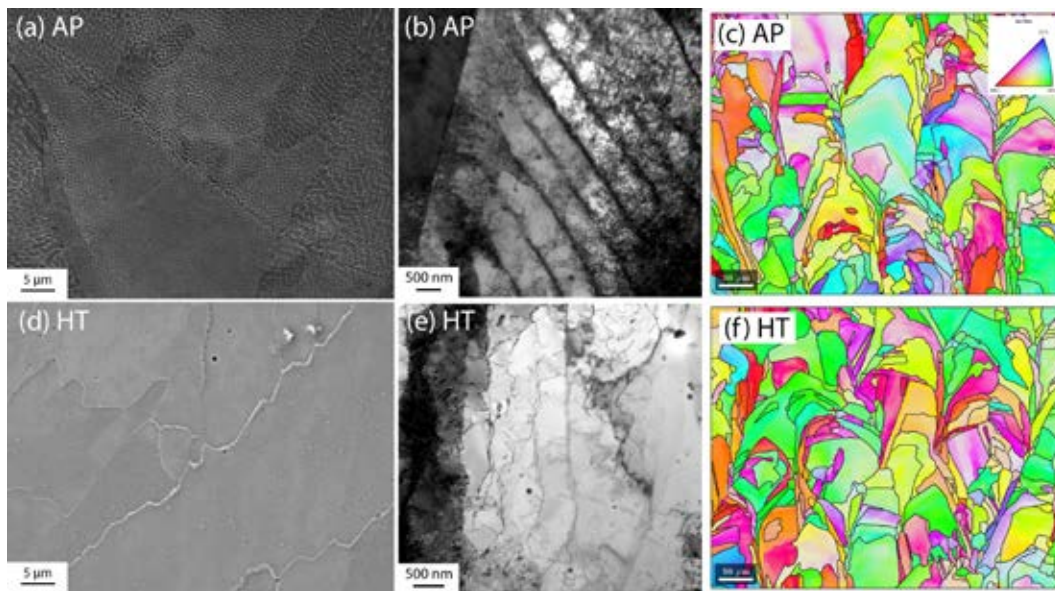


## Highlight

# Thermal stability and strengthening effect of dislocation cell structure in LPBF stainless steel 316L



Microstructures of the as-printed (AP) and 900 °C heat-treated (HT) samples. (a, d) SEM images showing cells in the AP sample but none in HT sample. (b, e) TEM images showing the difference in the dislocation networks. (c, f) EBSD inverse pole figure coloring maps, with boundaries ( $>2^\circ$ ) overlaid in black, showing similar grain structures in the two samples.

The microstructure of 316L stainless steel produced by laser powder bed fusion (LPBF) is hierarchical, and on a fine scale, it contains cell structures and loose dislocations. These microstructures govern the mechanical properties; it is therefore important to quantify them, understand their thermal stability and strengthening effect.

In this work, we annealed LPBF 316L samples at 500 °C, 800 °C and 900 °C, and found significant dissolution of the dislocation cell structure at the latter two annealing temperatures. The elimination of the cell structure by an-

nealing at 900 °C is accompanied by a 150 MPa decrease in yield strength, indicating a significant strengthening effect from the cell structure. An analysis based on crystal plasticity simulations suggests that this corresponds to an increase in the critical resolved shear stress on the slip systems of 54 MPa, which is consistent with an estimation of change in forest dislocation density.

This work highlights the significant role of cell structure in the microstructural engineering of metallic materials by additive manufacturing.

For further reading, please see:

[1] Wang, X., Quey, R., Nadimpalli, V. K., Juul Jensen D., & Yu, T. (2025). Role of cell structure in early-stage strengthening of L-PBF stainless steel 316L. In IOP Conference Series: Materials Science and Engineering (Vol. 1332, No. 1, p. 012017). IOP Publishing.

[2] Barode, J., Brander, M., Yu, T., Nadimpalli, V. K., Juul Jensen D., & Wang, X. (2025). Cell Structure in LPBF 316L—Microstructural Heterogeneity, Thermal Stability, and Mechanical Properties. *Materials*, 18(3), 475.