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Additive Manufacturing—The 2nd Asia–Pacific International Conference on Additive Manufacturing (APICAM 2019)

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The 2nd Asia–Pacific International Conference on Additive Manufacturing (APICAM 2019: https://www.apicam2019.com.au/) was held from 1 July to 3 July 2019 at Royal Melbourne Institute of Technology, Melbourne, Australia, organised by Materials Australia. The conference attracted 262 papers including 49 poster papers and covered a broad range of topics on additive manufacturing. There were six plenary sessions, which included: (1) "Recent Developments in Additive Manufacturing in Europe" by Professor Christoph Leyens of Technische Universität, Dresden, Germany; (2) "Production Level Additive Manufacturing" by Mr. Yathiraj Kasal of GE Additive; (3) "Polymers for Powder Bed Fusion" by Professor David L. Bourell of The University of Texas at Austin; (4) "Structure Evolution Across Build Layers in EB Additive Nickel Alloys" by Professor Tresa Pollock of the University of California, Santa Barbara; (5) "I AM SIEMENS—Industrialized Additive Manufacturing by Siemens" by Dr. Ingomar Kelbassa of Siemens AG; (6) "3D Printed Orthopaedic Implants in China" by Professor Huiping Tang of Northwest Institute for Nonferrous Metal Research, China. For this special topic in JOM, 12 papers were selected from this conference following a thorough review process. The key features of each article in this collection are summarised as follows.

In the first article, titled "Probing Ultrafast Dynamics in Laser Powder Bed Fusion Using High-Speed x-ray Imaging: A Review of Research at Advanced Photon Source", Tao Sun provided an informative update on the recent additive manufacturing (AM) research work using in situ high-speed x-ray imaging at Advanced Photon Source. The various phenomena and capabilities of the high-speed x-ray imaging discussed in this work are expected to attract more attention from the AM community to further the understanding of the metal AM processes.

In the second article, "Improvements in Ductility and Reliability of Mechanical Properties of Polyamide 11 Produced using Laser-based Powder Bed Fusion", D.L. Bourell and D.K. Leigh discussed the reliability, consistency and repeatability of part service properties across Polyamide 11 builds, which is one of the historic obstacles to widespread application of powder bed fusion (PBF) polymers in structural applications. The discussion was in the context of data from a service bureau for which approximately 88,000 tension tests had been performed on AM laser-sintered polyamide 11. This article can serve as an important point of reference for PBF polymers in structural applications.

The third article, "Tantalum Bone Implants Printed by Selective Electron Beam Manufacturing (SEBM) and Their Clinical Applications" by Tang et al. reports a unique study on the use of less than 90-ppm-oxygen spherical tantalum (Ta) powder to fabricate various lattice-structured bone implants by selective electron beam melting (SEBM). These Ta implants showed exceptional ductility due to their ultra-low oxygen content. Since 2016, the authors have enabled a total of 27 clinical applications in China using custom-designed and SEBM-printed Ta implants. All these lattice-structured Ta implants have performed satisfactorily in patients' bodies to date.

The fourth article, by Sun et al., deals with "Fatigue Performance of Additively Manufactured Ti-6Al-4V: Surface Conditions vs. Internal Defects". The authors added more systematic experimental data on a well-investigated topic of AM Ti-6Al-4V through carefully prepared samples and provided a range of useful insights into the relative influence of surface conditions and internal defects on the fatigue performance of AM Ti-6Al-4V, particularly for the design of AM Ti-6Al-4V bone implants.

The fifth article, "Microstructure and Mechanical Property of Ti-5Al-2.5Sn/Ti-6Al-4V Dissimilar Titanium Alloys Integrally Fabricated by Selective

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Laser Melting", discusses the fabrication of a Ti-5Al-2.5Sn/Ti-6Al-4V dissimilar titanium alloy material by SLM. The authors reported a defect-free metallurgical bonded interface and a range of other characteristics at the interface, along with the mechanical properties.

The authors of the sixth article presented an interesting study on the "Influence of Gas Flow Speed on Laser Plume Attenuation and Powder Bed Particle Pickup in Laser Powder Bed Fusion". They identified the influence of both the lower and the upper gas flow speed limits on the SLM build process. The experimental observations have immediate implications for control of defect formation in SLM-fabricated metal parts.

The seventh article, by Lehnert et al., centred on understanding the "Effect of Compositional Variation Induced by EBM Processing on Deformation Behavior and Phase Stability of Austenitic Cr-Mn-Ni TRIP Steel". The authors concluded that the Mn content can be significantly changed by a variation of the electron beam scan speed and, thus, the resulting energy density. This affects both the properties and deformation mechanisms of the EBM-fabricated alloy. Clearly, it remains challenging to fabricate Mn-containing steels by EBM.

In the eighth article, titled "Revealing the Mechanisms of Grain Nucleation and Formation During Additive Manufacturing", the authors presented an introduction to the interdependence model for alloy solidification, its recent validation by experiments and examples of how it can be applied to the solidification of alloys during AM. It provides useful insights into how a grain structure can be effectively controlled during metal AM processes.

Chen and co-workers in the ninth article on "Grain Growth during Keyhole Mode Pulsed Laser Powder Bed Fusion of IN738LC" reported an interesting development in minimising hot cracking during laser powder bed fusion (LPBF) of difficult-to-weld alloys. They found that with a change of 67° in scan direction after each layer, the regular growth of the lamellar microstructure was completely disrupted. As a result, the length of grain boundaries was considerably reduced and more randomly orientated. Correspondingly, cracks are short and mainly in the size range comparable to layer thickness.

In the tenth article, "Comparison of Microstructural Response to Heat Treatment of Inconel 718 Prepared by Three Different Metal Additive Manufacturing Processes", Schneider looked at the inherent differences in the response of Inconel 718 to heat treatments developed for wrought 718. Three different AM processes were used to fabricate the samples in this study. The author concluded that to address optimisation of heat treatments requires an in-depth understanding of how the starting microstructure responds to the anticipated heat treatments.

Computational materials engineering (ICME) has shown important implications for metal AM. The 11th article discusses "Optimal Design for Metal Additive Manufacturing: An Integrated Computational Materials Engineering (ICME) Approach". In this article, the authors illustrated an example of ICME-based PSPP (process structure-properties-performance) linkage in metal AM along with a hybrid physics-based data-driven strategy for its application in optimal design of a selected component. In addition, they discussed strategies for improvement of each part in the computational linkage of the PSPP chain.

Multi-material 3D printing offers exciting new opportunities for advanced manufacturing by 3D printing. The last article in this collection focuses on "Polyjet 3D Printing of Composite Materials: Experimental and Modelling Approach". The introduction of different types of rigid reinforcement particles of the 3D printed composite was demonstrated and quantified. Tensile results show that the interface of the dual material is strong enough to withstand the stretching during the tensile experiment. A numerical model was developed, and the results showed good agreement with experiments.

In summary, this selection of articles is published under the topic Additive Manufacturing—The 2nd Asia–Pacific International Conference on Additive Manufacturing (APICAM 2019) in the March 2020 issue (vol. 72, no. 3) of JOM and can be accessed via the JOM page at http://link.springer.com/journal/11837/71/8/page/1.

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