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PROCEEDINGS

Mechanism of Crack Resistance and Strength-Ductility in Additive Manufacturing of High Entropy Alloys

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ABSTRACT

In terms of grain refinement and component shape complexity, laser additive manufacturing (AM) is unmatched. This is exemplified by laser powder bed fusion (LPBF), whose rapid solidification and non-equilibrium metallurgy have expanded the understanding of ultra-fine grains and sub-stable organization among academics. At present, the reliability of LPBF components is being questioned by the industry due to the rapid heating and cooling cycles in AM processing, coupled with the extreme non-equilibrium heat-fluid-mass process, which renders LPBF printing vulnerable to metallurgical defects like microcracks and porosity. A significant impediment to the development of LPBF lies in the fact that current AM primarily utilizes conventional commercial-grade alloys, which have not been tailored to accommodate the unique characteristics of AM for specialist alloys. Indeed, crack nucleation and extension can be viewed as a pathway for the dissipation of the strain energy associated with thermal stresses in the materials. Based on this, we consider whether the challenge of suppressing thermal cracking in AM processing can be achieved by introducing other pathways than crack nucleation and extension to absorb strain energy. In this study, we preset a novel approach to inhibit cracks and enhance the mechanical performances of AM-produced alloys by manipulating stacking fault energy (SFE). By manipulating SFE, the thermal cycle-induced stress during the printing process can be effectively consumed via stacking faults formation, and the proposed strategy offers novel insights into the development of crack-free alloys with superior strength-ductility synergy for intricate structural applications.

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