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Overcoming the challenges of residual stress analysis by neutron diffraction in additively manufactured alloys

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Metal Additive manufacturing (AM) technologies such as Laser Powder Bed Fusion (LPBF) enable the fabrication of complex structures, giving rise to potential improvements in component and manufacturing efficiency. However, the processes are typically characterized by the generation of high magnitude residual stresses which can have detrimental consequences for subsequent applications. Therefore, the characterization of these residual stress fields and understanding of their formation and mitigation through optimized processing is crucial for the wider uptake of the technology. Due to the potential complex nature and high value of components manufactured by LPBF, it is important to have suitable characterisation methods which can determine the spatial variations of RS in a non-destructive manner. Neutron diffraction is considered to be the best suited for these requirements. However, the microstructures developed in the complex thermal cycles experience in the production can pose challenges to the ND method for residual stress analysis. The BAM has conducted significant research over the past years to overcome these obstacles, enabling higher confidence in the residual stresses determined in LPBF materials by neutron diffraction. This contribution will overview some of these advancements made recently at European neutron sources including on Stress-Spec at FRM2/MLZ.

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