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Editorial

Materials for Additive Manufacturing

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Abstract: This Special Issue of AIMS Materials Science was devoted to the topic “Materials for Additive Manufacturing”. It attracted significant attention from scholars and practitioners from ten different countries (Spain, Greece, France, Portugal, Italy, Finland, Ethiopia, Canada, Vietnam, and Iraq) and published five manuscripts of a total of ten submissions between April 2021 and March 2022. In addition, new materials, methodologies, and analysis approaches are presented in materials for additive manufacturing.

Keywords: materials; additive; manufacturing; 3D printing; FDM; FFF; SLS; residuals; modeling; performs; composites; mortars; natural; fibers

1. Introduction

Additive manufacturing 3D printing processes have become a topic of increased interest in recent years from both manufacturing and systems points of view, with increasing significance within the tailored made functional products [1]. 3D printing uses metals [2], ceramics [3], plastics [4], wooden [5] or composites [6] materials to build physical objects or constructions as prototypes or final parts/buildings [7]. 3D printing processes include—but are not limited to—material extrusion [8], powder bed fusion [9], binder jetting [10], directed energy deposition [11], material jetting [12], and sheet lamination [13]. Fused Filament Fabrication (FFF) [14], stereo-lithography (SLA) [15], selective laser melting (SLM) [16,17], Electron Beam Melting (EBM) [18], selective laser sintering (SLS) [19], and laminated object manufacturing (LOM) [20] are the most extensively technologies applied.

Additive manufacturing, thanks to layer-by-layer assembly, has already proved its suitability for structural as well as functional and smart applications [2,21,22]. Automotive [23], aerospace [24], biomedical engineering [25,26], education [27], food and agricultural [28,29], and fashion [30] are some of the areas that applied with success [31]. Materials and products based on additive manufacturing are being explored intensively, having excellent physical and mechanical properties [32].

2. Topics

This open Special Issue has accepted five quality peer-reviewed manuscripts, of which four are correlated to the material extrusion-based 3D printing process and one with the laser beam melting process.

2.1. Material extrusion process

2.1.1. Biobased with natural fiber 3D printing material

Rafiee et al. [33] investigated the mechanical, thermal, and microstructural properties of birch fiber-reinforced PLA composite granules, biobased with natural fiber thermoplastic polymers manufactured in-house for the fused filament fabrication process. Even if they achieved proper 3D printing of biocomposite filaments, they also pointed out that if the 3d printing parameters, including nozzle and bed temperatures and material flow rate, are optimised for generic and flawless filament extrusion, then minimal labour and end-products with better strength and resolutions can be achieved.

2.1.2. 3D printing concrete material

Volpe et al. [34] analysed magnesium potassium phosphate cement (MKPC) performance as an innovative cementitious material in terms of sustainability and the possibility of its use in extrusion-based 3D concrete printing. They discussed the relationship between the water to binder ratio and workability in two different quantities of retarders. Mixed compositions were also prepared by replacing sand with rubber or glass aggregates to create lightweight aggregate-based mortars. In addition, fly ash, a widely used material (but that will not be available in the next few years), was replaced with silica fume. They found that two formulations show appropriate rheological compressive properties.

2.1.3. Microwave applications

Martinez et al. [35] fabricated lightweight composite fused filament fabrication 3D printing toroidal samples based on a polyphenylene sulfide matrix and carbonyl iron particles. They tested it in electromagnetic performance and temperature resistance and compared it to those of commercial iron-filled polylactic acid (PLA) electromagnetic properties. They approved that this new high-temperature printable composite paves the way for developing efficient, low-cost, low weight, low power consumption and temperature-stable absorbers for microwave applications.

2.1.4. High-performance, lightweight composites

Mendizabal et al. [36] presented the novel ADDICOMP technology, which is an alternative preform manufacturing method using an additive high fibre content (up to 90%) polymeric coated process based on the fused filament fabrication (FFF) process. In addition, they presented the two developing phases of high fibre percentages ADDICOMP technology for manufacturing continuous fibre reinforcements for lightweight parts for the transport sector. The manufacturing phases include (a) the development of continuous fibre filaments coated with a polymeric material printable by the FFF process and (b) fine-tuning the FFF technology to print filaments with a very high content of continuous fibre.

2.2. Laser beam melting

2.2.1. Thermomechanical modeling of laser powder bed fusion

Psihoyos and Lampeas [37] developed a thermomechanical model for residual strain and stress (due to high-temperature gradients developed and thermal cycles) for predictions of laser power bed fusion (LPBF) parts quality and process optimisation. They tested the modelling efficiency of the proposed approach on a series of cases for which experimental data were available. The efficiency of the thermomechanical modelling method is demonstrated by the reduced computational time required.

3. Concluding

A common denominator describes all the above-mentioned extensive studies, i.e., they used cutting-edge materials and methods for additive manufacturing. Consequently, it is apparent that the special issue was operated as a suitable help for introducing new and innovative studies in the field of functional materials for additive manufacturing.

Conflict of interest

The author declares no conflict of interest.

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