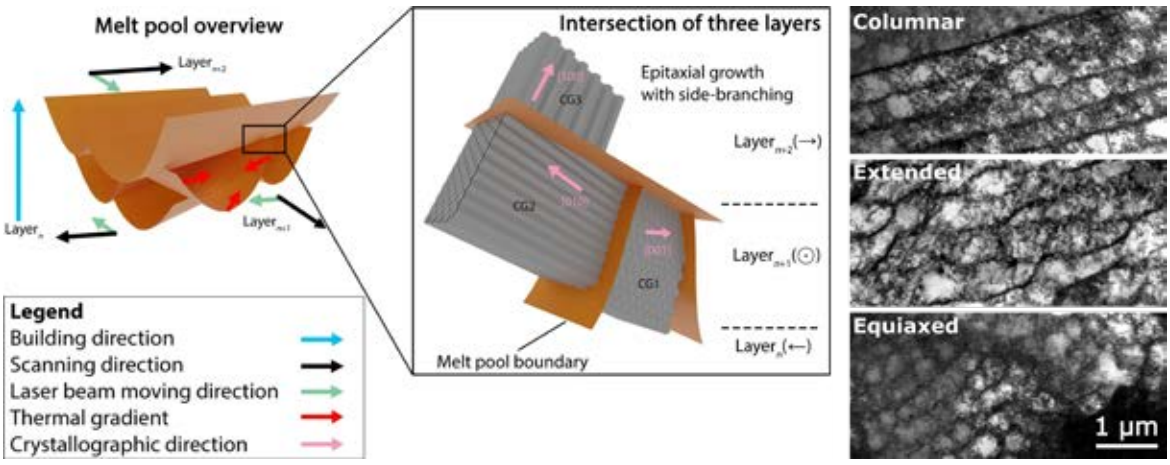
Highlight

Additive-manufacturing-induced cell structure in stainless steel 316L

The cell structure is a characteristic microstructural feature found in many metals produced by additive manufacturing, affecting their mechanical properties significantly.

In this work, the cell morphology within austenitic stainless steel 316L fabricated by laser powder bed fusion (LPBF) is characterized and its formation mechanism is analysed. The experimental results demonstrate that the cells have a 3D prism-like morphology aligned along a <100> crystallographic direction. There is a high dislocation density and a weak solute segregation at the cell boundaries. It is proposed that both the liquid-solid transformation and thermal strain contribute to the formation: the cells start to form during the initial liquid-solid transformation and evolve under the thermal strain during the cooling and subsequent thermal cycles.

The finding of the cell morphology is crucial to explore future methods for tailoring the cell structure of LPBF 316L, and insight into its formation mechanism allows for the control of texture and local dislocation density during the printing process. This offers promising opportunities to produce parts with optimized microstructures.



Schematic illustration of the L-PBF microstructure, showing melt pools within three layers. The building direction, scanning direction, laser beam moving direction, thermal gradients, and crystallography direction are indicated by the coloured arrows. The sketch in the black box is a zoom-in image of a region near a melt pool boundary intersection, showing 3D side-branching with cells aligned along the local thermal gradient. To the right: TEM images showing the three types of 2D cell morphologies that may be observed depending on the angle between the cell growth direction and the observation plane: columnar, extended and equiaxed.

For further reading, please see:

X. Wang, V. K. Nadimpalli, D. Juul Jensen and T. Yu (2024). Multiscale characterization of the additive-manufacturing-induced cell structure in 316L stainless steel: A comparative study. In *IOP Conference Series: Materials Science and Engineering* (Vol. 1310, p. 012034). IOP Publishing.

X. Wang, V. K. Nadimpalli, N. S. Tiedje, D. Juul Jensen and T. Yu (2025) Additive-Manufacturing-Induced Cell Structure in Stainless Steel 316L: 3D Morphology and Formation Mechanism. *Metall Mater Trans A* **56**, 506–517.