Check for updates

Institution of MECHANICAL ENGINEERS
Journal of MECHANICAL ENGINEERING SCIENCE

Editorial

"Mechanical characterization of parts fabricated by additive manufacturing"

Proc IMechE Part C: J Mechanical Engineering Science
2021, Vol. 235(10) 1701–1702
© IMechE 2020
Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/0954406220948759
journals.sagepub.com/home/pic
SAGE

Massimiliano De Agostinis[1], Giorgio Olmi[1] and Gabriele Arcidiacono[2]

The explosion in the numbers of industrial applications making use of additive manufacturing (AM) techniques requires the use of reliable experimental data and appropriate design methods in order to ensure the adequate performance and safety of newly designed AM components. This Special Issue represents a collection of both experimental end numerical studies, covering the two *realms* of metallic and polymeric materials. The Special Issue is completed by papers focused on design and optimization problems, and on repair as well as on cost issues related to the production of AM components, which provide useful guidelines for design engineers and researchers.

Papers (1) through (8) deal with the broad topic of experimental characterization of the mechanical properties of metallic materials processed by AM.

Razavi et al. studied the effect of porosities on the static mechanical properties of Ti6Al4V samples manufactured by LENS (Laser Engineered Net Shaping, i.e. a manufacturing process belonging to the class of Direct Energy Deposition methods).

In the following two papers, Balos et al. address some issues related to the application of two different hardness testing methods, namely Knoop and Vickers, to Maraging Steel samples manufactured by SLM (Selective Laser Melting), proposing optimal measurement parameters.

Papers (4) and (5) deal with applications of the Wire Arc Additive Method (WAAM): this process is of particular interest for the fabrication of large components, whose geometrical complexity ranges from simple to moderate, since it is characterized by high deposition rates, high energy efficiency and low costs. Duraisamy et al. carried out static mechanical tests, microstructural and chemical analyses on stainless steel samples, whereas Astarita et al. examined the correlation between the presence of defects and the mechanical properties of WAAM processed specimens built from ER70S-6 wire (a low-carbon steel with high contents of Silicon and Manganese).

Papers (6 – 8) share the topic of lattice structures manufactured by SLM. Gavazzoni et al. focused their attention on the effect of the specimen geometry on the mechanical response of a single unit cell (made by AlSi7Mg), operating under compression. The paper by De Pasquale et al. specializes general shaping strategies with the aim of increasing the lattice structure strength to mass ratio and strain energy absorption capability for practical application in the development of aircraft anti-icing systems. Finally, Concli et al. contribute, by a numerical and experimental study, to the understanding of the ductile behavior of trabecular structures made by A357 casting aluminum alloy.

The experimental characterization of the mechanical properties of polymeric material parts made by AM is covered by papers (9 – 16).

In paper (9), Patterson et al. investigated the impact strength of a wide range of full–infill polymer-based materials processed with various orientations and raster angles via Fused Deposition Modeling (FDM). All experiments were carried out using ASTM IZOD Type E tests, with a 2.7 J pendulum.

Cosmi and Dal Maso are the authors of paper (10), which describes the design and validation process of an in-house-built machine for tensile testing of 3D-printed polymeric materials. Such machines have the potential of reducing testing costs with respect to the case of high-end commercial test benches.

Papers (11) and (12) deal with the compressive and tensile properties of polymeric AM parts, respectively. On the one hand, the paper authored by Kumar and Kumar Jain analyses the compressive behaviour of ethylene vinyl acetate (EVA) specimens processed through extrusion-based additive manufacturing. All the specimens were fabricated by an in-house developed fused layer modelling process, and the experimental design takes input parameters such as raster angle, layer thickness and infill percentage into account. The paper by Dave et al., on the other hand, investigates the effects of part orientation,

[1]University of Bologna, Bologna, Italy
[2]University Guglielmo Marconi, Rome, Italy

Corresponding author:
Massimiliano De Agostinis, University of Bologna, Via Zamboni, 33, 40126 Bologna, Italy.
Email: m.deagostinis@unibo.it

infill density and infill pattern on the tensile properties and modes of failure of poly-lactic acid (PLA) specimens made by FDM.

As of today, joining issues in AM parts are largely unexplored: papers (13) and (14) shed light on some of those. The first paper, by Kumar et al. investigates the feasibility of joining dissimilar FDM samples, made of Acrylonitrile Butadiene Styrene (ABS) and Polyamide (PA), by addition of Aluminum particles during the deposition process. Optimal process parameters were defined for the Friction Stir Welding (FSW) process. The following paper, authored by Spaggiari and Denti, sheds light on the combined use of FDM and structural adhesive. The aim of this research is twofold: first, to enhance the adhesive performance exploiting the capability of AM processes to tailor the bonding surface of the adherend; second, to overcome one of the main limitations of AM: the comparatively small building volume available in commercial printers.

Since the full exploitation of AM capabilities may open new paths for designers, paper (15) by Jilich et al., describes how a robotic gripper, specifically developed for grasping and handling textiles and soft flexible layers, can be miniaturized and improved by polymeric additive manufacturing-oriented re-design. In paper (16) MacArthur investigates the tensile properties of a successfully worn 3D printed transtibial sockets manufactured by FDM.

Still looking at AM processes from the designer's standpoint, papers (17) and (18) deal with more general methods aimed at improving the strength (or stiffness) to weight ratio of AM parts.

In paper (17), Dragoni and Ciace set focus on the development of a new class of intrinsically strong, stiff and lightweight filling materials, generated by transforming 3D tessellated arrangements into kinematically-rigid wireframes made up of trabecular ligaments. Paper (18), by Mantovani et al. exploits the use of topology optimization algorithms in conjunction with metal AM for the development of an automotive Body-in-White component.

Finally, papers (19) and (20) deal with cost issues related to the production of AM parts. In the first one, Šoškic et al. introduce a model for calculating the production costs of the multi-jet-fusion technology, deriving it from a previously developed model for the selective laser sintering technology. In the latter, Ciappi et al. carry out a technological and financial assessment of the restoration of turbine blades by means of AM processes, presenting a comparison between this innovative repair technology and the conventional industrial technologies.

It is the Editors' belief that the present selection of papers may constitute a useful piece of information for those involved in mechanical characterization, design and production of AM processed components.