From Nanometer to Centimeter – Training Early Career Researchers for the Future of Surface Engineering in Australia

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With a project start in February 2019, the Australian Research Council (ARC) will fund the new Training Centre in "Surface Engineering for Advanced Materials" (SEAM), led by Professor Christopher C Berndt, Professor of Surface Science and Interface Engineering at Swinburne University of Technology, Melbourne. The centre will be based at Swinburne and will be one of the largest training centres of its kind in the southern hemisphere, delivering commercial benefits for industry.

SEAM has been funded by the ARC under the Industrial Transformation Training Centre (ITTC) scheme and aspires to train the next generation of early career researchers in the field of surface engineering; which includes thermal spray and laser based additive manufacturing.

Professor Berndt shares his vision: "SEAM will be Australia's premier manufacturing R&D centre that focuses on applied research with tangible outcomes to nurture and cultivate the industrial innovation leaders of tomorrow. SEAM industrial-based research focuses on surface engineering that addresses applied engineering challenges."

The lead, Swinburne University of Technology together with RMIT University and the University of South Australia, form the primary University Partners. There are 15 core industry partners - D&T Hydraulics and Engineering, GrapheneX, Innofocus Photonics Technology, LaserBond, MacTaggart Scott Australia, Romar Engineering, Ruag Australia, Titomic, Santos, Sutton Tools, United Surface Technologies and SCG Chemicals, as well as the Australian Nuclear Science and Technology Organisation (ANSTO), the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Defence Materials Technology Centre (DMTC) as core research organisations.

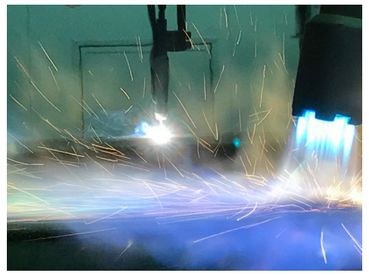
Moreover, the project is supported by 14 scientific and engineering collaborations to constitute a wide benefit in Australia and overseas for the surface engineering community. Our collaborators are committed to facilitating technology transfer, sharing technical knowledge and bringing state of the art solutions to industrial manufacturing challenges.

These national bodies and international partner organisations include the Welding Technology Institute of Australia (WTIA), the Victoria University of Wellington (in New Zealand), Materials Australia (MA), Australian Corrosion Association (ACA), as well as international universities and companies leading the surface engineering market.

The drivers: SEAM addresses Australia's Industrial Transformation Priorities

Surface engineering has emerged over the past three decades as a keystone technology that enhances the operational capability of an engineered assembly. For instance, the benefits of new materials and thermal spray coatings, that cover most industrial sectors, are well documented in a 2016 roadmap for the technology [1], which states that 'The global market (revenue generated through material, equipment and coating manufacturing) was estimated at USD 7.58 bn in 2015 and is expected to grow at a compound annual growth rate of 7.79% to reach USD 11.89 bn by 2021. Market drivers include the rising demand for electricity production, air transport, automotive manufacturing and economic development.' The additional surface engineering processes (as shown in Figure 1) within SEAM exceed these financial markets and encompass a broader range of applications.

SEAM hits targets of technological and scientific needs that are under-represented in Australia. The industrial significance can be gauged by analysing public available data. Australian Bureau of Statistics [2] showed that the total employment projection for 2017 in Australia was 12.1 million, with 231,100 in the mining sector, 907,200 in manufacturing, 428,000 in research services, 234,800 in tertiary education, 9,100 in education and training and 217,100 in repair and maintenance. Thus, approximately 13% of the Australian workforce could be positively affected by SEAM. The Total Gross Value Added (Total GVA) by industry to the Australian economy during the 2016 financial year was A$1,548 billion with the above sectors contributing about 25.6%. SEAM is,



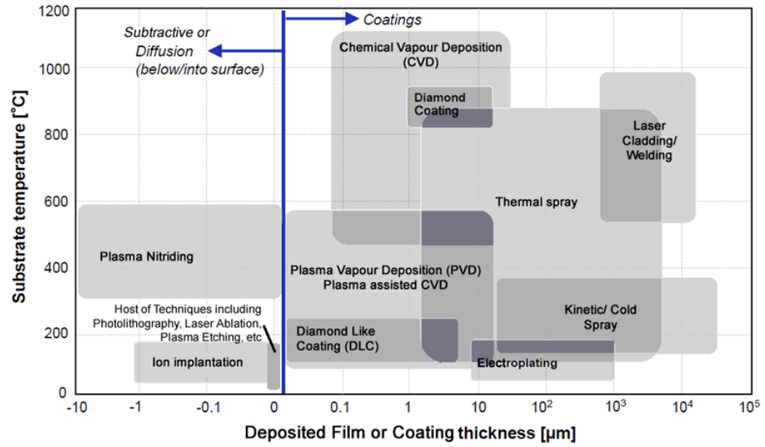


Figure 1 above: Different surface engineering methods that will be explored in the SEAM initiative.
Figure 2 below: Thermal spraying as a surfacing process for thick coatings

therefore, focussed on making an impact on significant financial and employment sectors that drive growth for Australia. SEAM intends to build on current national and international expertise to fulfil this gap in Australia's R&D portfolio.

The skill and capacity build-up for Australian end-users is approached in three different themes. These surface engineering themes form the technological foundation of SEAM and promote interaction between and among these technologies.

- **Theme 1:** Nanoscale surface modifications and thin films, such as PVD and CVD, that are used in applications ranging from films for bacterial and infection control, to microelectronics, to hard coatings for the machining industries.
- **Theme 2:** Thick coatings manufactured by laser cladding and thermal spray technologies. These overlays are used for wear and corrosion protection in heavy industries such as defence, mining, agriculture, steel, oil and gas, etc as well as for the repair and re-manufacturing of many components.
- **Theme 3:** Additive manufacturing (AM) is a multi-layer deposition process that creates a 3D bulk material. The two prime AM technologies explored are via (i) Laser Metal Deposition (LMD) and (ii) cold spray. Dimension of parts manufactured by these techniques are only limited by the size of the robot handling the deposition nozzle.

In total, SEAM will train up to 24 PhD students, 6 post doctorate research engineers and numerous undergraduate interns, over the next 5 years. The students and early career researchers will have a tremendous opportunity to engage with, and learn from, the best organisations and industries in the field of surface engineering. They will drive the development of the next generation of innovations in surface engineering of

advanced materials. The "SEAM Team" will generate a significant level of benefit to industry, to education and to the fundamental understanding of advanced materials and surface engineering, which is the core to developing new advanced manufacturing products.

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[1] Vardelle, A. and 41 co-authors, The 2016 Thermal Spray Roadmap (2016), Journal of Thermal Spray Technology, Volume 25(8) pp 1376–1440.

[2] Department of Employment, 2017 Industry Employment Projections- 5 years to May 2022. Retrieved from lmip.gov.au/PortalFile.

SEAM
ARC TRAINING CENTRE
Surface Engineering for Advanced Materials