Numerical modeling and experimental characterization for mechanical properties of metallic parts fabricated by selective laser melting processes

†*Xue Wang[1], Liping Zhao[2] and Heow Pueh Lee[1]

[1]Department of Mechanical Engineering, National University of Singapore, Singapore.
[2]National Metrology Centre, 1 Science Park Drive, Singapore 118221.

†*Presenting and corresponding author: mpewax@nus.edu.sg

Abstract

As a well-known additive manufacturing technique, selective laser melting (SLM) process has demonstrated growing applications in various industrial fields due to its capability of fabricating metallic parts with complex geometries and ability of handling wide ranges of materials. During SLM process, a computer-controlled laser beam is implemented on a powder bed platform to selectively melt and bond a thin layer of the metallic powder into a designed slice of solid. Subsequently, additional layers of powder are applied on top of the previously created solid slice, solidified by the selective laser scanning and bonded to the processed layers such that the entire product is successively built in a layer-by-layer manner.

In such a SLM technique, specific configurations of process parameters such as laser power and scanning speed affect significantly microstructure of the fabricated product, resulting to distinct macroscopic mechanical performance [1-2]. To bridge the microscopic and macroscopic behavior, the present study develops a finite element model to evaluate the mechanical properties of the SLM fabricated parts by taking into account the microstructural details as functions of process parameters. The numerical results are validated by the mechanical properties of SLM parts experimentally characterized following ASTM test guidelines. The proposed model could benefit the material development process by providing estimated mechanical properties of parts fabricated by various SLM process parameters without experimental cost.

Keywords: Selective laser melting (SLM), numerical modeling, microscopic and macroscopic behavior.

References

[1] Ahmadi, A., Mirzaeifar, R., Moghaddam, N. S., Turabi, A. S., Karaca, H. E., & Elahinia, M. (2016) Effect of manufacturing parameters on mechanical properties of 316L stainless steel parts fabricated by selective laser melting: A computational framework, *Materials & Design* **112**, 328-338.

[2] Wei, K., Gao, M., Wang, Z. and Zeng X. (2014) Effect of energy input on formability, microstructure and mechanical properties of selective laser melted AZ91D magnesium alloy, *Materials Science and Engineering A* **611,** 212-222.