EFFECTS OF SURFACE ROUGHNESS REDUCTION TECHNIQUES ON THE PERFORMANCE OF ALM SPACE COMPONENTS IN INCONEL 718 ALLOY

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The project aims to study in depth the surface microgeometry of metal powder based additive layer manufacturing processes and to analyse surface roughness reduction techniques and their effects on the performance of structural parts, such as space components. Powder based additive layer manufacturing technologies offer significant advantages for optimizing and expanding the aerospace sector by enabling the production of critical components such as engines, thrusters, and structural parts through selective fusion of metal powders. For example, the Inconel 718 alloy, known for its high mechanical properties, good corrosion resistance, and high-temperature strength, is extensively used in the production of space components through Selective laser Melting (SLM) technology.

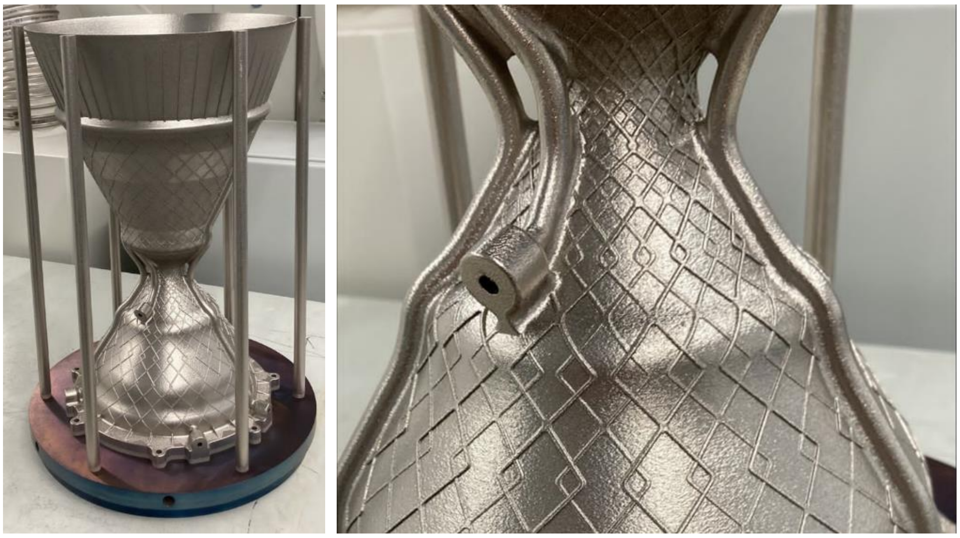

Figure 1 – ALM Combustion Chamber

However, surface roughness poses a significant challenge in the production of space components using metal 3D printing. The presence of a rough surface can compromise system performance and reliability. Therefore, reducing surface roughness can provide numerous benefits. This study will analyse the key advantages associated with reducing surface roughness in space components manufactured using powder based additive layer manufacturing technology.

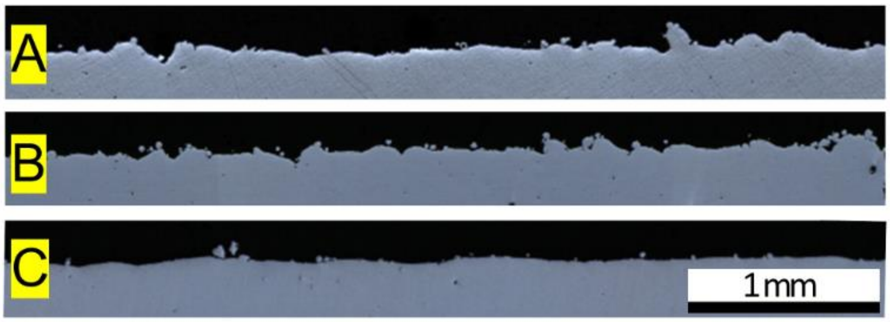

Figure 2 – ALM Surface Roughness [1]

Reducing surface roughness contributes to friction reduction between the component and the surrounding fluid, thereby enhancing system efficiency and overall performance of the engine or thruster. Additionally, reducing surface roughness improves the aerodynamics of the space component by reducing airflow or fluid resistance during flight, leading to improved efficiency and decreased overall aerodynamic drag. Surface roughness reduction also helps mitigate stress and fatigue on the component, enhancing its durability and reliability in the demanding space environment. Moreover, a smoother surface reduces the accumulation of contaminants on the component surface, thereby preserving performance and integrity over time. Lastly, a smoother surface facilitates cleaning and maintenance operations, reducing time and effort required.

Special attention will be given to the interaction between the surface roughness of Inconel 718 components and High-Test Peroxide (HTP), a propellant used in space. Surface roughness can increase the contact area between Inconel 718 and HTP, promoting chemical adhesion and oxygen absorption on the material's surface. Oxygen generated during HTP decomposition can react with the rough surface of Inconel 718, causing accelerated oxidation and potentially compromising the structural integrity of the material. Therefore, analysing surface roughness reduction techniques will be crucial to ensure the durability and reliability of space components manufactured using SLM technology and Inconel 718 alloy.

[1] Reiber, T., Rüdesheim, J., Weigold, M., Abele, E., Musekamp, J., Oechsner, M., *Influence of contour scans on surface roughness and pore formation using Scalmalloy® manufactured by laser powder bed fusion (PBF-LB)*, Materialwiss. Werkstofftech. 2021, 52, 468. https://doi.org/10.1002/mawe.202000287

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