Three-dimensional thermomechanical simulation of EBM process

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ABSTRACT

Due to the complexity of the physics, many models presented in the literature for Electron Beam Melting (EBM) simulations are considering thermal aspects only [1]. However, heat transfer may be affected by the change of the material properties during the melting and the cooling phases. Therefore, uncoupled thermal models may not be well adapted for predicting the melt zone.

In this work, an improved but still rather simple computational analysis is presented for a more detailed prediction of EBM process outcomes. A coupled thermomechanical analysis is developed in which nonlinearities due to the variation of material properties when the material melts are considered. The thermal expansion and the shrinkage of solid material during heating and cooling and the stress formation within the solid material are modelled. Particularly, a new analytical formulation is introduced to account for physical aspects such as powder layer shrinkage during the melting phase. Ti6Al4V has been considered for preliminary validation of the model by comparisons between experimental and numerical results. A novel experimental setup [2] is used in which several single line tracks are melted using both continuous and MultiBeamTM strategies. The model response was evaluated by comparing calculated widths and heights of the melted line with the microscope images of the cross section of the lines. Comparisons between the pure thermal and coupled thermomechanical models are also presented.

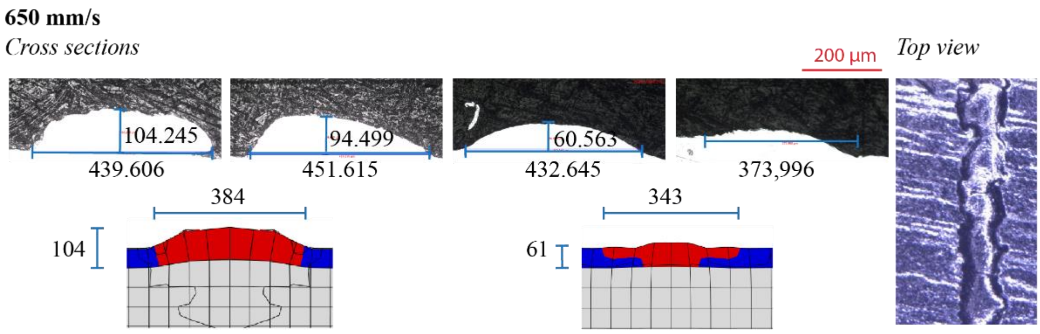

Figure 1 Comparison between experimental and numerical results in the case of MultiBeam™.

REFERENCES

[1] Galati, Manuela, and Luca Iuliano. "A literature review of powder-based electron beam melting focusing on numerical simulations." *Additive Manufacturing* Vol.**19**, pp. 1-20 (2018)

[2] Galati, Manuela, Anders Snis, and Luca Iuliano. "Experimental validation of a numerical thermal model of the EBM process for Ti6Al4V." *Computers & Mathematics with Applications* (2018)