Enhancement of the mechanical behavior of L-PBF Al alloys by optimized thermo(mechanical) post-processing routes

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Laser Powder Bed Fusion (L-PBF) processed AlSi10Mg is known for having high strength but low ductility behavior, with the interconnected Si network being the initiation point of damage. In this work, various thermomechanical post-processing treatments have been envisaged to tailor the microstructure and the mechanical properties of AlSi10Mg processed by L-PBF: heat-treatments and friction stir processing are compared to hot isostatic pressing. Both the static and fatigue properties were investigated. In-depth microstructural and damage analyses complete the study.

On the one hand, optimized stress relieve heat-treatments (SRHT) allow to reach larger ductility thanks to a (partial) globularisation of the Si phase. Depending on the temperature and duration of the SRHT, a compromise is reached between high strength and large ductility.

On the other hand, Friction Stir Processing (FSP) of L-PBF AlSi10Mg brings locally globularised Si particles, homogenized microstructure and lower porosity levels. While the resulting tensile behavior is similar after FSP and after SRHT, the fatigue life is promisingly improved after FSP.

Besides AlSi10Mg, the work focuses on Scalmalloy® in which the presence of Sc and Zr paves the way for hardening treatments through the precipitation of $Al_3(Sc,Zr)$ particles. This alloy presents intrinsically better mechanical properties than the conventional L-PBF Al-Si alloys. Both heat-treatments and FSP post-treatments were studied and optimized in order to improve the fatigue life of L-PBF Scalmalloy® without jeopardizing its static performances.