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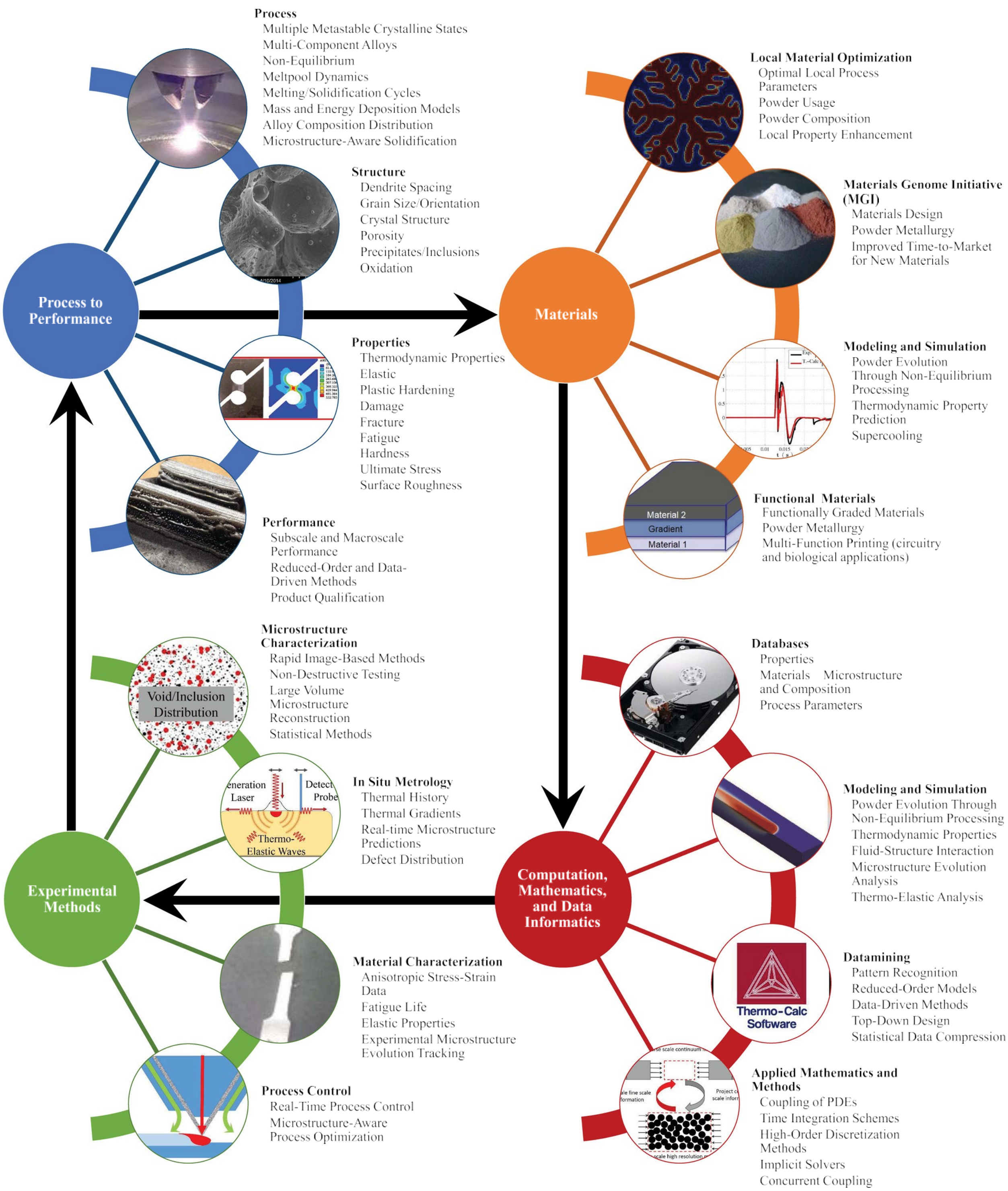
Linking Process, Structure, Property, and Performance for Metal-Based Additive Manufacturing: Computational Approaches with Experimental Support

Smith, J., Xiong, W., Yan, W., Lin, S., Cheng, P., Kafka, O.L., Wagner, G.J., Cao, J., Liu, W



Scientific Achievement

Additive manufacturing (AM) methods for rapid prototyping of 3D materials (3D printing) have become increasingly popular with a particular recent emphasis on those methods used for metallic materials. These processes typically involve an accumulation of cyclic phase changes. The widespread interest in these methods is largely stimulated by their unique ability to create components of considerable complexity. However, modeling such processes is exceedingly difficult due to the highly localized and drastic material evolution that often occurs over the course of the manufacture time of each component. Final product characterization and validation are currently driven primarily by experimental means as a result of the lack of robust modeling procedures. In the present work, the authors discuss primary detrimental hurdles that have plagued effective modeling of AM methods for metallic materials while also providing logical speculation into preferable research directions for overcoming these hurdles. The primary focus of this work encompasses the specific areas of high-performance computing, multiscale modeling, materials characterization, process modeling, experimentation, and validation for final product performance of additively manufactured metallic components.

Significance

Additive manufacturing (AM) methods for rapid prototyping of 3D materials (3D printing) have become increasingly popular with a particular recent emphasis on those methods used for metallic materials. These processes typically involve an accumulation of cyclic phase changes. The widespread interest in these methods is largely stimulated by their unique ability to create components of considerable complexity. However, modeling such processes is exceedingly difficult due to the highly localized and drastic material evolution that often occurs over the course of the manufacture time of each component. Final product characterization and validation are currently driven primarily by experimental means as a result of the lack of robust modeling procedures. In the present work, the authors discuss primary detrimental hurdles that have plagued effective modeling of AM methods for metallic materials while also providing logical speculation into preferable research directions for overcoming these hurdles. The primary focus of this work encompasses the specific areas of high-performance computing, multiscale modeling, materials characterization, process modeling, experimentation, and validation for final product performance of additively manufactured metallic components. research initiatives in the area of computational analysis of AM materials, processes and products as potentially acceptable solutions.

Citation

Smith, J., Xiong, W., Yan, W., Lin, S., Cheng, P., Kafka, O.L., Wagner, G.J., Cao, J., Liu, W.K. (2016) "Linking process, structure, property, and performance for metal-based additive manufacturing: computational approaches with experimental support", *Computational Mechanics*, DOI: 10.1007/s00466-015-1240-4.