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Influence of build direction on residual stresses and textures in lightweight alloys produced by additive manufacturing (AM).

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The freedom in complexity of AM metal parts allows very stiff and extreme light designs made of AlSi11Mg0.5 alloy and are entering serial production in automotive industry amongst others. Nevertheless, the production process of laser powder bed fusion (LPBF) is prone to the formation of residual stresses (RS). Furthermore, the parts may have distortions and must undergo a subsequent heat treatment to release RS, which is cost and energy intensive or not possible at all. Therefore, a pro-found understanding of the formed RS is mandatory for structural integrity assessment and successful industrial manufacturing suitable for industry. The LPBF production process is closely linked to texture formation, which results in anisotropic mechanical properties. In the current presentation, we investigate the evolution of residual strains and texture of an additively manufactured AlSi11Mg0.5 alloy component as function of building directions. This preliminary study uses high energy synchrotron X-rays to assess the strains of the different phases in this alloy and corresponding pole figures are derived to correlate the texture with the resulting stress profiles. In addition the influence of heat treatment on the strain level is studied as a function of spatial position within the AM parts. A brief outlook how this results can be used and further extended by neutron diffraction measurements to qualify and mitigate stress induced failure mechanisms in real parts will also be given.

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