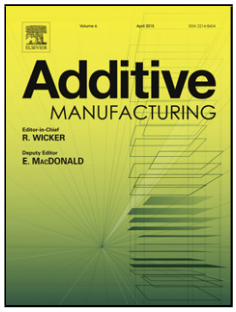

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Quantitative texture prediction of epitaxial columnar grains in additive manufacturing using selective laser melting7

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Highlights

- A texture prediction method was proposed for epitaxial columnar grains in SLM.
- The texture prediction method was combined with the melt pool prediction.
- Process and microstructure were linked quantitatively for the metal SLM AM process.
- Texture evolution with the number of layers for SLM AlSi10Mg was simulated.
- The simulated texture showed pattern and intensity similar to experiment results.

Abstract

Metal additive manufacturing (AM) such as selective laser melting (SLM) has the powerful capability to produce very different microstructural features, hence different mechanical properties in metals using the same feedstock material but different values of process parameters. However, the relation between processing-microstructure is mostly investigated by experiments, which is expensive and time-consuming since the parameter space is quite large. The lack of a reliable theoretical model of the processing-microstructure relationship of AM material is preventing AM technology from being widely adopted by the manufacturing community. Hence, the goal of this work is to establish the link between the microstructure (texture) and the process parameters (laser power, scanning speed, preheat and scanning strategy) of a metal SLM process. To achieve the above goal, a quantitative semi-empirical method is proposed to predict the texture of the epitaxial columnar grains grown from polycrystal substrates. Combined with the melt pool prediction by the Rosenthal solution, the processing and microstructure were linked together quantitatively. The proposed method is used to estimate the texture evolution with the number of layers for EOS-DMLS-processed AlSi10Mg (unidirectional scanning direction in one layer and no rotation of scanning direction between layers). The texture reaches a steady state after five layers, and the steady state texture has similar pattern and intensity to that obtained from the experiment using the same process parameter values and scanning strategy.

Keyword: additive manufacturing; selective laser melting; texture; microstructure

1. Introduction

Selective laser melting (SLM) is a powder bed fusion metal AM technique that utilizes a moving laser beam to melt the powder particles in each layer selectively, which leaves behind metallic layers joined together to form the desired geometry [1, 2]. Previously, optimization of the process parameters was predominately for the goal of minimizing the porosity [3]. For metallic structural components, the