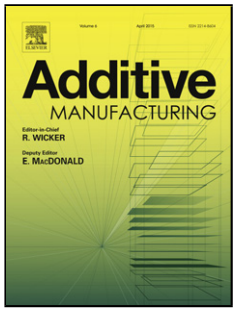

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NUMERICAL MODELLING AND EXPERIMENTAL VALIDATION IN SELECTIVE LASER MELTING

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Abstract. In this work a finite-element framework for the numerical simulation of the heat transfer analysis of additive manufacturing processes by powder-bed technologies, such as Selective Laser Melting, is presented. These kind of technologies allow for a layer-by-layer metal deposition process to cost-effectively create, directly from a CAD model, complex functional parts such as turbine blades, fuel injectors, heat exchangers, medical implants, among others. The numerical model proposed accounts for different heat dissipation mechanisms through the surrounding environment and is supplemented by a finite-element activation strategy, based on the born-dead elements technique, to follow the growth of the geometry driven by the metal deposition process, in such a way that the same scanning pattern sent to the numerical control system of the AM machine is used. An experimental campaign has been carried out at the Monash Centre for Additive Manufacturing using an EOSINT-M280 machine where it was possible to fabricate different benchmark geometries, as well as to record the temperature measurements at different thermocouple locations. The experiment consisted in the simultaneous printing of two walls with a total deposition volume of 107 cm^3 in 992 layers and about 33,500 s build time. A large number of numerical simulations have been carried out to calibrate the thermal FE framework in terms of the thermophysical properties of both solid and powder materials and suitable boundary conditions. Furthermore, the large size of the experiment motivated the investigation of two different model reduction strategies: exclusion of the powder-bed from the computational domain and simplified scanning strategies. All these methods are analysed in terms of accuracy, computational effort and suitable applications.

Keywords: Additive Manufacturing (AM) process, Metal Deposition (MD) process, powder-bed technologies, Selective Laser Melting (SLM), Finite-element (FE) modelling, Heat transfer analysis.

Contents

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