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Multiaxial static and fatigue strength of LPBF-manufactured AlSi10Mg in as-built and T6 conditions

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Laser powder bed fusion (LPBF) technology has now reached a significant level of commercial maturity, offering some of the most reliable solutions in the additive manufacturing (AM) field. Components are manufactured for sectors, such as automotive and aerospace, that require high performance levels as well as critical quality standards. However, AM processes introduce defects that result in high variability of mechanical properties and low reproducibility. This entails the need to thoroughly understand the behaviour of the materials used, studying their response to the different types of stresses typical of real-world applications. The research activity presented is based on the analysis of the mechanical properties of the aluminium alloy AlSi10Mg, which is widely used due to its good strength-to-density ratio. Since the heat treatment applied is among the factors that most influence the mechanical characteristics and the presence of defects in AM components, focus is put on the comparison between the as-built condition and T6 heat treatment, composed by a solution phase followed by quenching and artificial ageing. Static tensile and torsion tests are initially carried out to determine the material's ultimate tensile strength and ductility, and further laboratory tests are performed to analyse the variation of surface roughness due to different printing orientations, relative density and hardness (Brinell tests). Real components often experience cyclic loading conditions during their service life: for this reason, the experimental campaign focuses on the characterisation of fatigue behaviour, both uniaxial with tension-compression load cycles and multiaxial with axial/torsional in-phase load cycles. For each case study, the chosen load ratio is R = -1 and the objective is to determine the trend of the S/N curves in the range of high number of life-cycles.

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