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Numerical Analysis of Wire Laser Additive Manufacturing for Low Carbon Steels+

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Abstract : This work explores the benefit of the thermo-metallurgical simulation to tackle the Wire Laser Additive Manufacturing (WLAM) of low-carbon steel components. The Finite Element Analysis is calibrated by process monitoring via thermal imaging and thermocouples measurements, to study the complex thermo-metallurgical behavior inherent to the WLAM process of low carbon steel parts.A critical aspect is the analysis of the heterogeneity in the resulting microstructure. This heterogeneity depends on both the thermal history and the residual stresses experienced during the WLAM process. Because of low carbon grades are highly sensitive to quenching, a high-gradient microstructure often arises due to the layer-by-layer metal deposition in WLAM. The different phases have been identified by scanning electron microscope. A clear influence of the heterogeneities on the final mechanical performance has been established by the subsequent mechanical characterization. The thermo-metallurgical analysis has been used to determine the actual thermal history and the corresponding thermal gradients during the printing process. The correlation between the thermos-mechanical evolution, the printing parameters and scanning sequence has been established. Therefore, an enhanced printing strategy, including optimized process window has been used to minimize the microstructure heterogeneity at ArcelorMittal.

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