Welsh Opto-electronics Forum). Advisory roles and consultancies create and reinforce relationships which can and do lead to more substantive research collaborations. Mechanisms supporting such engagement include Knowledge Transfer Partnerships (KTPs, for example with Cellpath Ltd, Morgan Electro Ceramics Ltd, Russell IPM Ltd) and, in Wales, the Academic Expertise for Business (A4B), Strategic Insights Programmes (with academic staff 'placed' in companies, for example. with View Holographics, Veterinary Tissue Bank, United Utilities) and Innovation Vouchers (e.g. with KK Fine Foods). University and Departmental Business Development staff create opportunities for the development of new relationships and support existing relationships. For example, such support enabled 'Photovoltaics' to operate the Thin Film PV Knowledge Transfer Centre to increase its engagement with business (Welsh Government A4B programme ref. HE 03 KTC 1002, 2010-2013) and for 'Functional Polymers' to create the Industrial Biopolymers Knowledge Transfer Centre with Bangor University (A4B programme ref. HE 06 KTC 1003), 2011-2012) which led to current KTP's with Cellpath and Quay Pharmaceuticals.

Examples of productive relationships
Functional polymers

A TSB project in conjunction with Durham, UCL and MI-Swaco (TP/8/OIL/6/I/Q2506L; £1.6M), was concerned with developing biodegradable polymers to act as inhibitors in drilling muds used in the North Sea to replace currently used petrochemical derived polymers which have harmful effects on the aquatic environment . A new product was developed and tested in the laboratory and pilot scale batches have been produced by toll manufacturers for further testing in an oil field environment (Patent GB1119367.9 (2011)). A TSB project (TP14/SMP/6/I/BA143E; £1.79M) in collaboration industrial partners including Marks&Spencer, Germaines Ltd and Innovia Films, involved developing a protocol for the extraction and modification of chitin from prawn shells (Food Hydrocolloids 31 166(2013)) to produce derivatives with enhanced antimicrobial activity for application in 'active' packaging and in seed coatings. Field trials on sugar beet seeds coated with chitosan dervatives were undertaken in the USA in 2012 and showed improved product yield. A patent is currently being prepared for submission.

Functional thin films

Research in colour holography has involved the design and development of a "Full Colour Holographic Copier" in collaboration with View Holographics Ltd. Work has been undertaken to optimise the nanoparticles in terms of their recording exposure sensitivity and to develop

an economical large scale manufacturing process. Ongoing collaboration with partners at Gooch & Housego, Moor Instruments, Vivid Components and Peninsula Medical School, Exeter, UK, has resulted in the production of true colour holograms and a patent has been filed [US 7653269B1]. Photovoltaic research include partnerships with Swansea University SPECIFIC IKC (EP/1019278/1;£439K) and with Liverpool University on projects involving sinter-free inkjet printing of metal interconnects for thin film PV (EP/K009478/1; £237K) and high-power, low-weight, flexible thin film photovoltaics for space application (EP/K019597/1;£332K) with Surrey University. Industrial partnerships have resulted in recent patent applications for defect detection in solar cells (GB1316121.1) and a novel coating head for in-line deposition of semiconductor thin films and photovoltaic devices (GB1302306.4).

Composite Materials and Ultra Precision Surfaces

In advanced composite research a relatively new area is the application of composites in lightweight mirror systems thus linking into the expertise in ultraprecision surfaces. The National Facility for Ultra Precision Surfaces is producing 1.4m hexagonal mirror segments under contract to the ESO, as prototypes for the planned 39m Extra Large Telescope, ELT [<http://www.eso.org>]. It has developed the only metrology capability in Europe satisfying the exceptionally-challenging nanometre-level requirements to measure mirror segments and the only capability to polish edges of optics such as segments directly without edge-roll.

Contributing to economic, social and cultural development is fundamental to the University and staff are encouraged to consider how impact will arise as an integral element of a research proposal. The University's Research Services department provides professional support to staff in terms of creating, reviewing and gaining approval for funding agreements and contracts. The University's IP policy makes provision for the creators of IP to share in any net surplus generated through its commercialisation; there are also financial incentives to encourage academic consultancy.

c. Strategy and plans

The Materials, Engineering and Manufacturing Research centre provides leadership and academic support to research staff. It is a vehicle for the enhancement of research activities, and encourages research active staff to engage with academic and industrial communities and the public at large to maximise the impact of their research.

Engagement with the public – for example through the Professorial lecture series and the Wrexham Science Festival – helps staff generate awareness of the University's expertise and capacity (<http://www.wrexhamsf.com/>,

<http://glyndwr.ticketsolve.com/shows/upcoming/tags/talks>). Researchers in UoA13 engage actively with the scientific community. Publication of research outputs in peer reviewed international journals is encouraged and contributes to applications for promotion to Reader or Professor. The University has set up a Repository and staff are encouraged to submit their publications to maximise their impact and contributing to awareness of the University's expertise and capacity. Researchers are supported to present their research at national and international conferences. Details of Materials research are included on the University website

(<http://www.glyndwr.ac.uk/en/Ourresearch/Researchcentres/UniversityResearchCentreforMaterialsEngineeringandManufacturing/>). For some collaborative research projects individual websites are set up to highlight the research being undertaken (e.g. <http://www.fp7-fisica.eu>). The organisation of conferences also serves to promote expertise and capacity (e.g. 'Gums & Stabilisers for the Food Industry', <http://www.foodhydrocolloidstrust.org.uk/>).

Engagement with industry will continue to be supported through mechanisms such as the Welsh Government A4B programme, RCUK and TSB initiatives and examples of specific projects and likely impacts are highlighted below.

In **Functional Polymers**, chitosan research will continue through a new TSB project (Project

no. 101440; £929K) led by Unilever involving establishment of chemical and biochemical processes for the extraction and modification of biopolymers from waste streams. The project will ultimately lead to the development of novel biopolymer systems that can be used in personal care formulations. It will have environmental benefits by replacing currently used polymers derived from petrochemicals by a natural polymer and will also reduce waste.

In **Functional Thin Films**, Photovoltaics research will increase R&D related to exploitation of the unique research position in atmospheric pressure MOCVD of thin film materials for PV solar energy. This will be achieved through industrial partnerships with, for example, Scanwel Ltd, Tata Steel, NSG, Qioptiq Space Technology and Surrey Satellites together with RCUK, EU and TSB funding.

In **Composite Materials and Ultra Precision Surfaces**, future research in collaboration with Airbus is to develop an understanding of the microwave processing of composites and to develop realistic processes to make this possible industrially. Research into large optics manufacture and associated technologies has enabled the research group to identify a series of platform capabilities that have enabled them to address emergent market opportunities for challenging optics in the fields of optical grinding, smoothing, polishing and associated metrology.

d. Relationship to case studies

The Impact Case Studies describe outcomes enabled by the focus on applied research.

Economic impacts of computer controlled polishing and metrology of ultra-precision surfaces

This case study exemplifies the University's strategy of building research capacity in key areas. The OpTIC Technium (operated for the Welsh Government by a company limited by guarantee) was established in North Wales in 2004 to enhance collaboration between businesses and academia in the field of opto-electronics and associated technologies. Market surveys had demonstrated the growing world-wide demand for metre-scale optics, leading to the establishment of the National Facility for Ultra Precision Surfaces at OpTIC. Prof. Walker re-located his research from UCL to the new National Facility at the end of 2004. OpTIC itself was acquired by Glyndŵr University from the Welsh Government in 2009, and Walker became Professor of Optics at Glyndŵr and Professorial Research Associate at UCL (0.5 fte each). Zeeko Ltd (www.zeeko.co.uk) was established in 2000 to commercialize Walker's research into advanced surface-removal processes and measurement techniques. A 5M€ contract was placed in 2008 with OpTIC Technium for the provision of seven aspheric prototype segments for the primary mirror for the planned 39m European Southern Observatory Extra Large Telescope, ELT [<http://www.eso.org>]. The research underpinning that work involves collaboration between Glyndŵr, UCL and Zeeko Ltd and forms the basis for the impact case study.

Modification of hydrocolloids to produce novel and enhanced food products

This case study exemplifies the University's strategy of developing and maintaining relationships with industrial partners. In this case the impact of the research has been made possible by the University's ongoing relationship with Japanese food ingredients company San Ei Gen FFI. San Ei Gen through its subsidiary Phillips Hydrocolloids Research Ltd has sponsored the Phillips Hydrocolloids Research Centre at Glyndŵr University since 2003, extending the agreement twice since then, in 2008 and 2011. Glyndŵr University staff member Dr (now Professor) Saphwan Al-Assaf was appointed Director of the Centre. The activities of the PHRC complement and extend the work of the Centre for Water Soluble Polymers directed by Professor Peter Williams. The work of the PHRC is focussed in particular on supporting innovation by San Ei Gen, San Ei Gen's clients and directly with leading international companies.