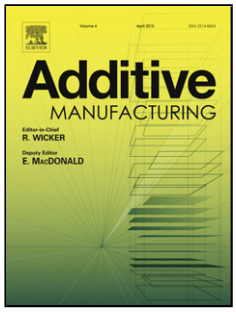

Title: A Modified Method for Estimating Inherent Strains from Detailed Process Simulation for Fast Residual Distortion Prediction of Single-Walled Structures Fabricated by Directed Energy Deposition

Authors: Xuan Liang, Lin Cheng, Qian Chen, Qingcheng Yang, Albert To

PII: S2214-8604(18)30485-8
DOI: https://doi.org/10.1016/j.addma.2018.08.029
Reference: ADDMA 487

To appear in:

Received date: 5-7-2018
Revised date: 17-8-2018
Accepted date: 24-8-2018

Please cite this article as: Liang X, Cheng L, Chen Q, Yang Q, To A, A Modified Method for Estimating Inherent Strains from Detailed Process Simulation for Fast Residual Distortion Prediction of Single-Walled Structures Fabricated by Directed Energy Deposition, *Additive Manufacturing* (2018), https://doi.org/10.1016/j.addma.2018.08.029

A Modified Method for Estimating Inherent Strains from Detailed Process Simulation for Fast Residual Distortion Prediction of Single-Walled Structures Fabricated by Directed Energy Deposition

Xuan Liang, Lin Cheng, Qian Chen, Qingcheng Yang, and Albert To*

Department of Mechanical Engineering and Materials Science, University of Pittsburgh, Pennsylvania 15261

*Corresponding author: albertto@pitt.edu

Abstract

Predicting residual distortion in metal additive manufacturing (AM) is important to ensure quality of the fabricated component. The inherent strain method is ideal for this purpose, but has not been well developed for AM parts yet. In this paper, a modified inherent strain model is proposed to estimate the inherent strains from detailed AM process simulation of single line depositions on top of each other. The obtained inherent strains are employed in a layer-by-layer static equilibrium analysis to simulate residual distortion of the AM part efficiently. To validate the model, depositions of a single wall and a rectangular contour wall models with different number of layers deposited by a representative directed energy deposition (DED) process are studied. The proposed model is demonstrated to be accurate by comparing with full-scale detailed process simulation and experimental results. To make the method practical, a small-scale detailed simulation model is proposed to extract the mean inherent strains. Based on this approach, simulation results applied to the rectangular contour wall structures of different heights show that the modified inherent strain method is quite efficient, while the residual distortion of AM parts can be accurately computed within a short time. The improvement of the computational efficiency can be up to 80 times in some specific cases.

Keywords

Residual distortion; modified inherent strain method; process simulation; directed energy deposition; metal additive manufacturing