Contribution ID: **28** Type: **Oral Presentation**

L-PBF process parameter optimization for thin structures

Wednesday, 18 September 2024 12:10 (20 minutes)

Laser Powder Bed Fusion (L-PBF) technology offers the capability to manufacture a diverse range of components and features, which span from thin or hollow structures to massive elements. Typically, the primary parameters in the L-PBF process, such as laser power, scan speed, and hatching distance, are optimized for components with significant print areas, which can be divided into core and border regions. Nevertheless, L-PBF technology also empowers the creation of intricate lattice structures, based on the repetition of thin struts and nodes or thin curved surfaces. In the case of thin structures, the printed area's width often falls below 10 times the meltpool width, potentially resulting in a notable increase in material porosity or surface roughness.

In the present work, the effects of the laser scanning parameters and the scanning strategy on the material density, microstructural features, and surface roughness were experimentally investigated. A wide set of process parameters and scanning strategies has been developed. Thin planar specimens, having a section angled 60° to the baseplate and a vertical one, were printed. The surface roughness of the vertical and angled surfaces was measured using an optical profilometer. The material microstructure and the local surface irregularities were investigated through metallographic sections containing the specimen build direction. The most promising process parameter sets were validated through a specifically devised specimen, which consisted of a sinusoidal-shaped thin foil, built in the vertical direction. It presented a series of upward- and downward-facing surfaces with an angle ranging from 90° to 10° to the baseplate.

The correlations between the scanning strategy, energy density, surface roughness, and material porosity were finally obtained. It allowed us to define a robust strategy for the process parameters optimization in the case of thin structures.

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Session Classification: Laser Melting, Electron Beam Melting & Direct Energy Deposition Processes

Track Classification: Laser Melting, Electron Beam Melting & Direct Energy Deposition Processes