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Tuning the mechanical properties of Ti-6Al-4V-3Fe by *in situ* alloying during laser powder bed fusion

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Laser powder bed fusion is a well-established additive manufacturing technique, where a component is built by selectively melting and fusing powders within and between layers using a high power-density laser. Printing of alloys can be performed either with pre-alloyed powders or by mixing multiple powders. The latter method is called *in situ* alloying assisted processing. Recently, it was shown that the addition of small amounts of fine Fe powder to a pre-alloyed Ti-6Al-4V powder allows printing a fine-grained microstructure, as opposed to the conventional large-grained columnar microstructure observed for Ti-6Al-4V. In this work, we demonstrate how it is possible to tune the local mechanical properties of a 3D printed Ti-6Al-4V-3Fe component. We investigate the phase and temperature evolution during laser printing by high-speed operando X-ray diffraction [2] and post-processing electron microscopy. By varying the energy input, it is possible to change the nature of the melt pool, thereby influencing the degree of powder mixing and the local cooling rates. This, in turn, influences the stabilization of the high-temperature beta phase. We demonstrate that with increasing laser scanning speeds, larger fractions of the beta phase are retained, resulting in significantly higher ductility and lower strength.

Keywords: Operando X-ray diffraction, Ti-6Al-4V-3Fe, in situ alloying, phase transformation, mechanical properties

[1] Marco Simonelli *et al. The Influence of Iron in Minimizing the Microstructural Anisotropy of Ti-6Al-4V Produced by Laser Powder-Bed Fusion*, Metallurgical and Materials Transactions A volume 51 (2020) 2444–2459
[2] Samy Hocine *et al. Operando X-ray diffraction during laser 3D printing.* Materials Today 34 (2020) 30-40