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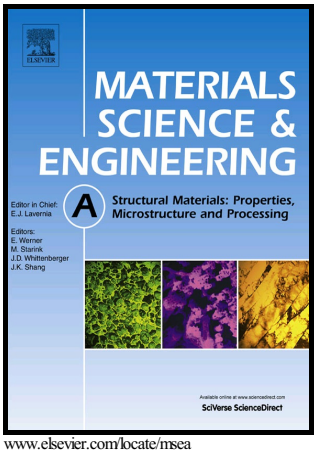

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PII: S0921-5093(18)30542-2
DOI: https://doi.org/10.1016/j.msea.2018.04.045
Reference: MSA36365

To appear in: *Materials Science & Engineering A*

Received date: 16 February 2018
Revised date: 6 April 2018
Accepted date: 10 April 2018

Cite this article as: Sharniece Holland, Xiaoqing Wang, Xiaoying Fang, Yuebin Guo, Feng Yan and Lin Li, Grain Boundary Network Evolution in Inconel 718 from Selective Laser Melting to Heat Treatment, *Materials Science & Engineering A,* https://doi.org/10.1016/j.msea.2018.04.045

Grain Boundary Network Evolution in Inconel 718 from Selective Laser Melting to Heat Treatment

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Abstract

Inconel 718 fabricated by selective laser melting (SLM) was used to investigate the evolution of grain boundary (GB) network structures from as-SLM to heat-treated (HT) samples. Using electron backscatter diffraction (EBSD) data and percolation theory based cluster analysis, GB character distribution and GB network topological metrics were computed at different build locations and directions. The microstructures of the as-SLM samples reveal large spatial heterogeneity in grain morphology and are dominated by general GBs (*i.e.*, $\sum$ >29), which form one connected cluster spanning across the whole GB network. Heat-treatment homogenizes the microstructure and leads to the formation of annealing twins as a result of recrystallization, which dramatically increases the number of special boundaries (mainly twin $\sum$ 3 and twin-related $\sum$ 9, $\sum$ 27 boundaries with ~ 60 % in boundary length fraction). However, these special boundaries have not yet fully connected/merged to form a percolated path throughout the GB network. The triple junction distributions of the HT sample are dominated by J_1-type that consists of one special and two general boundaries, further confirming the interweaving GB network made of the general and special boundary clusters. In addition, the implication of applying GB engineering to the SLMed parts is discussed based on the comparison of GB network structures between the SLMed alloys and the conventionally GB engineered metals and alloys.

Keywords: Inconel 718, selective laser melting, microstructure, grain boundary, network, grain boundary engineering