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Thermal simulation of scanning paths in LBM additive manufacturing

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ABSTRACT

The process of Laser Beam Melting (LBM) is a technique of direct manufacturing that uses a laser with a high power to melt the powder, according to scanning paths. During this process, the achieved temperatures in local areas could generate significant thermal gradients. These gradients lead to the apparition of residual stresses that affect the mechanical characteristics of the part and may cause deformations, as well as micro and macro cracks due to the cooling of the part [1].

In this context, scanning paths play a major role in the fusion and solidification of the material and therefore of the part. For that reason, it is necessary to validate the generation of trajectories considering the thermal behaviour induced by this process.

The purpose of this communication is to define and use an analytical thermal 2D model that allows the analysis of the laser trajectories in each layer, in an efficient way.

The proposed approach consists, first, in applying impulsive temperature excitations along the scanning path and then, in summing the thermal conduction effects in the material in order to calculate the distribution of the temperature field over the whole surface, at each time step.

The developed model was validated in the case of the Ti6Al4V alloy through a comparison with a finite element thermal simulation of industrial software. The proposed method was then implemented to analyze trajectories commonly used in the literature and industry.

The results of the analysis show that the scanning paths have an effect on the thermal behaviour during manufacturing. Indeed, they can cause the appearance of overheated zones that may generate several defects in the part. Thus, this study highlights the importance of optimizing the scanning paths to homogenize the thermal distribution and reduce the residual stresses.

The thermal simulation model will be used to synthesize the scanning paths in the future.

REFERENCES

- [1] Foroozmehr, E. and Kovacevic, R. *Effect of path planning on the laser powder deposition process: thermal and structural evaluation*. The international Journal of Advanced Manufacturing Technology. (2010) **51**:659-669.