TRAINING THE NEXT GENERATION OF SURFACE ENGINEERS AND TECHNOLOGISTS

On August 2, the Australian Research Council announced funding for a new training center in Surface Engineering for Advanced Materials (SEAM), to be led by Christopher C. Berndt.

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The new center will be based at Swinburne University of Technology in Melbourne, Australia, and will be one of the largest training facilities of its kind in the southern hemisphere. SEAM is akin to sister centers such as the Center for Thermal Spray Research (CTSR) at Stony Brook University, Fraunhofer Institute for Surface Engineering and Thin Films, Laboratoire d'Etudes et de Recherches sur les Matériaux, les Procédés et les Surfaces (LERMPS), and the NSERC Green Surface Engineering for Advanced Manufacturing Strategic Network at Concordia University. SEAM is funded by the Australian Research Council (ARC) under the Industrial Transformation Training Center (ITTC) plan and aims to train the next generation of early career researchers in the field of surface engineering, which includes thermal spray and laser based additive manufacturing (Fig. 1).

"SEAM will be Australia's premier manufacturing R&D center that focuses on applied research with tangible outcomes to nurture and cultivate the industrial innovation leaders of tomorrow. SEAM research will focus on surface engineering for advanced materials that solve the engineering challenges of the future," explains Berndt, who is also a co-founder of CTSR.

STRONG ACADEMICS AND INDUSTRIAL FOCUS

SEAM aims to solve crucial surface engineering problems, such as their design, fabrication, testing, analysis, and pathways towards value-added applications, all of which enable the Australian manufacturing industry to be more efficient and profitable in the global marketplace. To spearhead enrichment

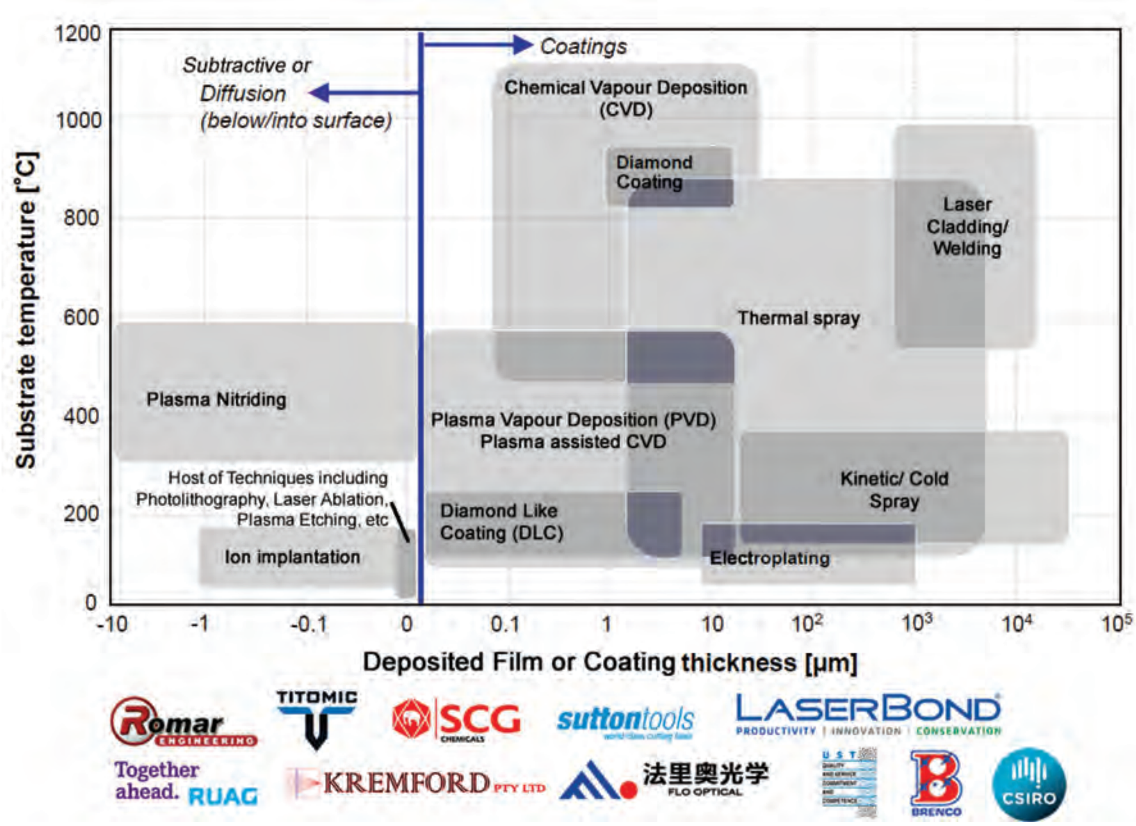

Fig. 1 — Surface engineering methods to be explored in the SEAM initiative.

**Member of ASM International*

of Australia's manufacturing industry, SEAM research will draw upon a global surface engineering expert network that covers Australasia, Asia, Europe, and North America. The lead, Swinburne University of Technology, together with RMIT University and University of South Australia, form the primary university partners. Core industry partners include Brenco Aerospace, D&T Hydraulics and Engineering, Innofocus Photonics Technology, Kremford, Laserbond, MacTaggart Scott Australia, Romar Engineering, Ruag Australia, Titomic, Sutton Tools, United Surface Technologies, and SCG Chemicals, as well as the Australian Nuclear Science and Technology Organization, the Commonwealth Scientific and Industrial Research Organization, and DMTC as core research organizations.

International partner organizations include the Welding Technology Institute of Australia, Victoria University of Wellington (New Zealand), Materials Australia, Australian Corrosion Association, Nanyang Technological University (Singapore), Jinan National University (China), Indian Institute of Technology Madras (India), Institute of Plasma Physics (Prague), State University of New York at Stony Brook, ASB Industries (Ohio), Inovati (California), GTV Verschleißschutz GmbH (Germany), and Flame Spray North America Inc. (South Carolina).

SEAM has four goals aligned with its initiative toward the industrialization of academic outcomes (Fig. 2). These include:

1. Implementing industry/academic projects that tackle specific surface engineering issues of critical consequence for partner organizations, for example, wear and corrosion resistance within the mining sector, and antibacterial films for medical implants. Solutions will evolve from applied research based on a foundation of scientific understanding rather than the current trial and error methods that lead to quick but highly risky and costly short-term fixes.
2. Training future industrial and engineering staff via embedding the next generation of surface engineers and technologists into industrial sectors. Further, academics and other professionals within SEAM will engage with partner organizations by visiting their manufacturing environments to help implement new technologies developed in SEAM.
3. Creating a strong and pervasive training team where industry will work closely with academia to maximize their return by leveraging members of the SEAM team. Additional joint projects will be nurtured within SEAM so that industry can maximize growth and achieve its potential.
4. Establishing a pragmatic mindset where SEAM research feeds into the economic and productivity needs of industry aimed at enhancing economic growth and competitiveness.

The central box in Fig. 2 indicates the industrial needs, listed as applications, innovation, control of manufacturing processes and surface properties, and training of a skilled workforce. Each organization brings its expertise and unique equipment to SEAM for processing, fabrication, characterization, and testing of materials. The left-hand side of Fig. 2 presents summary inputs into SEAM categorized under access to resources, training inputs, partner organizations, and the three universities who contribute academic investigators and equipment. STEM training is embedded methodically throughout SEAM as a strict requirement. Training, partner organizations, and societal outputs are listed on the right-hand side.

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 example, the benefits of new materials and thermal spray coatings are well documented in a 2016 roadmap for the technology[1], which states that, "The global market (revenue generated through material,

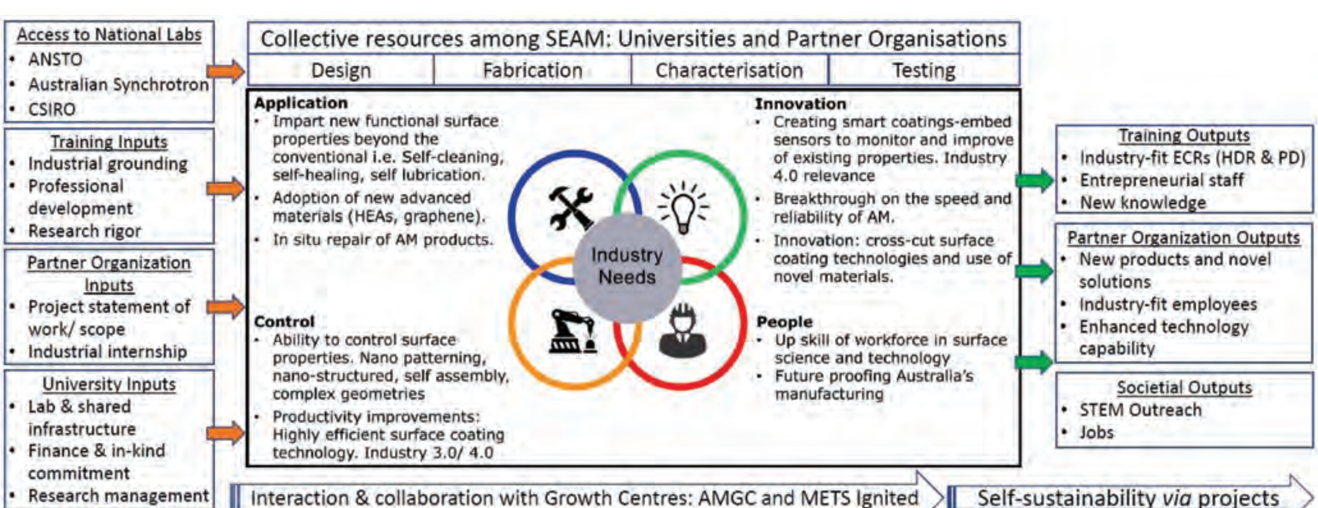

Fig. 2 — SEAM's goal is the industrialization of academic outcomes.

equipment, and coating manufacturing) was estimated at USD $7.58 billion in 2015 and is expected to grow at a compound annual growth rate of 7.79% to reach USD $11.89 billion by 2021. Market drivers include the rising demand for electricity production, air transport, automotive manufacturing, and economic development." Additional surface engineering processes (shown in Fig. 1) within SEAM exceed these financial markets and encompass a broader range of applications.

SEAM hits targets of technological and scientific needs that are underrepresented in Australia. The industrial significance can be gauged by analyzing available public data. The Australian Bureau of Statistics[2] shows the total employment projection for 2017 in Australia is 12.1 million, with 231,100 in the mining sector, 907,200 in manufacturing, 428,000 in research services, 234,800 in tertiary education, 9100 in education and training, and 217,100 in repair and maintenance. Thus, roughly 13% of the Australian workforce could be affected by SEAM. The total gross value added by industry to the Australian economy during FY 2016 was Australian $1548 billion with the above sectors contributing about 25.6%. SEAM is therefore focused 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 fill this gap in Australia's R&D portfolio.

In addition, it is recognized that the global need for surface engineering of advanced materials is strong. For example, it is estimated that economic losses due to corrosion account for approximately 4% of GDP for industrialized nations[3], which could be mitigated by technologies such as thermal spray surface engineering. Another example of a field that could benefit from advances in surface engineering is the medical device industry. Globally, the medical technology market is expected to grow at 4.5% per year and achieve sales of USD $455 billion by 2018. In Australia, recent figures (2013-2014) show that the turnover is approximately $11.8 billion in 2012-13 and the medical industry employs more than 19,000 people. Given that the level of imported goods is $5.59 billion compared to exported goods of $2.23 billion, opportunities for new Australian inventions to make an impact are huge, particularly in the development of new thin film technology[4].

BUILDING SKILLS AND CAPACITY

Three surface engineering themes form the technological foundation of SEAM, which promotes interaction between and among these technologies (Fig. 3).

Theme 1: Nanoscale surface modifications and thin films such as PVD and CVD 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 are manufactured by laser and thermal spray technologies. These overlays are used in heavy industries, mining, and in commercial transportation for repair and remanufacturing of components.

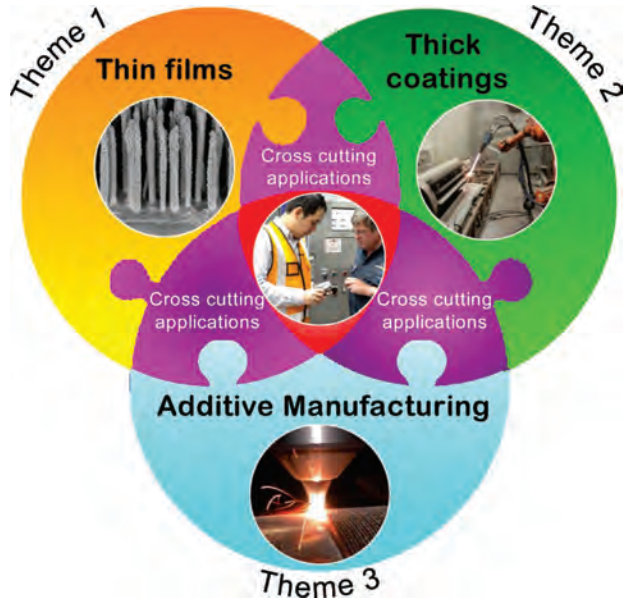

Fig. 3 — Three surface engineering themes form the technological foundation of SEAM.

Theme 3: Additive manufacturing (AM) is a layer-by-layer deposition process that creates a new surface. The two prime AM technologies explored include laser technology and cold spray. These are considered the most challenging because they involve fabricating near-net artifacts from difficult to process metals such as titanium alloys.

Surface engineering technologies are most often considered to be independent silos that do not interact. SEAM challenges this narrow viewpoint because of the high potential for advanced materials systems that may arise by integration and interactions across the three surface engineering themes. Thus, a component can be surface engineered by taking advantage of microstructural features over several grain size scales, i.e., from nano to macro. This combinatorial materials modification approach enables fabrication of advanced surface coatings as composites or laminates. Therefore, SEAM's multi-themed approach will create new surface coatings that will demonstrate unique materials properties to service the demanding requirements of industry, including development of the next generation of manufactured products.

In summary, the initial cohort of 23 Ph.D. students, six postdoc research engineers, and 20 undergraduate interns—all beginning in 2019—will have a tremendous opportunity to engage with and learn from the best organizations and industries in the field of surface engineering. These early career researchers will drive development of the next generation of innovations in surface engineering of advanced materials. The SEAM team will generate significant benefits to industry, education, and to the fundamental understanding of advanced materials and surface engineering, which is critical to developing advanced manufacturing products. **~iTSSe**

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