Mechanical properties of selective laser melted aluminium alloy AlSi10Mg: from bulk to thin structures

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Nowadays, additive manufacturing (AM) of metallic parts is increasingly considered as a viable manufacturing process for industrial sectors with stringent quality criteria. More specially, the growing development of this recent manufacturing technology attracts increasing interest in aeronautic applications. The AM technology facilitates the processing of complex designs and lightweight parts. Among the existing AM technologies, the selective laser melting (SLM) technology consists in the layer-by-layer local melting of a metallic powder by a laser heat source. In the present work, this SLM technology is used to process AlSi10Mg bulk and thin structures (including lattice structures).

The low ductility and low fatigue life of the parts is the main issue to be solved when applying this technology to critical structures. Their very high strength compared to cast alloys of the same composition is clearly an asset of the technology. This high strength is due to a very fine Si rich network that should be maintained in post-treatment. The lack of post-necking deformation and fatigue life is due to large porosities in the bulk that are initial sites for failure. In addition, the poor fatigue life is also due to a significant surface roughness favoring early fatigue crack initiation. The modification of the process parameters and in particular the order of scanning of thin structures can significantly improve the surface roughness. For treating the large bulk porosity, the use of post-treatments are reliable solutions for the improvement of the fatigue life of AM parts. The challenge is that heat treatments may also be sources of large porosities.

Lattice structures are interesting structures for lightweight design. The production of AlSi10Mg structures by additive manufacturing is however challenging due to the heterogeneous nature of the thermal field resulting in heterogeneities of porosities and microstructure. Again, the solution is a better control of the process parameters as a function of the geometry.