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In situ synchrotron X-ray diffraction study of deformation behaviour of Ti-6Al-4V-Mo alloys manufactured using Laser Powder Bed Fusion

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Laser-based additive manufacturing processes involve complex cyclic thermal history characterized by directional heat dissipation, large temperature gradient, repeated melting and rapid solidification. This leads to the formation of strong crystallographic texture for the prior β grains and brittle martensitic microstructure in Ti-6Al-4V. Consequently, the as-built Ti-6Al-4V parts show low ductility <10%, low rate of work hardening, and limited fatigue strength, which are unsatisfactory for aerospace applications. Therefore, the development of new alloys exhibiting a good combination of strength, ductility, and work hardening tailored for rapid solidification processing conditions is required.

In this study, in-situ alloying is explored for Ti-6Al-4V-Mo alloys during Laser Powder Bed Fusion to achieve desired phase compositions and phase stabilities, ensuring a good combination of strength and ductility. During uniaxial tension, in-situ high-energy synchrotron X-ray diffraction (HE-SXRD) was performed to track the deformation processes and mechanisms of stable and metastable Ti alloys. The results obtained gain new insights into how locally tuned phase stability influences the deformation behavior of additively manufactured Ti alloys, which facilitates the microstructural design when exploiting the TRIP effects.

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