ICCES, 2024, vol.30, no.2
DOI: 10.32604/icces.2024.012499

PROCEEDINGS

In-Situ Monitoring of Interplay Between Melt Pool, Spatter and Vapor in Laser Powder Bed Fusion Additive Manufacturing

Xin Lin[1,2,3] and Kunpeng Zhu[1,2,3,*]

[1]Precision Manufacturing Institute, Wuhan University of Science and Technology, Heping Road, Qingshan district, Wuhan, 430081, China

[2]Hubei Key Laboratory of Theory and Application of Advanced Materials Mechanics, Wuhan University of Technology, Heping Road, Qingshan district, Wuhan, 430081, China

[3]Institute of Intelligent Machines, Hefei Institutes of Physical Science, Chinese Academy of Sciences, Huihong Building, Changzhou, 213164, China

[*]Corresponding Author: Kunpeng Zhu. Email: zhukp@iamt.ac.cn

ABSTRACT

This paper reveals the interplay mechanism between melt pool, spattering and vapors, aiming to further improve the forming quality through in-situ monitoring with a CMOS camera. A Residual Network based on Convolutional Block Attention Module and Focal loss function is proposed to extract multi-scale features of single tracks and learn about their behavior changes. A t-SNE clustering analysis is utilized to analysis a large amount of time sequence data on the melt pool by collecting the schlieren photographs. It is found that patterns of unstable melt pool changing corelate to the defects in single tracks, such as, regularity, necking, surface humping, flat-wide and discontinuity. According to signal processing and statistical analysis, the laser powder influences the spatter' angle more than scanning speed in the mode where vapor entertainment acts as the driving force inducing solid spatter ejection. Vapor plume inclines against the scanning direction but alters direction until the line energy exceeds the threshold of 1.5 J/mm.

KEYWORDS

Additive manufacturing; laser powder bed fusion; in-situ monitoring; melt pool; spatter ejection; vapors

Funding Statement: This work was supported in part by the National Natural Science Foundation of China [grant number 52175481] and China Postdoctoral Science Foundation [grant number 2023M743539].X received the grant. https://www.nsfc.gov.cn/; https://jj.chinapostdoctor.org.cn/website/index.html.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.