Contribution ID: **206** Type: **Poster**

Manufacturing a safer world: Residual Stress in AM determined by diffraction techniques

Wednesday 9 December 2020 17:40 (20 minutes)

Additive manufacturing (AM) technologies are experiencing a rapid growth. They promise breakthrough in engineering design (tailored parts), efficiency (environmental impact), and performance (safety). Laser Powder Bed Fusion (LPBF) is an AM method permitting the fabrication of complex structures that cannot otherwise be conventionally produced. Nevertheless, the high cooling rates associated with the process result in the formation of complex residual stress (RS) fields, which can undermine the material safety. Diffraction-based methods using penetrating neutrons and high energy X-rays at large scale facilities offer a non-destructive method to spatially resolve surface and bulk RS in complex components. These techniques also allow tracking the changes of RS following applied thermal / mechanical loads. Therefore, they represent one of the most reliable methods to assess the materials integrity in structures.
This presentation overviews some of the success stories of using large scale facilities by the BAM (the German Federal institute for Materials Research and Testing) for the determination of RS in AM metallic alloys. In particular, the study of the influence of process parameters (e.g. scanning strategies) on the RS state and the relaxation of this stress through heat treatment is presented. It is also shown how such information is used to improve the safety of AM structures. Finally, some of the challenges for diffraction-based RS analysis in AM materials are discussed.

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Session Classification: Joint poster session of MLZ User Meeting and DN2020

Track Classification: DN: Materials