# High-temperature tensile behavior of additively manufactured 316L stainless steel deformed by high-pressure torsion

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Additive manufacturing (AM) enables the production of metallic components with enhanced design freedom, reduced material waste, and improved mechanical properties. Among the widely used materials in AM, 316L stainless steel stands out as a versatile alloy employed in various industries, with an operating temperature of up to 600°C. Due to its practical significance, the additive manufacturing of 316L stainless steel via the powder bed fusion of metal with laser beam (PBF-LB/M) technique has been extensively studied in recent years. To ensure reliable performance at high temperatures, the tensile properties of PBF-LB/M 316L must be thoroughly investigated. Tensile testing of PBF-LB/M 316L stainless steel, as reported in [1], was conducted across a temperature range of 20°C to 700°C. The study revealed a significant reduction in both strength and ductility beyond 200°C due to a change in deformation mechanisms. At lower temperatures, the interaction between the PBF-LB/M-induced microstructure and deformation twins played a key role in enhancing mechanical performance. However, as the temperature increased, twinning was no longer observed, and deformation became predominantly governed by dislocation motion, leading to a decline in material strength and ductility.

In this study, 316L stainless steel rods were fabricated using the PBF-LB/M technique. Disk-shaped samples, approximately 11 mm thick, were then extracted from the rods and subjected to high-pressure torsion (HPT) for 10 rotations under the pressure of 5.15 GPa and rotational speed of 0.1 rpm. The HPT-deformed samples exhibited more than twice the hardness of the as-printed material. We investigated the tensile performance of both as-printed and HPT-deformed PBF-LB/M 316L at 20°C, 300°C, and 600°C. At 20°C, the HPT-deformed samples demonstrated approximately three times the ultimate tensile strength of the as-printed material, albeit with a significant reduction in ductility. At 300°C, the strength enhancement remained comparable, while the ductility loss was less severe. Remarkably, at 600°C, the HPT-deformed samples retained twice the strength of the as-printed PBF-LB/M 316L while exhibiting similar ductility. These findings, along with detailed microstructural and deformation analyses, will be presented and discussed at the meeting.

## Reference

[1] S. Dryepondt, P. Nandwana, P. Fernandez-Zelaia, F. List, *Microstructure and high temperature tensile properties of 316L fabricated by laser powder-bed fusion*, Additive Manufacturing 37 (2021) 101723.