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High temperature deformation behavior of additively manufactured Inconel 718

Sabari Rajan[a*], N.T.B.N. Koundinya[a], B.K.Nagesha[b], Jivan Kumar[b], G. D. Janaki Ram[c] and Ravi Sankar Kottada[a]

[a] *Department of Metallurgical and materials engineering, IIT Madras, Chennai – 600036, India*
[b] *Materials Group, GTRE, DRDO, Bengaluru – 560 093, India*
[c] *Department of Metallurgical and Materials Engineering, IIT Hyderabad, Kandi – 502 884, India*
*Corresponding author: sabariedujob@gmail.com

Additive manufacturing (AM) of Ni-base superalloys has witnessed a quantum leap in technological advancement to achieve the near-net shape with required microstructure for many of the critical components subjected to high temperatures. Formation of fine grain microstructure due to higher solidification rate together with high thermal gradient is the norm in laser powder bed fusion (LPBF) methods. However, mechanical anisotropy across the build components has been reported attributing to build direction dependent microstructure. Although there are few reports addressing the mechanical anisotropy at room temperature, hardly any high temperature reports on this aspect. Therefore, we attempt to evaluate the mechanical anisotropy at high temperature in a candidate Ni-base superalloy Inconel 718.

Tensile specimens were built along (vertical) and perpendicular (horizontal) to the build direction using LPBF. Subsequently, quasi-static tensile tests were conducted in the temperature range of 25 to 900ºC and at various strain rates. Besides, constant load creep experiments were conducted in the stress range of 500 – 690 MPa and in the temperature range of 550 – 650°C. Curiously, the vertical build samples exhibited marginally lower minimum creep rate than horizontal build ones. Post-deformation microstructural characterization was carried out using SEM, EBSD and TEM to understand the substructure evolution. A plausible mechanism responsible for such intriguing behaviour is explained by correlating the mechanical data together with microstructural characterization.

Keywords: Inconel 718, Additive manufacturing, Laser powder bed fusion, Creep, High temperature deformation, Anisotropy