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Fundamentals of diffraction-based residual stress and texture analysis of laser powder bed fused Inconel 718

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Laser powder bed fusion (PBF-LB/M) of metallic alloys is a layer wise additive manufacturing process which provides significant scope for more efficient designs of components, benefiting performance and weight, leading to efficiency improvements for various sectors of industry. However, to benefit from these design freedoms, knowledge of the high produced induced residual stress and mechanical property anisotropy associated with the unique microstructures is critical. X-ray and neutron diffraction are considered the benchmark for non-destructive characterization of surface and bulk internal residual stress. The latter, characterized by the high penetration power in most engineering alloys, allows for the use of diffraction angle close to 90° enabling a near cubic sampling volume to be specified. However, the complex microstructures of columnar growth with inherent crystallographic texture typically produced during PBF-LB/M of metallics present significant challenges to the assumptions typically required for time efficient determination of residual stress. These challenges include the selection of an appropriate set of diffraction elastic constants and a representative strain-free reference for the material of interest. In this presentation advancements in the field of diffraction-based residual stress analysis of L-PBF Inconel 718 will be presented. The choice of an appropriate set of diffraction-elastic constants depending on the underlying microstructure will be described.

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