CAPABILITY STATEMENT

Biomedical and Biomaterial Devices

UNIVERSITY OF WOLLONGONG AUSTRALIA

The University of Wollongong (UOW) has an international reputation for the strength of its biomedical research and capacity to develop biomaterial devices resulting from its long-standing excellence in materials research.

The work ranges from developing synthetic biosystems such as nerve regeneration, bionic muscles and implantable devices, to developing devices like the "BioPen" (pictured), which allows surgeons to design customised implants on-site while conducting surgical procedures.

UOW's Innovation Campus is home to the Australian Institute for Innovative Materials (AIIM), which houses two of the University's leading research institutes – the Institute for Superconducting and Electronic Materials (ISEM) and the Intelligent Polymer Research Institute (IPRI), which is a key research strength at UOW and is the lead node of the Australian Research Council (ARC) Centre of Excellence for Electromaterials Science (ACES) and lead node of the Australian National Fabrication Facility (ANFF) - Materials node. Researchers from these institutes collaborate with other researchers, particularly from the School of Chemistry, the School of Medicine and the Illawarra Health and Medical Research Institute (IHMRI) on biomedical and biomaterial projects.

The IPRI/ACES group has a strong Bionics program with a close connection with St Vincents Hospital, Melbourne, which provides access to surgeons and other clinicians. Researchers and clinicians are focusing on the use of novel electromaterials and advanced manufacturing techniques to build devices for biomedical applications such as nerve regeneration and regrowth, bone regeneration, implantable devices, artificial (bionic) muscles and epilepsy detection and control.

Prototyping and device development facilities at the AIIM Processing and Devices Building allow researchers to design and build prototypes, taking their ideas from concepts to products that are closer to commercialisation.

On the University's Wollongong campus, the Centre for Medical Radiation Physics and the Biomechanical Research Laboratory also contribute to our expertise in these fields through their own research and through collaborations with the research groups at AIIM.

World-first biofabrication Masters degree

In 2014 the University of Wollongong launched the world's first Masters degree in medical treatments based on printing and regrowing human tissue, in partnership with three other world-leading biofabrication research institutes.

ACES, which is headquartered on the University's Innovation Campus, and its partner institutions are offering the Masters in Biofabrication for Future Manufacturing.

Bio-fabrication – a process of regrowing human tissue using 3D printing techniques – will enable health professionals to offer patients improved, personalised treatments for nerves and tissue damaged by disease or injury. Potential applications range from treatment for spinal chord damage, to helping repair tissue after a mastectomy.

The University of Wollongong partners with the Queensland University of Technology (Australia), the University Medical Centre Utrecht (The Netherlands) and the University of Würzburg (Germany). Each participating university has a track record in key areas of biofabrication including polymer chemistry, cell biology, clinical implants and the process of fabrication. In 2017 we will launch a newly-funded ARC Linkage training hub in biofabrication.

ARC Centre of Excellence

The Australian Research Council Centre of Excellence in Electromaterials Science (ACES) is committed to expanding knowledge of materials to create the next generation of "smart devices" to create new health and energy solutions.

Led by the University of Wollongong, with headquarters at the University's Innovation Campus, ACES incorporates six Australian collaborators and five international organisations

known for their expertise in materials and device fabrication. The centre's key strength is its expertise in end-to-end biofabrication solutions, with skills in forming printable bio-inks, stem cell biology, custom printing and developing 3D hardware allowing researchers to develop concepts into actual products.

ACES Executive Research Director Professor Gordon Wallace is a Laureate Fellow and Director of the University of Wollongong's Intelligent Polymer Research Centre (IPRI).

Intelligent Polymer Research Institute

Professor Wallace and his team at IPRI, the lead node of the Australian Research Council (ARC) Centre of Excellence for Electromaterials Science (ACES), are recognised as world leaders in the development of 'intelligent' materials and nanotechnology.

Researchers work with materials in the nano-domain (that is, with particles as small as one billionth of a millimetre) where electronic conductivity is vastly higher than in larger structures. Their challenge is to make materials at these nanodimensions and assemble them into larger structures (micro or macro) that retain the special characteristics of the nanocomponents, resulting in improved functionality.

IPRI is renowned for expertise in the electrochemistry of organic conductors in the application such as artificial muscles, wearable and implantable energy sources, and biomedical applications.

Global Challenges Program: Manufacturing Innovation and Living Well, Longer

The University's Global Challenges Program sponsors interdisciplinary research to tackle "big picture" issues and several new biomedical products have emerged from the Manufacturing Innovation and Living Well, Longer challenges.

The projects involve diverse research teams providing a holistic approach to the design and evaluation of new products. Examples of these include:

- The next-generation condom that addresses barriers to use in developing countries
- A vibration-free driver's seat for heavy vehicles that improves physical and cognitive wellbeing
- Smart fabric wearable technologies for an ageing population
- Active compression garments for the treatment of conditions such as lymphoedema

Institute for Superconducting and Electronic Material

The ISEM, led by Distinguished Professor Shi Xue Dou, a Fellow of the Australian Academy of Technological Science and Engineering, boasts more than 150 researchers and postgraduate students. The ISEM has developed a dynamic, innovative research environment and has research programs on superconductivity, energy storage and management, spintronics and electronic materials, optics science, and emerging programs on solar energy conversion and on nanomaterials for health protection.

ISEM researchers are pioneering development of advanced nanoceramics for a number of health protection applications, including: free radical scavengers for neurodegenerative diseases and radiation protection; smart theranostic nanoparticles for highly selective cancer therapies based on induction of controlled oxidative stress in malignant cells; and next-generation highly efficient multifunctional inorganic UV filters for sunscreens optimized for Australian conditions, which provide simultaneous strong UV filtering and biological protection from reactive oxygen species. Researchers at the ISEM are part of a multi-disciplinary team to design and develop "smart liposomes" based on magnetic nanoparticles, to be used for targeted drug delivery in cancer treatment. The ISEM, in collaboration with the CMRP, is also developing novel types of radiosensitizers, based on heavy-element ceramic nanoparticles, for advanced radiation therapies.

Centre for Medical Radiation Physics

The Centre for Medical Radiation Physics (CMRP) is a research team within the University of Wollongong's School of Physics which is dedicated to the development of semiconductor detectors and dosimeters for clinical applications in radiation protection, radiation oncology and nuclear medicine as well as high energy physics applications.

CMRP specialises in fields ranging from innovative cancer treatments such as radioactive seed implant brachytherapy and intensity modulated radiation therapy for treating tumours in the head and neck, to detection instruments for hazard radiation in space and avionics environments. It works closely with many international institutes, including the National Space Biomedical Research Institute in the United States.

Biomechanics Research Laboratory

UOW's Biomechanics Research Laboratory is developing innovative strategies, based on rigorous applied biomechanics research, to decrease injury potential and optimise the quality of life for individuals of all ages.

Responsive clothing is the new frontier of sports and health technology, with UOW researchers leading the way in solutions that prevent injury and improve comfort. Members of the BRL regularly pursue collaborative projects with researchers.

This has led to the development of the Intelligent Knee Sleeve, the Bionic Bra and the Lymph Sleeve. These are three examples of cutting-edge "wearable technologies" developed via collaborations among biomechanics researchers, material scientists, chemists, mechatronic engineers, clinicians, patients and industry.

The Bionic Bra is the world's first responsive bra that senses changes in a woman's breast motion and automatically tightens to provide breast support when needed. The Lymph Sleeve has the potential to transform the lives of women who suffer from breast cancer-related lymphoedema.

In 2015, UOW signed a collaboration agreement with BSN Medical in Germany, to further develop an active lymph sleeve.

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