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Stability of 316L stainless steels manufactured by selective laser melting against martensite formation during fatigue

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Two batches of 316L stainless steels with unique hierarchical but non-equilibrium microstructures, which comprise grains, sub-grains and characteristic rod-like dislocation network arrangement coinciding with the fine columnar solidification cells were fabricated using different SLM (selective laser melting) manufacturing systems and powders. Cylindrical specimens of high relative density with microstructure corresponding to the as-built state, i.e. without any post-heat treatment, were fatigued at room temperature under strain- or stress-controlled conditions until fracture. While a small amount of magnetic phase was detected by a Feritscope^{TM} magnetic sensor on the fracture surfaces in both batches of 316L steels, the presence of deformation-induced martensite in the bulk of fatigued material was rarely revealed (see also [1]). The Feritscope^{TM} measurements are complemented by microstructural analyses performed at different length scales using diverse experimental techniques (color etching, EBSD, TEM). The propensity to the formation of deformation-induced martensite in both SLMed 316L steels is discussed in terms of small but important differences in their chemical composition.

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References

[1] B. Blinn, M. Ley, N. Buschhorn, R. Teutsch and T. Beck, Investigation of the anisotropic fatigue behavior of additively manufactured structures made of AISI 316L with short-time procedures PhyBaL$_{LIT}$ and PhyBaL$_{CHT}$, Int. J. Fatigue 124 (2019) 389–399.