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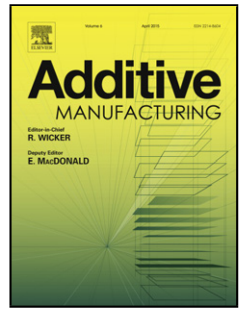

Title: In situ surface topography of laser powder bed fusion using fringe projection

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<AT>In situ Surface Topography of Laser Powder Bed Fusion Using Fringe Projection

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<ABS-HEAD>Abstract

<ABS-P>Being able to characterize the process signatures of powder bed based additive manufacturing process is key to improving the product quality. This paper demonstrates the implementation of a digital fringe projection technique to measure surface topography of the powder bed layers during the fabrication. We focus on developing the metrology tool and observing the types of information that can be extracted from such topographical data. The performance of the system is demonstrated with selected in situ measurements. Experimental results show this system is capable of measuring powder bed signatures including the powder layer flatness, surface texture, the average height drop of the fused regions, characteristic length scales on the surface, and splatter drop location and dimension.

<KWD>Keywords: Additive manufacturing; fringe projection; powder bed fusion; in situ metrology; surface topography.

<H1>1. Introduction

Metal additive manufacturing has been developing rapidly over the past few decades. The quality of parts generated by the metal additive process has improved dramatically, but has reached a limit using the trial and error approach. The key to overcome this limit is in situ monitoring of the process signatures [1]. In situ measurements will add to our knowledge about the physics behind additive processes and expedite process development that leads to improved material and structural properties. Real-time monitoring also allows for possible feedback control to compensate or correct detected errors, or abort continued construction of defective parts.

The majority of research on in situ metrology of Laser Powder Bed Fusion (LPBF) additive processes focuses on two types of sensors – thermographic sensors and high-resolution imaging sensors. Thermographic sensors are useful for on-line monitoring of temperature related signatures, including real time melt pool dimensions, temperature profile, temperature history, as well as other factors [2–5]. High resolution imaging sensors are mostly used for evaluation of geometric features and identification of defects in each build layer [6,7]. Both of these sensors are limited to two dimensions. Investigations on in situ measurement of layer-wised surface