Laser shock peening of Scalmalloys® and its effect on necessity of stress relief heat treatment

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An increasing industrial appetite to adapt the Laser Shock Peening (LSP) process in their manufacturing operations has led to several developments over the recent years. LSP is classified as a cold working process having a potential to enhance mechanical and microstructural features of components made in a variety of alloys. The process induces compressive stresses in components through a confinement layer and an ablation layer. A pulsed laser generates a rapidly expanding plasma in the ablation layer, while the confinement layer prevents its expansion away from the material. This plasma is responsible for developing the compressive stress in the material.

Although the LSP process has been used on several materials, studies on its applicability to Scalmalloys® are limited. Scalmalloy® components with complex geometries, widely used in critical aerospace applications, are typically additively manufactured (AM) using the laser powder bed fusion (LPBF) process. LPBF process induces high residual stress in the component, which then requires a stress relief heat treatment prior to further operations.

This study investigates the effect of laser shock peening on components made in Scalmalloy® using the LPBF process. Using a methodical design of experiments scheme, the peening parameters were optimised to suit the application. Different ablation layer materials and confinement media were used for the trials. The effect on residual stress induced distortion, microstructure and mechanical properties were analysed.

Another aspect of this study was focussed on understanding the potential of LSP to eliminate or minimise stress relief heat treatment after AM build. Shortening such energy intensive and time consuming processes can significantly improve the productivity and reduce the cost of production, encouraging wider and quick adoption of the technology in industries.