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Editorial

Characterization and Modelling of Manufacturing–Microstructure–Property–Mechanism Relationship for Advanced and Emerging Materials

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Depending on the state of its raw materials, final products, and processes, materials manufacturing can be classified into either top-down manufacturing and bottom-up manufacturing, or subtractive manufacturing (SM) and additive manufacturing (AM). Some important top-down manufacturing methods include casting [1], welding [2], hot rolling [3], cold rolling [4], cryo-forming [5], heat treatment [6], equal channel angular pressing [7], high pressure torsion, [8], and accumulative roll bonding [9], while some important bottom-up manufacturing techniques include powder metallurgy sintering [10–12] and filtered arc deposition [13]. The disadvantages of bottom-up manufacturing, in comparison to top-down manufacturing, are its limitations in fabricating large samples and its inability to avoid contamination and residual porosity in its final products. Recently, the AM approach has attracted increasing interest, and some important AM processes include wire-arc-based methods [14,15], laser-based AM methods [16], electron-beam-based AM methods [17], and cold spraying [18]. Regarding the development of the materials, both conventional materials with novel structures (such as nanograined microstructures or ultrafine-grained microstructures [19–22]) and novel materials (such as high entropy alloys with more than four principal alloying elements [23]) have become popular for material scientists and engineers, owing to their attractive physical and mechanical properties. In addition to experimental characterizations, advanced modelling also plays a critical role, particularly in revealing the phenomena that are hardly observed in experiments. Some important modelling tools that are related to this manufacturing include the finite element method (FEM) [24], crystal plasticity FEM [25], discrete element method (DEM) [26], molecular dynamic (MD) model [27], and atomistic-continuum coupled multiscale model [28]. With the quick development of computational techniques, these models are providing increasing contributions to our understanding of the manufacturing–structure–property–mechanism relationships between various materials under different conditions. This Special Issue has collected the recent advances and investigations within the research that has been filed on manufacturing, covering all of these above mentioned topics.

Hedhibi et al. [29] studied the influence of pseudo-ternary oxides on mechanical properties and microstructures, by comparing the activating tungsten inert gas (ATIG) weld with the conventional tungsten inert gas (TIG) weld. They optimized the composition of the flux and found an improvement in the ultimate tensile strength (UTS), from about 571 MPa for the conventional TIG weld to about 600 MPa for the optimal ATIG weld. Ahmed et al. [30] developed a novel refilling technique for the friction stir spot welding (FSSW) joints of AA6082-T6 sheets. The mechanical testing showed higher-bearing tensile shear loads in all the refilled FSSW joints than those that were given by the as-received

FSSW joints. In order to improve the mechanical and tribological performances of an AZ91 Mg alloy, Ataya et al. [31] added short carbon fibers to the AZ91 matrix. They observed a large influence of the carbon fibers' orientation on both the compressive strength and the wear resistance of the Mg composite; however, they did not observe an obvious difference in the hardness. The paper published by Wan et al. [32] is about a laser-based AM of an Mg alloy. They successfully improved the wear and corrosion resistance of an AZ91D alloy by introducing an Al-Si alloy coating with an addition of Y_2O_3, using a laser cladding process. Yin et al. [33] studied the microstructures and textures of various automobile steels and their influences on quasistatic tensile deformation behavior, with a strain rate of 0.001 s^{-1} and dynamic tensile deformation behaviors with a wide strain rate range, varying from 33 to 600 s^{-1}. Zhang et al. [34] investigated the relationship between an ultrasonic vibration treatment and the microstructure evolution during the high-temperature forming process of 9310 steel. It was observed that the flow stress of the 9310 steel decreased with an increase in the deformation temperature or a decrease in the strain rate. Kubiak and Lesnikowski [35] investigated the influence of mechanical deformation on the characteristic impedance of sewed textile signal lines (TSLs). Regardless of the tensile forces, only the substrate weave was found not to affect the characteristic impedance change.

Chen et al. [36] studied the vibration characteristics of submarine-like structures with laminated materials that consisted of spherical, cylindrical, and cone shells with multiple built-in annular plates, based on a numerical model. Li et al. [37] developed a numerical discrete model that was based on a meshless Chebyshev-RPIM shape function, in order to study the vibration of a rotating cross-ply laminated combined conical–cylindrical shell in a thermal environment. In their study, Zhang et al. [38] focused on the vibration characteristics of a laminated composite double cylindrical shell system (LCDCSS), coupled with a variable number of annular plates. Dzwierzynska and Lechwar [39] proposed an algorithmic-aided approach for the design and optimization of the curvilinear steel bar structures of unit roofs, and their structural analysis was further verified by an FEM analysis, taking both the permanent and environmental loads into account. With the help of a computational fluid dynamics (CFD) model, Li et al. [40] simulated a high-pressure hydrogen flow through their newly proposed Tesla-type depressurization structure. They found that this pressure could be reduced by 237% if the standard orifice plate was replaced with a Tesla-type orifice structure. Furthermore, the subject of surface roughness in materials and manufacturing engineering has attracted increasing attention in recent years [41]. Lu et al. [42] studied the surface roughness of face gears, based on a non-contact measurement that was obtained via 3D optical scanning and FEM simulations. The paper by Yang et al. [43] is about the rough surface characterization parameter set (CPS) and redundant parameter set (RPS) that are used for surface modeling and performance. They successfully proposed a model for a performance evaluation of different workpiece surfaces, based on their capacity to fully cover the surface topography information. Li et al. [44] conducted MD simulations in order to study the hydrogen-induced dislocation nucleation (DN) and plastic deformation of <001> and <1–10> grain boundaries (GBs) in nickel bicrystals. Additionally, they also studied the influence of grain size on the hydrogen embrittlement (HE) of nanograined iron materials, which was also based on MD simulations [45]. Their study indicated that grain refinement could be an effective strategy for resisting H-induced brittle failure, owing to the fact that finer materials have a lower H concentration at the GBs, and an improved GB-mediated intergranular deformation, thus resulting in a lesser possibility of initiating cracks.

The variety and quality of all these papers are addressed to both academic and industrial researchers who are looking for new information that can contribute to the advancement of future research in these highly challenging fields. It is our hope, as guest editors, that you find this volume interesting. We would like to express our sincere gratitude to the authors for their contributions and cooperation during the editorial process. We are indebted to the reviewers for their constructive suggestions and comments. We thank the editorial team for their strong support throughout the entire process.

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