Accepted Manuscript

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PII: S0045-7825(16)30053-6
DOI: http://dx.doi.org/10.1016/j.cma.2016.02.023
Reference: CMA 10855

To appear in: *Comput. Methods Appl. Mech. Engrg.*

Received date: 3 July 2015
Revised date: 4 November 2015
Accepted date: 17 February 2016

Please cite this article as: J.C. Steuben, A.P. Iliopoulos, J.G. Michopoulos, Discrete element modeling of particle-based additive manufacturing processes, *Comput. Methods Appl. Mech. Engrg.* (2016), http://dx.doi.org/10.1016/j.cma.2016.02.023

Discrete Element Modeling of Particle-Based Additive Manufacturing Processes

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Abstract

A critical element for the design, characterization, and certification of materials and products produced by additive manufacturing processes is the ability to accurately and efficiently model the associated materials and processes. This is necessary for tailoring these processes to endow the associated products with proper geometrical and functional features. In an effort to address these needs in a computationally elegant and at the same time physically realistic manner, this paper presents the development of a methodology for simulating particle-based additive manufacturing processes which employs the Discrete Element Method (DEM). The details of the DEM-based methodology are presented first and the approach is demonstrated on a pair of test problems involving laser sintering of metal powders. The paper concludes with a discussion on how this approach may be generalized to broader classes of additive manufacturing systems, and details are given regarding future work which must be accomplished in order to further develop the present methodology.

Keywords: Additive Manufacturing; Layered Manufacturing; Rapid Prototyping; Particle Methods; Discrete Element Methods; Laser Sintering; Laser Accretion; Selective Laser Sintering; Selective Laser Melting; Direct Metal Laser Sintering; Laser Cladding; Laser Engineered Net Shaping; Electron Beam Melting; Direct Metal Deposition; Granular Dynamics; Powder Metallurgy; Multiphysics; Heat Transfer;

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