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X.P. Ding, H.M. Li, G.Y. Wang, H.Z. Cao, Q. Zhang, H.L. Ma

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X.P. Ding[a,b] H.M. Li[b] G.Y. Wang[b] H.Z. Cao[b] Q. Zhang[b] H.L. Ma[b]

[a] State Key Laboratory of Advanced Welding and Joining, Harbin Institute of Technology, Harbin 150001, China

[b] Chongqing Institute of Green and Intelligent Technology, Chinese Academy of Sciences, Chongqing 400714, China

*Corresponding author. Tel.: +86 023 65935771; fax: +86 023 65935583

E-mail address: dingxueping@cigit.ac.cn (X P DING)

Abstract

Infrared (IR) thermography is applied to study the thermal behavior of laser metal-wire additive manufacturing (AM) in vacuum. IR thermal images are obtained and analyzed. Based upon IR thermography analysis, the thermal cycle, remelting and cooling rate in AM process is discussed. In addition, the width of cladding layer is predicted and defect like lack of fusion is detected.

Keywords

Additive manufacturing; IR thermography; Thermal cycle; Defect

1. Introduction

In recent years, additive manufacturing (AM) has got more and more attention in manufacturing industry. As known, AM is one technology that builds three-dimension objects by adding layer-upon-layer of material. According to additive material form, AM could be classified into powder-based and wire-based. Compared to powder-based AM, wire-based AM has the advantage of higher material usage efficiency, higher deposition rate, lower cost, less pollution and et al [1]. Therefore, development of wire-based AM is very potential and meaningful. In this study, laser metal-wire additive manufacturing is researched. Experiments are performed in vacuum.

As known, AM is one hot-working process and the temperature distribution and history of cladding region is important for investigating metallurgical phenomena and properties. Therefore, it is meaningful to study the thermal behavior during AM. Nowadays, many studies have been done for powder-based AM but little study for wire-based AM [2-5]. Therefore, in this paper, we focus on the study for thermal behavior of laser metal-wire AM in vacuum using IR thermography.

2. Experimental procedure

The experiment system consists of laser system, wire feeding system, motor system, vacuum system and temperature measurement system. The schematic of experiment system is shown in Fig.1. The used laser source is a continuous wave fiber laser with wavelength of 1080nm, diameter of 0.8mm and maximum power of 200W. The metal wire is feeding vertically downward. The angle between the laser axis and the wire axis is 45°. In the motor system, the laser head combined with wire feeder head achieve *x*-axis and *y*-axis motion and the substrate moves along *z*-axis. For providing vacuum environment, a mechanical pump is equipped. In temperature measurement system, the IR thermography used is FLIR ThermalCAM A655sc imaging system. It has a 640*480