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Ali Foroozmehr, Mohsen Badrossamay, Ehsan Foroozmehr, Sa'id Golabi

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Finite Element Simulation of Selective Laser Melting Process Considering Optical Penetration Depth of Laser in Powder Bed

Ali Foroozmehr[a], Mohsen Badrossamay[b], Ehsan Foroozmehr[1b], Sa'id Golabi[a]

[a] *Mechanical Engineering Department, Kashan University, Iran*
[b] *Mechanical Engineering Department, Isfahan University of Technology, Isfahan, Iran*

Abstract

A three dimensional finite element model (FEM) is introduced in this work in order to simulate the melt pool size during the Selective Laser Melting (SLM) process. The model adopts the Optical Penetration Depth (OPD) of laser beam into the powder bed and its dependency on the powder size in definition of the heat source. The model is used to simulate laser melting of a single layer of stainless steel 316L on a thick powder bed. The results of the model for the melt pool depth are validated with the experimental results. The model is then used to predict the effect of different scanning speeds on the melt pool depth, width, and length. The results showed that the melt pool size varies from the beginning of a track to its end and from the first track to the next. The melt pool size, however, reaches a stable condition after a few tracks. This concept was used to simplify the process modeling in which reduces the computational costs.

Keywords: Selective Laser Melting, Finite Element Simulation, Optical Penetration Depth, Melt pool size, AISI 316L

1. Introduction

Additive Manufacturing (AM) is referred to technologies that fabricate directly three-dimensional objects in layer-by-layer fashion. Selective Laser Melting (SLM), as one of the powder bed fusion (PBF) AM processes, enables production of complex metallic parts from a CAD model. A schematic of a typical SLM process is depicted in Fig. 1. In this process, in order to deposit powder layers with predefined thickness, an amount of powder comes up to the build table and a roller or blade spreads powder at the build platform. Full dense parts created by scanning a high intensity laser beam in a special pattern and local consolidation of the powder bed in successive layers. A neutral gas flow, usually nitrogen or argon gas, protects molten pool

* Corresponding Author; *Tel:* (+98) 31 3391 5238, *Fax:* (+98) 31 3391 2628,
E-mail address: eforoozmehr@cc.iut.ac.ir

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