Multi-Laser Powder-Bed Fusion

R. Aswathanarayanaswamy [1], L. Howlett[1], R. Jones[1], H. Wong[2], K. Dawson[2], C. Sutcliffe[1,2]

1- Renishaw Additive Manufacturing Product Division Stone Staffordshire, ST15 0SH

2- School of Engineering, University of Liverpool, L69 3GH

Corresponding author: Chris.Sutcliffe@renishaw.com

Production rate is an important factor in metal Additive Manufacturing (AM) throughout industry. We have developed three laser system arrangements: (1) Laser Powder Bed Fusion (L-PBF) – one laser system in operation, (2) Single-Multi L-PBF (SM-L-PBF) – multiple laser systems where one laser manufacture one component, and (3) Multi-Multi L-PBF (MM-L-PBF) – multiple laser systems where any laser systems can manufacture any components. In this study, the L-PBF and SM-L-PBF arrangements were used to produce test specimens from Inconel 625 powder. Stress relieving heat treatment was conducted on As-Built (AB) specimens. Both AB and Heat-Treated (HT) specimens were subsequently tested for density, microstructure, tensile strength and hardness. Results indicate that heat treatment increases specimen ductility without compromising other mechanical properties. SM-L-PBF has shown an increase in the build rate of 2.55 times when compared to L-PBF, with little to no compromises in specimen mechanical properties. Due to improvements in chamber gas flow, both L-PBF and SM-L-PBF specimens have densities over 99.99%, significantly greater than that reported in literature [1]. The observed tensile properties exceed the ASTM requirements for Inconel 625 [2,3]. Average specimen hardness [4] and grain size [5] are of the same order to that reported in the literature. This study has demonstrated that, a multi-laser system opens up opportunities to increase SLM build rate in an industrial setting, without compromising specimen mechanical properties.

[1] A.B. Spierings et al (2015) Processing ODS-Modified In625 using SLM, Proceeding of Solid Freeform Fabrication Symposium
[2] ASTM B564-17a, Standard Specification for Nickel Alloy Forgings
[3] ASTM B446-03, Standard Specification for UNS N06625, UNS N06219 and UNS N06650 Rod and Bar
[4] N. Harrison (2016) SLM of Nickel Superalloys: Solidification, Microstructure and Material Response, PhD Thesis, University of Sheffield
[5] C. Li et al (2017) Microstructure Evolution Characteristics of Inconel 625 Alloy from Selective Laser Melting to Heat Treatment, Journal of Materials Science and Engineering A 705 (2017) 20-31