Numerical modelling of Selective Laser Melting in Additive Manufacturing and its experimental validation

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ABSTRACT

This work presents the computational strategy adopted for the numerical simulation of the Selective Laser Melting (SLM) technology used in Additive Manufacturing (AM).

SLM is used to fabricate industrial components by powder bed technology in a layer-by-layer manner. Hence, firstly the CAD geometry is sliced, and later, the scanning sequence is generated to allow for the selective melting of the different sections of the sliced geometry.

The SLM machine makes use of a high power laser beam for the powder melting, while Titanium-64 powder is our reference material.

The objective of this work consists of: (i) assessing the inherent shrinkage method to reproduce the manufacturing process in a layer-by-layer manner; (ii) calibrating the model parameters according to the experimental evidence provided by IK4-LORTEK.

The transient coupled thermomechanical analysis defined for the high-fidelity simulation of the AM process [1,2] is replaced by a faster sequence of quasi-static mechanical computations according to the metal deposition in the building sequence. The scanning path is not faithfully reproduced; instead, a layer-by-layer strategy is adopted. This is feasible because, compared to other available AM technologies (e.g. wire-feeding or blown powder), the scanning speed is much faster (almost 10 times) and the power source used for the melting process is much smaller (almost 10 times). Hence, the laser spot and the corresponding Heat Affected Zone (HAZ) is much smaller and the cooling process much faster than for other manufacturing technologies. Avoiding the transient thermal analysis, the thermal stresses are computed by defining an inherent strain field as a function of the material shrinkage and the process parameters that characterise the manufacturing process.

The solution strategy proposed is calibrated by the experimental work carried out at IK4-LORTEK, where the distortions and residual stresses induced by the manufacturing process are measured for a number of samples.

REFERENCES

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