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Editorial

Materials Innovation and Design using Manufacturing Techniques

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Materials manufacturing processes and systemic mechanical behavior investigations are necessary requirements for materials innovation and applications. Mechanical performance and cost-effectiveness are pivotal parts of the application and requirement-driven material design process. Therefore, the structure-property relationship addresses the material design and mechanical and chemical (i.e., corrosion) performance in various engineering applications.

Subtractive manufacturing methods involve machining and removal materials for developing a product. In such a method is time-consuming and materials are wasted during the process. Likewise, with various materials production methods, additive manufacturing (AM) is an efficient method for developing a material part. The method has capabilities of design freedom and cost-effectiveness. Using the method, material parts are produced layer-by-layer addition, and product design is provided by a CAD (Computer-Aided Design) model. Such a process allows producing complex geometric parts and material waste management as well. Several forms of AM methods are using in producing metallic parts. Such products have widespread importance in automotive, aerospace, biomedical applications.

Researchers are investigating wide varieties of AM-produced metallic alloys and non-metallic materials across the globe. Selective laser melting (SLM), 3D printing (3DP), and electron beam melting (EBM) are the popular types of AM methods for producing metallic parts. In the SLM method, several processing parameters, such as laser power, laser scanning speed, and layer thickness associated with product development. Such processing parameters change the microstructure of the materials, hence have an immense effect on the mechanical behavior of the produced parts. Rapid solidification, grain size, layer orientation, melt pool boundaries, and energy density deposited in layers produce anisotropy of the materials.

The mechanical behavior of AM-produced parts depends on the microstructure of the materials. Quasi-static deformation and dynamic behavior under impact conditions are influenced by the microstructural anisotropy of the materials. Impact dynamics have broad applications, such as vehicle collision, sports, and aircraft engine collision.

In the present era, microstructural development and mechanical performance of materials are necessary to record properly. Varieties of microstructural characterization techniques are included in recent reports. Mechanical behavior of corresponding microstructure is also investigated and reported. Besides the excellent effort in material investigation and innovation, artificial intelligence can be employed to analyze data to understand the capabilities in microstructural modification in the material phase and defect formation at the corresponding geometric structure. Therefore, materials with high performance and efficiency, and cost-effective engineering parts can be developed using additive manufacturing methods.

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