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Residual stresses in AISI 316 L stainless steel manufactured via powder bed fusion

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Powder Bed Fusion, especially Selective Laser Melting (SLM), has gained high acclaim among material engineers in the recent years since it brings a new possibility of production of engineering components with complex shapes. Additionally, by further rotary swaging, the mechanical properties of the components can be enhanced alongside the reduction of some characteristic defects of the SLM process. On the other hand, the anisotropy, brought by the SLM itself, present in the workpieces (WPs) and the further mechanical treatments can give rise to complex residual stress (RS) distribution within the WPs. In this study, the RS distribution in AISI 316 L stainless steel samples, prepared by SLM method with different laser cladding orientations and levels of rotary swaging, were examined by neutron diffraction multi-linear scanning technique. According to results, only SLM manufactured WPs exhibit in general a centrosymmetric distribution of RS with tensile character at the periphery and compression character in the center of samples, in every measured direction. However, the detailed differences of RS between samples can be most probably attributed to the different build directions of the WPs. The additional cold rotary swaging process then destroys the symmetric distribution of RS in directions perpendicular to the processing route, while the symmetry is kept, and the RS gradient is increased in the parallel direction.

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