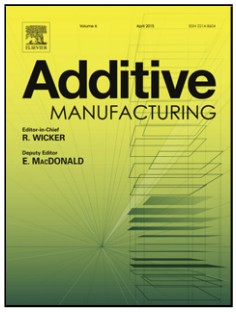

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PII: S2214-8604(18)30201-X
DOI: https://doi.org/doi:10.1016/j.addma.2018.06.019
Reference: ADDMA 433

To appear in:

Received date: 26-2-2015
Revised date: 22-6-2018
Accepted date: 24-6-2018

Please cite this article as: John G. Michopoulos, Athanasios P. Iliopoulos, John C. Steuben, Andrew J. Birnbaum, Samuel Lambrakos, On the multiphysics modeling challenges for metal additive manufacturing processes, *<![CDATA[Additive Manufacturing]]>* (2018), https://doi.org/10.1016/j.addma.2018.06.019

On the Multiphysics Modeling Challenges for Metal Additive Manufacturing Processes

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Abstract

In order to establish modeling and simulation (M&S) in support of Additive Manufacturing Processes (AMP) process control for tailoring functional component performance by design, a methodology is introduced for identifying relevant M&S challenges. This exercise is meant to spur research addressing the specific issue of tailoring functional component performance by design, as well as AMP-related process optimization more generally. A composition abstraction that connects process control with functional performance of the multiscale modeling processes is presented, from both the forward and inverse analysis perspectives. A brief ontology is introduced that describes the ordering of dependency and membership of all components of a model, which serves the purpose of isolating potential challenge areas. An application space where this ontology unfolds is also presented to further elucidate the complexity of the potential challenges. Certain features of AMPs that are usually ignored by the community during modeling are a specific focus. Furthermore, two semantically reduced modeling approaches involving continuum abstractions for the computational domains are presented. The solutions of the relevant system of coupled partial differential equations are used to demonstrate both the positive and negative implications of a series of assumptions routinely made in M&S of AMPs. Finally, a discrete element method model is presented to highlight the challenges introduced by the specific nature of this approach. A closing section highlights the most important