Applications of Finite Element Simulations in Additive Manufacturing Process Control

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Key Words: *laser powder bed fusion, additive manufacturing, phase change, melt pool monitoring, real time control, experimental validation*

ABSTRACT

Modelling and simulations in additive manufacturing (AM) technologies have seen an exponential growth over recent years in terms of both accuracy and efficiency. In this work, we propose the validation of a numerical model suitable to simulate heat transfer problems and its application to AM process control.

In particular, we first present the validation of a phase-change heat transfer model suitable to simulate laser powder bed fusion (LPBF) processes [1]. Experimental measurements are obtained on the Additive Manufacturing Metrology Testbed, an LPBF machine located at the National Institute of Standards and Technology (NIST) for a Nickel-alloy (IN625) bare plate. Once validated the numerical model is used for two different applications, showing the possibilities and the mutual benefits of an interaction between experiments and numerical simulations. The first application consists of a parameter optimization study for residual heat factor control algorithm [2]. We aim at predicting the optimal control parameters given a specific scan strategy in order to minimize melt pool variations throughout the overall process and in particular in critical regions (e.g. geometric features). The second application instead presents an innovative methodology for real-time process control [3], where by means of a reverse measurement technique we are potentially able to adjust *on-the-fly* the machine parameters to control the melt pool variations. In particular we can monitor the melt pool shape during the entire process comparing the thermal camera signals directly with the predicted numerical results.

References

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