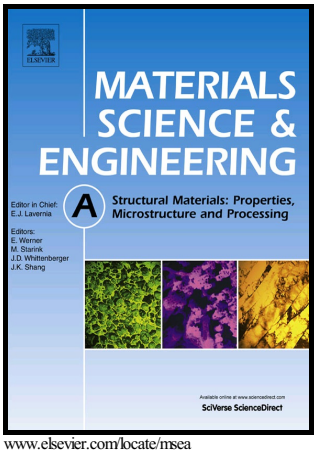
# Formation mechanism of the α variant and its influence on the tensile properties of laser solid formed Ti-6Al-4V titanium alloy

Zhuang Zhao, Jing Chen, Xufei Lu, Hua Tan, Xin Lin, Weidong Huang




www.elsevier.com/locate/msea

PII: S0921-5093(17)30325-8
DOI: http://dx.doi.org/10.1016/j.msea.2017.03.035
Reference: MSA34818

To appear in: *Materials Science & Engineering A*

Received date: 23 December 2016
Revised date: 5 March 2017
Accepted date: 7 March 2017

Cite this article as: Zhuang Zhao, Jing Chen, Xufei Lu, Hua Tan, Xin Lin and Weidong Huang, Formation mechanism of the α variant and its influence on the tensile properties of laser solid formed Ti-6Al-4V titanium alloy, *Material Science & Engineering A,* http://dx.doi.org/10.1016/j.msea.2017.03.035

# Formation mechanism of the α variant and its influence on the tensile properties of laser solid formed Ti-6Al-4V titanium alloy

Zhuang Zhao, Jing Chen*, Xufei Lu, Hua Tan, Xin Lin, Weidong Huang

*(State Key Laboratory of Solidification Processing, Northwestern Polytechnical University, Youyi Western Road, Xi'an, Shaan Xi 710072, People's Republic of China;*

*Key Laboratory of Metal High Performance Additive Manufacturing and Innovative Design, MIIT China, Northwestern Polytechnical University, Youyi Western Road, Xi'an, Shaan Xi 710072, People's Republic of China)*

**Abstract:** Laser solid forming (LSF) is a newly developed additive manufacturing which offers a less material waste and reduction in lead-time for fabricating aerospace titanium alloys components. In this paper, two types of block with different build dimension (section geometries) were fabricated by LSF with same processing parameters. The corresponding microstructure, texture, and tensile properties were investigated systematically. The results show that the samples exhibits similar columnar β grains morphology and <100> fiber texture, but very different α variant characterizations (morphology and texture) due to the different thermal history they experienced respectively. The fine basket-weave microstructure with weak texture can be obtained under the fast cooling conditions, while the colony microstructure shows a strong transformation texture as a result of variant selection in the relative slow cooling rate. The α characterizations depend strongly on the competition growth mechanism between the $\alpha_{WGB}$ (grin boundary Widmanstatten structure) and $\alpha_I$ (intragranular α nuclei) during cooling process. The presence of $\alpha_{GB}$ (grain boundary α layers) enhances the nucleation of certain variants in β→α phase transformation. Tensile results reveal that fine basket-weave microstructure has relative high strength and ductility with dimple fracture mode. The colony microstructure shows a feature of dominant brittle fracture appearance and results in low tensile ductility.

*Key words: Microstructure characterization, α variant, Tensile properties, Laser solid forming, Ti-6Al-4V titanium alloy*



## 1. Introduction

Laser solid forming (LSF) is one kind of additive manufacturing technology to fabricate three dimensional metallic components with complex structure[1-3]. The attraction of industry to LSF is that it can be used for near-net shape fabrication of expensive aerospace components without substantial machining, resulting in a less

* Corresponding author. Tel.: +86 029 8846 0801; fax:+86 029 8849 5106
e-mail: phd2003cjj@nwpu.edu.cn