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Editorial

Additive Manufacturing (AM) of Metallic Alloys

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The introduction of metal additive manufacturing (AM) processes in industrial sectors, such as the aerospace, automotive, defense, jewelry, medical and tool-making fields, has led to a significant reduction in waste material and in the lead times of the components, innovative designs with higher strength, lower weight and fewer potential failure points from joining features.

This Special Issue on "Additive Manufacturing (AM) of Metallic Alloys" contains a mixture of review articles and original contributions on some problems that limit the wider uptake and exploitation of metal AM.

The variation in the quality of the parts and to the repeatability of the laser powder bed fusion process (L-PBF) was reviewed by Yadav et al. [1]. Their review focuses on the types of process defects that can be monitored via process signatures captured by in situ sensing devices and recent advancements in the field of data analytics for easy and automated defect detection.

One of the main causes that can lead to the poor quality of the components produced or the non-completion of the construction of the components is to be identified in the residual stresses. The fast and accurate prediction of residual stress is of great importance in the aerospace, automotive, and medical industries. Mirkoohi et al. [2] proposed a fully coupled thermomechanical analytical model to predict residual stress in the L-PBF process. In this process, due to the high-temperature gradient, the part experiences a high amount of thermal stress which may exceed the yield strength of the material. The proposed model uses a moving point heat source approach, the Green's function of stresses, and the Johnson-Cook flow stress model in order to predict the temperature field, the thermal stress, and the yield surface of the part under repeated heating and cooling, respectively.

The residual stress and other physical quantities, such as molten pool morphology, temperature field, and distortions, were examined by Saadlaoui et al. [3] in order to analyze and better understand the laser welding and melting of a powder bed fusion process. The results of this study can be used to improve and validate the numerical simulations of these processes.

Macroscale modeling plays an essential role in simulating AM processes. However, they cannot predict local quality problems such as a lack of fusion or surface roughness due to the fact that they often require a lot of computation time to get a certain accuracy of the results. Galati et al. [4] proposed an accurate and simple three-dimensional (3D) model to estimate the potential faulty process conditions that may cause quality issues or even process failure during the electron beam melting (EBM) process. Heat transfer analysis accuracy is demonstrated with a more accurate literature model. A multilayer simulation validates the model capability in predicting the roughness of a manufactured Ti6Al4V sample.

The fracture behavior and mechanical properties of the support structures for the components produced with this titanium alloy by the L-PBF process were investigated by Weber et al. [5]. In addition to fixing a part onto the building platform and the use of supporting overhanging structures, the support structures are necessary for heat dissipation, the avoidance of residual stresses and the compensation of residual stress-induced warping. The importance of support structures is often underestimated. This study is therefore based on the analysis of the process parameters that allow having suitable support structures for the purposes for which they are used. The experiments revealed that the struts produced with support parameters had no significantly lower tensile strength than the comparative parts.

The importance of design does not only concern the support structures but also, and above all, the components themselves. In fact, one cannot think of producing a component designed for traditional technologies with additive ones. Each technological process has its own design rules that depend on the constraints of the process itself. Galati et al. [6] investigated the designing for additive manufacturing (DfAM) and designing for assembly (DfA), to increase the material efficiency of the components for high-precision applications. The new methodology proposed allows a considerable reduction in the weight of the components and a simultaneous improvement in performance, as well as a reduction in the number of parts of a component that lead it to be economically competitive on an industrial level.

Remaining in the field of design, for the fabrication of mesoscale metal parts, Liu et al. [7] proposed the novel design of a low-cost electrochemical additive manufacturing (ECAM) 3D printer based on a microfluidic system. A copper circuit was printed on a non-conductive substrate to demonstrate a possible application of the ECAM system in the fabrication of functional electronics.

This Special Issue also includes a study conducted by Zhao et al. [8] on the microstructures and mechanical properties of ausrolled nanobainite steel. Due to their excellent mechanical properties and extraordinarily slender ferrite plates, high-C carbide-free nanostructured bainite steels are widely used in railway frogs, bearings, and automobile sheets in many industries.

Conflicts of Interest: The author declares no conflict of interest.

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