Yield surface identification of additively manufactured stainless steel 316L considering its printing orientation

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Stainless steel 316L (SS316L) is highly valued across industries for its excellent mechanical properties, corrosion resistance, and formability, making it ideal for additive manufacturing. Its biocompatibility and strength at high temperatures further enhance its use in medical, aerospace, and energy sectors. With low thermal conductivity, a high melting point, and non-magnetic properties, SS316L also supports complex geometries in industrial applications, ensuring versatility and broad utility. In this work, the yield surface behaviour of additively manufactured (AM) stainless steel 316L are investigated under complex loading conditions, focusing on the effect of printing orientation. Using the Laser Powder Bed Fusion Melting (LPBF-M) method, stainless steel tubes were fabricated in three orientations: horizontal (XY), vertical (Z), and 45° (ZX), as shown in Figure 1a.

Yield surfaces were determined based on a 0.005% plastic offset strain criterion [1], revealing significant variations in mechanical properties due to the orientation. It can be observed from Figure 1b, that the XY-printed specimens demonstrate the largest yield surface, while Z-printed specimens exhibit lower tensile yield properties. This anisotropic behaviour is attributed to the texture developed during the additive manufacturing process. The yield surface analysis, coupled with the probing technique employed during biaxial stress testing, offers valuable insights into the material's anisotropic hardening and texture effects, contributing to a deeper understanding of the mechanical behaviour of AM stainless steel 316L. These findings will be instrumental in improving constitutive models and optimizing AM processes for structural applications in engineering.

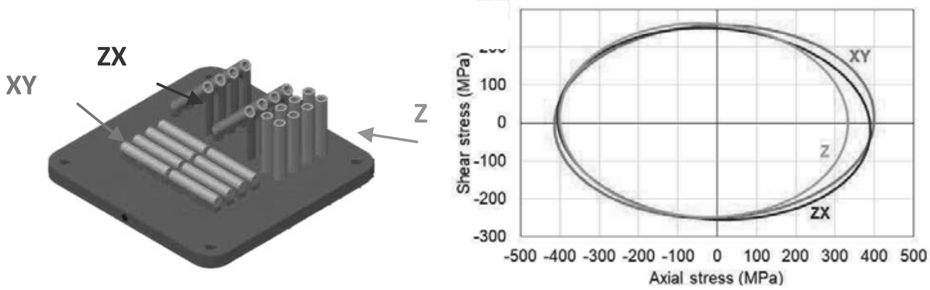

Figure 1. *Printing orientation of specimens on the build plate (a); comparison of the yield surfaces for three build orientations (b).*

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Reference:

1. Dubey, V. P., Kopec, M., Łazińska, M., & Kowalewski, Z. L. (2023). Yield surface identification of CP-Ti and its evolution reflecting pre-deformation under complex loading. *International Journal of Plasticity*, 103677.