Special Issue on “Additive Manufacturing Technologies and Applications”

technologies

Editorial

Special Issue on "Additive Manufacturing Technologies and Applications"

Salvatore Brischetto * , **Paolo Maggiore and Carlo Giovanni Ferro**

ASTRA (Additive Manufacturing for Systems and Structures in Aerospace) Group, Politecnico di Torino, Department of Mechanical and Aerospace Engineering, Corso Duca degli Abruzzi 24, 10129 Torino, Italy; paolo.maggiore@polito.it (P.M.); carlo.ferro@polito.it (C.G.F.)

* Correspondence: salvatore.brischetto@polito.it

Received: 8 September 2017; Accepted: 11 September 2017; Published: 12 September 2017

Additive Manufacturing (AM) is a well-known technology, first patented in 1984 by the French scientist Alain Le Mehaute. Its distinctive feature is the addition of material with different methods (e.g., powder or wire) in place of the subtraction of material from a raw part. AM has been widely introduced in the preliminary and conceptual design phase, thanks to its reduced production costs and realization time for a prototype. In the last two decades, this technique has also been considered for low-scale mass production due to some advantages. This method allows the construction of so-called evolutionary shapes: structures of complex design that are impossible or difficult to build via traditional milling or machining. Evolutionary shapes are usually the result of a topological optimization. For these reasons, important mass savings or increases in structure mechanical properties are obtained using AM. The present Special Issue proposes articles in the area of Additive Manufacturing with particular attention to the different employed technologies and the several possible applications. The main investigated technologies are the Selective Laser Sintering (SLS) and the Fused Deposition Modelling (FDM). These methodologies, combined with the Computer Aided Design (CAD), provide important advantages. Numerical, analytical and experimental knowledge and models are proposed to exploit the potential advantages given by 3D printing for the production of modern systems and structures in aerospace, mechanical, civil and biomedical engineering fields.

This Special Issue of *Technologies* comprises 11 selected papers about different additive manufacturing methodologies and related applications and studies. The first paper by Petersen et al. analyses the significant impact in the near future of Do-It-Yourself (DIY) manufacturing via 3D printing on the toy and game markets. The second paper by Laureto and Pearce describes a manufacturing technology that allows a constrained set of metal–polymer composite components. The main conclusion is that an open source software and hardware tool chain can provide low-cost industrial manufacturing of complex metal–polymer composite-based products. Ferro et al. propose a multi-functional panel concept that integrates the anti-icing system directly inside the primary structure. The core of the sandwich includes trabecular non-stochastic cells that allow the presence of a heat exchanger directly embedded in the leading edge. This solution is easily produced in a single-piece component using Additive Manufacturing (AM) technology without the need of joints, gluing or welding. A preliminary investigation of the mechanical properties of the core produced via the Selective Laser Melting (SLM) method is proposed. Mazzucato et al. propose the monitoring of a new deposition nozzle solution for Direct Energy Deposition (DED) systems through a simulation–experimental comparison. Preliminary tests are carried out by varying powder, carrier and shielding mass flow, demonstrating that the last parameter has a significant influence on the powder distribution and powder flow geometry. Vora et al. show the creation of an Al339 alloy from compositionally distinct powder blends. The in-situ alloying of this material and the Anchorless Selective Laser Melting (ASLM) processing conditions allow components to be built in a stress-relieved state, enabling the manufacture of overhanging and unsupported features. This novel method, known as ASLM, maintains processed material within a stress-relieved state throughout the duration of a build. Kutzer and DeVries discuss a new methodology that applies material onto or around existing surfaces with multilayer and thick features. The main novelties of the paper are the derivation of deposition paths giving a prescribed set of layers; the design, characterization and control of a proof-of-concept testbed; and the derivation and application of time evolving trajectories subjected to the material deposition constraints and mechanical constraints of the testbed. Results show the feasibility of conformal material deposition with multilayer and thick features. Brischetto et al. propose Fused Deposition Modelling (FDM) characterization in order to apply this technology in the construction of aeronautical structural parts when stresses are not excessive. A statistical characterization of the mechanical properties of ABS (Acrylonitrile Butadiene Styrene) specimens during compression tests is proposed. A capability analysis is also used as a reference method to evaluate the boundaries of acceptance for both mechanical and dimensional performances. The statistical characterization and the capability analysis are proposed in an extensive form in order to validate a general method that will be used for further tests in a wider context. Ilie et al. show that the layer-by-layer building methodology, used within the powder bed process of Selective Laser Melting (SLM), facilitates control over the degree of melting achieved at each layer. This control can be used to manipulate levels of porosity within each layer, affecting resultant mechanical properties. The results indicate that there is potential to use SLM for customising mechanical performances over the cross-section of a component. Prashanth et al. study the properties of five different metals/alloys fabricated by means of SLM. The results show that SLM is a reliable fabrication method to produce metallic materials with consistent and reproducible properties. Petersen and Pearce study a representative model for the potential future of 3D printing in the average American household by employing a printer operator who is relatively unfamiliar with 3D printing and 3D design files of common items normally purchased by the average consumer. Twenty-six items are printed in thermoplastic and a cost analysis is performed through comparison to comparable and commercially available products at a low and high price range. The paper by Patterson et al. analyses SLM and the Direct Metal Laser Sintering (DMLS) processes. SLM/DMLS can produce full-density metal parts from difficult materials, but it tends to suffer from severe residual stresses introduced during processing. This feature limits the usefulness and applicability of the process, particularly in the fabrication of parts with delicate overhanging and protruding features. The purpose of this study is to examine the current status and progress made toward understanding and eliminating the problem in overhanging and protruding structures.

The articles published in this Special Issue present only some of the most important topics about additive manufacturing technologies and applications. However, the selected papers offer significant studies and promising methodologies.

Acknowledgments: The Guest Editors would like to thank all the authors for their invaluable contributions and the anonymous reviewers for their fundamental suggestions and comments.

Conflicts of Interest: The authors declare no conflict of interest.