Thermal process modelling of lattice materials during powder bed fusion

Can Ayas

Delft University of Technology
Mekelweg 2, 2628 CD, Delft, The Netherlands
e-mail: c.ayas@tudelft.nl

ABSTRACT

3D printing, or additive manufacturing (AM), recently became a direct mean of production in order to benefit from the design freedom and customizability that are inherent to the printing process. Powder bed fusion (PBF) is a promising additive manufacturing process suitable for producing metallic parts in biomedical and aerospace applications. It is especially suitable for producing so called lattice materials which are lightweight repetitive porous structures made up of slender struts.

During PBF process of micro-lattice materials a three-dimensional network of struts are formed by selectively melting and solidification with a laser beam scanning over a metallic powder bed. However, in PBF often a constant laser power density is used during the build process. For some geometries, this can lead to local overheating of the powder, which may cause the metal to evaporate or formation of an excessively large melt pool. Conversely if local under-heating takes place continuous struts may not form which virtually vanishes the mechanical performance of the resulting lattice material. In order to predict potential over/under-heating for a given unit cell topology, models needs to be developed for lattice materials. In this paper we extend the thermal simulation of the build process has been developed for bulk components [1] to lattice materials. For that purpose, a moving boundary problem is formulated for the evolution of the lattice geometry and thermal history. The advantage to be exploited is to keep the number of degrees of freedom fixed during the build process. A thermal load is applied to the top of a growing strut and thermal history is analysed. The orientation of struts with respect to the build direction and their connectivity are investigated by means of quantifying the resulting ratio of time scales between the growth and thermal conduction.

REFERENCES

[1] Y. Yang, M.F. Knol, F. van Keulen, C. Ayas, "A semi-analytical thermal modelling approach for selective laser melting", *Additive Manufacturing*., Vol. **21**, pp. 284-297, (2018).