Role of microstructure on mechanical anisotropy in additively manufactured AlSi10Mg alloy

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Additive manufacturing (AM) of aluminum alloys is being considered as an attractive process to manufacture light-weight automotive components. Among the various Al alloys, hypoeutectic Al-Si-Mg alloys are being widely used due to their combination of good castability and mechanical properties up to elevated temperatures (≤ 250°C). Typically, these alloys derive their strength from the homogenous distribution of eutectic phases across the microstructure. During additive manufacturing, the prevailing thermal cycles across the solidifying melt pools lead to the stabilization of columnar microstructures with heterogeneous distribution and morphology of eutectic phases. These inherent microstructural features result in anisotropy in the mechanical properties of additively manufactured aluminium components.

In this study, efforts were made to understand the anisotropy in the mechanical properties of additively manufactured AlSi10Mg alloy as a function of build orientations. Tensile specimens were manufactured by using a laser powder bed fusion method under various orientations with respect to build directions. Subsequently, a monotonic uniaxial tensile test was carried out at a strain rate range of 10^{-5} to 10^{-1} s^{-1} at room temperature. Post-deformation microstructural characterization was carried at various levels to understand the role of microstructure on deformation behaviour. An attempt was made to correlate the experimental results with the dispersion hardening models to elucidate the role of eutectic phases and their orientation distribution on the mechanical properties.

Keywords: AlSi10Mg, Additive manufacturing, Deformation, Hypoeutectic alloys, Anisotropy