Prediction of thermo-physical properties and tensile strength of AlSi10Mg using Phase-Field method and Calphad data

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ABSTRACT

During a Selective Laser Melting (SLM) process, applied thermal cycles and solidification velocities are considerablyincreasedwhen compared to ordinary directional solidification. That results in a very fine cellular-dendritic, out-of-equilibrium and inhomogeneous microstructure. Indeed, the SLM process can be described as a highly non-linear problem depending on various phenomena such as heat transfer, fluid flow, moving boundaries and crystalline anisotropy [1].

AlSi10Mg alloy additively manufactured is widely used in automotive and aerospace.The prediction of its long-term behavior is of interest and strongly linked to its original state after solidification and heat treatment.Standard analytical methods are not enough to assess the mechanical and thermo-physical properties of the formed microstructure. The aim of this work is to apply a phase-field method combined with Calphad calculations to predict these properties after a heat treatment applied on the as-built sample as a stress release operation.

The implemented phase-field model is based on Kim-Kim-Suzuki model [1] for the expression of the free energy as a function of the chemical composition. Moreover, the elastic energy in the system due to the volume misfit between the precipitates and the matrix is hereconsidered. Its results are post-processed to provide thermo-physical properties and mechanical properties.

These values based on predictionsare compared to the ones deduced fromexperimental measurement in particular differential scanning calorimetry (DSC), dilatometry, laser flash diffusivimetry (LFA) and micro or nano-indentation. Once validated, themethodology will offer a quick and efficient prediction for different thermal post treatments.

REFERENCES

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