## MLZ User Meeting 2024



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## Utilizing in-situ characterization techniques to probe the heat treatment response and micromechanical performance of LPBF processed and heat-treated Ti-6Al-4V

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Ti-6Al-4V is the workhorse among all titanium alloys that are processed by solidification-based AM technologies. Its popularity resides from its interesting combination of quasi-static and dynamic mechanical properties, and its relatively low density, making it a candidate material for lightweight applications.

The structural performance of L-PBF processed Ti-6Al-4V parts, however, is heavily affected by the formation of a martensitic phase during rapid cooling, its partial decomposition during sequential heating and cooling cycles and a macroscopic internal stress distribution within L-PBF processed Ti-6Al-4V parts.

Martensite decomposition and stress relaxation behaviour in L-PBF processed Ti-6Al-4V is investigated using in-situ dilatomettry, allowing to inductively heat a sample while being irradiated by synchrotron X-rays, enabling to simultaneously measure the thermal expansion, phase fraction and internal stress evolution of an LPBF processed Ti-6Al-4V during heating and cooling.

The micromechanical behaviour of as-built and heat-treated two-phase Ti-6Al-4V samples is compared, both in the elastic and plastic regime, based on X-ray synchrotron diffraction spectra recorded during uniaxial tensile loading. The elastic stiffness and plasticity variations in the different hexagonal  $\alpha$  and  $\alpha$ 'phase directions is discussed and compared with numerically predicted critical resolved shear stress values.

The plastic deformation behaviour, strain localization and fracture onset of bilamellar Ti-6Al-4V, is discussed based on strain fields, obtained by 2D digital image correlation, recorded during uniaxial tensile loading inside a scanning electron microscope.

Generally, recommendations are given on how to heat treat LPBF processed Ti-6Al-4V alloys in order to enhance its quasi-static mechanical performance.

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