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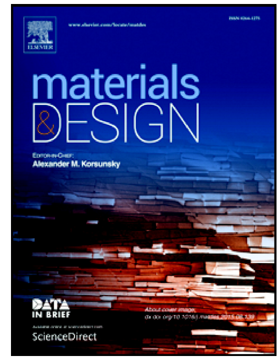

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Defects-dictated tensile properties of selective laser melted Ti-6Al-4V

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Abstract

As-processed metals and alloys made by selective laser melted (SLM) are often full of defects and flaws such as dislocations, twins, elemental segregations, impurities and porosities, which can positively or negatively impact mechanical properties. Here, we systematically characterize the tensile behavior of SLM Ti-6Al-4V at quasi-static strain rate and room temperature, including state-of-art *in situ* synchrotron X-ray diffraction (SXRD) and computed tomography (SXCT). These studies reveal that the tensile yield strength and uniform elongation are mainly dictated by the as-built microstructure, while the strain-to-failure is sensitive to the porosity, even in very high-density samples (>99.5%). *In situ* SXRD reveals that the micro-plasticity in as-built Ti64 initiates at a stress level that is well below its macroscopic yield strength, signified by the early lattice strain deviation behavior of (0002) and $\{11\bar{2}0\}$ reflections. SXCT reveals pore growth mechanisms when the tensile axis is perpendicular to the build direction, whereas no such behavior is observed as the tensile axis is along the build direction. These anisotropic pore growth mechanisms result in vast differences in the strain-to-failure of SLM materials. Our melt-pool dynamics modeling with the same laser conditions as the experiments identified a previously unknown pore source; i.e., edge-of-track pores.

Keywords: selective laser melting; Ti-6Al-4V; synchrotron X-ray diffraction; X-ray computed tomography; pores; plasticity.

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