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Improving surface finish in SLM additive manufacturing components by implementing remelting techniques

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Abstract

With the current prevalence of complex and custom parts being produced through Additive Manufacturing (AM), the role of a tailored approach to post-processing will be crucial in ensuring their suitability for a given application. The layer-by-layer manufacturing approach through powder or wire precursors allows for greater design optimisation for both internal and external features, previously not possible with subtractive machining techniques.

In traditional manufacture the utilisation of subtractive machining results in the part achieving a specified surface finish and geometry, where such machining results from fixed tool based machining or abrasive processes. For surfaces produced through additive means, the subsequent surface finish is highly dependent upon the part orientation within the build volume and therefore can vary across the part. Consequently, AM surface roughness is recognised to be significantly inferior to more traditional machining processes. In some cases, this precludes the direct use of AM parts or necessitates additional surface finishing process.

A strategy of remelting deposited layers is proposed as a method for improving part surface finish and forms the primary aim of this paper. In this study a series of AM cubes were produced using four different remelting techniques were used: i) standard single up-skin laser scans ii) twin path laser scan up-skin only iii) triple path laser scan up-skin only and iv) twin path laser scans on the last 20 layers. Focus variation microscopy (FVM) was utilised to quantitatively assess the surface roughness on both the top and side faces. Measurements and characterisation were conducted in accordance with ISO 25178-2/3. X-ray Computed Tomography (XCT) was additionally employed to allow for an understanding of the remelt strategy influence on subsurface characteristics such as porosity.

The arithmetical mean height roughness (Sa) was obtained post remelt and showed significant influences being imparted using each remelt technique. The results show a 3 fold reduction from the original 20µm Sa, through use a twin path multi-layer scan. However this can only be achieved at the cost of increasing build time by around 18%. The surface present on the as-built surface is anisotropic in nature with stochastic accumulations within the hierarchical topography due to the melting process inherent with SLM approaches, the resulting effects of the remelt has a ‘smoothing’ effect on these features, reducing the peak based roughness parameter values and reductions in both Ssk and Sku with each remelt pass. This research has highlighted the effects of implementing a remelt process and its viability for in-situ post-processing of SLM AM surfaces using the laser energy source. The process would have clear advantages for surfaces that are difficult to physically access using traditional contact based finishing processes.

Keywords: Additive Manufacturing, SLM, Powder Bed Fusion, XCT, Focus Variation, Surface Roughness.