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Editorial

Additive Manufacturing (AM) for Advanced Materials and Structures: Green and Intelligent Development Trend

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Additive manufacturing (AM) is an emerging and rapidly evolving technology that has revolutionized the way products are developed, fabricated and commercialized. This has enabled the disruption of long-running manufacturing processes, leading to economic and societal change. Many design and manufacturing technologies are receiving widespread attention to advance AM technology towards high efficiency, high precision, high performance, and low cost in an environmentally friendly manner. This Special Issue focuses on exploring topical issues in additive manufacturing processes, material design, structure design, process planning, and performance evaluation. The call for articles for this Special Issue resulted in an enthusiastic response from the research community, who contributed an excellent series of high quality and technically diverse manuscripts. This Special Issue "Additive Manufacturing (AM) for Advanced Materials and Structures: Green and Intelligent Development Trend" covers topics surrounding the structural design of complex components, the integrated, advanced design for the preparation and manufacture of high-performance materials, and performance optimization; containing a mix of 20 communications, original articles, and review articles.

In the ever-expanding field of additive manufacturing processes, Chao et al. [1] have proposed a novel high-resolution fused deposition 3D printing technique based on electric field-driven (EFD) jet deposition. An experimental approach based this process was devised to print polycaprolactone (PCL) porous scaffold structures. To explore the application prospects of this technique in the fabrication of microchannel structures, Chao et al. [2] have successfully printed waxy structures with a size of tens of microns.

Laser-based additive manufacturing processes are of long-standing interest among emerging additive manufacturing processes. For example, in laser powder bed fusion (LPBF) technology, scholars have conducted extensive research into structural design, material and part properties, and process strategies. With regard to structural design, Li et al. [3] have developed an optimization method for a body-centered cubic with Z support (BCCZ) lattice based on parametric modeling. The designed BCCZ structures were able to maintain their strength whilst also retaining light weights. Ma et al. [4] have prepared diamond lattice structures with different material distributions using selected laser melting techniques. The mechanical behavior of the structures was investigated under quasi-static and dynamic loading, and the gradient sheet diamond (GSHD) was found to possess the highest yield strength. With regard to material and part properties, Shen et al. [5] used LPBF to fabricate SiC-reinforced Al–Zn–Mg–Cu composites in situ. The results showed that the organization of the composites was regulated, the matrix grains were refined, and the grain orientation growth was suppressed. In a similar fashion, to improve the mechanical properties of the AlSi10Mg alloy prepared by LPBF, Lu et al. [6] have investigated the effect of nano-Si3N4 reinforcement on the densification behavior, microstructure, and tensile properties of AlSi10Mg. It was revealed that the tensile and yield

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strengths of the composites steadily increased with increasing nano-Si_3N_4 content, while the elongation decreased. Li et al. [7] have analyzed the fracture behavior of 316L stainless steel fabricated with defects by selective laser melting using a near-field kinetic approach. They demonstrated that crack sprouting is caused by the defects and crack branching contributes to complex multi-crack extensions. The effect of scanning strategy on the quality of the manufactured part is also important in process optimization. Cao et al. [8] have examined the effect of the transient temperature field of the molten layer in LPBF under linear and annular laser scanning strategies on the forming accuracy and quality of the manufactured part. Their analysis identified that annular scanning was more suitable than linear bi-directional scanning for the high-precision fabrication of thin-walled Fe–Cr–Al overlays. Other laser-based additive manufacturing processes such as laser cladding have also been the focus of attention. Wang et al. [9] used this technique to produce WC (hard tungsten carbide) Co–Cr alloy coatings with different mass fractions on 316L substrates. It was found that laser cladding of the Co–Cr–WC composite layer could significantly improve the wear and corrosion resistance of the 316L substrate. Lasers also have the important ability to fabricate micro/nanostructures. Du et al. [10] have manufactured Se-doped silicon thin films by irradiating Si–Se bilayer-coated silicon with femtosecond (fs) and picosecond (ps) lasers. Their work revealed that the changes brought about by ps laser processing are significant for ultrafast laser processing of brass-doped silicon in silicon-based integrated circuits. Ultrafast lasers can effectively process special materials and improve the mechanical properties of parts, giving them the advantage over short pulse lasers and continuous wave lasers. Finally, Wu et al. [11] have reviewed the interaction mechanisms between ultrafast lasers and metallic materials and discussed the current status and challenges of ultrafast laser application in the formation of special materials.

Aside from laser-based additive manufacturing processes, fused deposition modeling (FDM), projection stereolithography, and resistive additive manufacturing are also discussed. Tura et al. [12] have used adaptive neuro-fuzzy methods and artificial neural networks to predict the tensile strength of ABS parts manufactured using fused deposition models. The results showed that an enhanced mechanical strength can be achieved by optimizing the process parameters. Based on FDM technology, Yang et al. [13] have explored an additive manufacturing process based on continuous carbon fiber-reinforced polylactic acid (PLA) composite prepreg filaments, resulting in the direct additive manufacture of lightweight and high-strength composite honeycomb load-bearing structures. Regarding stereolithography, Wen et al. [14] introduced a structure optimization-based compensation method to improve the geometric accuracy of microstructures printed by projective stereolithography. As for resistive additive manufacturing, Li et al. [15] have optimized the relative process parameters and analyzed their effects on the morphology of coating formation.

The concept of additive manufacturing can also be extended to high-performance coating preparation, which has received increasing attention in recent years. Zhang et al. [16] have researched the tribological properties of different crystalline diamond coatings prepared by the microwave plasma chemical vapor deposition (MPCVD) method in dry and seawater environments, providing important insights into the wear behavior of diamond coatings in seawater. Zhou et al. [17] investigated the nanomechanical properties of Ni-Co-Al-Ce coatings fabricated by velocity oxygen-fuel (HVOF) spraying, providing vital predictions for the erosion resistance of MCrAlY coatings. Li et al. [18] have synthesized two types of cemented carbide tools based on WC–Co–Zr and WC–Ni–Zr, namely cemented carbide tools and functional gradient cemented carbide (FGC) tools with FCC-phase ZrN-rich surfaces, which have potential in future hybrid additive/subtractive manufacturing applications.

Green, intelligent, and high-performance manufacturing processes are the focus of this Special Issue; therefore, several other studies on manufacturing trends are herein presented. The influence of inclusions on the mechanical properties of spring steels is significant; thus, Li et al. [19] have investigated the effect of alkalinity and Al_2O_3 content on slag viscosity and structure to explore their effect on inclusion removal from steel. The generation of coal fly ash (CFA) in manufacturing is a serious barrier in the development of eco-friendly process manufacturing. Qi et al. [20] have constructed three different regression models to quickly and accurately predict the generation of CFA, thus saving time in planning of CFA disposal.

This Special Issue, "Additive Manufacturing (AM) for Advanced Materials and Structures: Green and Intelligent Development Trend," can be considered as a review of the progress of additive manufacturing over the past year in the areas of advanced materials, structural design, and manufacturing processes.

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

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