The Influence of Build Parameters on the Collapse Behaviour of a Highly Porous, Random, Open-Cell Lattice 3D Printed from IN718 Alloy

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Modern additive manufacturing (AM) strategies increasingly focus on optimizing process parameters in order to balance production efficiency with the mechanical performance of complex geometries. In this context, particular attention is given to structures with an extremely high volumetric porosity of 96% and ligament diameters ranging from 0.4 to 1.2 mm, whose collapse behaviour is especially sensitive to microstructural defects and phase distribution. This study investigates the influence of Selective Laser Melting (SLM/PBF-LM) build parameters on the mechanical response of High-Porosity Random Open-Cell Lattices (HPROCL) fabricated from Inconel 718 (IN718) alloy using a Renishaw AM 250 system [1].

Two distinct sets of build parameters, designated as Set A and Set B, were evaluated to assess the effect of processing conditions on the collapse behaviour of the lattice while reducing build time and microporosity. For the standard configuration (Set A), a laser power of 200 W was employed, with energy densities ranging from 2.2 to 5.5 J/mm^2 for volume scanning and from 0.6 to 3.1 J/mm^2 for surface layers. In contrast, the modified configuration (Set B) utilized a lower laser power of 175 W, with energy densities of 1.9 to 4.9 J/mm2 for the volume and 4.5 to 6.4 J/mm^2 for the surface. The resulting structures were then subjected to quasi-static (MTS) and dynamic (DIHPB [2]) compression at loading velocities of 2.5×10^{-5} m/s and 10 m/s, respectively. Dynamic impacts reached nominal strains above 0.5, with collapse mechanisms and failure modes captured via synchronized DIC and high-speed imaging (HSC).

The results confirm that appropriate adjustment of SLM/PBF-LM build parameters can enhance both manufacturing efficiency and the collapse resistance of highly porous IN718 lattice structures.

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