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Rate controlling mechanisms in the deformation of additively manufactured SS316 steel

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Unique solidification kinetics in additive manufacturing (AM) has added unique features in the AM microstructures. Features such as high dislocation density cells, solute segregation, high fraction of low angle grain boundaries and columnar grain morphology are known to impart unconventional strength and ductility combinations compared to well-established conventional casting and forming route. In such complex microstructures, interaction of mobile dislocations with other short-range obstacles such as solutes and forest dislocations become imperative phenomena to understand the thermally activated mechanisms of deformation. Activation volume derived from strain rate jump tests serve as the key parameter to identify the responsible rate controlling mechanism. In the present investigation three AM SS316 steel microstructures, obtained by different heat treatments are compared with the wrought microstructure on the basis of activation volume and strain rate sensitivity determined from uniaxial tensile strain rate jump tests. Despite having highest dislocation density, as-printed AM microstructures were found least sensitive to strain rate compared to heat treated AM and wrought microstructures. Correlations between the strain rate sensitivity, dislocation density, inter-solute distance and their effect on the evolution of strength and ductility for different microstructures of SS316 will be discussed in this presentation.

Keywords: *Additive Manufacturing, Activation Volume, Rate Sensitivity, SS316, Solute Segregation.*