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LASER ADDITIVE MANUFACTURING OF HIGH REFLECTIVITY ALUMINIUM ALLOYS

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ABSTRACT

As metal additive manufacturing (AM) technologies are increasingly adopted for end-use products, the bank of materials manufactured by this technology are bound to grow at a rapid rate. AM is often deployed as it enables the ability to manufacture components with high geometric complexity and has the potential to reduce cost and lead times. Ultimately, there is a potential to locally tailor material properties from the microscale to the macroscale using this approach. The AM of each material comes with its own set of challenges – the most common issues being porosity and residual stresses due to the localized thermal loads, particularly for the laser powder bed fusion (LPBF) AM technology, which currently has the highest industrial uptake. The issue of porosity in particularly critical for the automotive, aerospace, and defense industries wherein aluminium (Al) alloys are commonly used. Aluminium alloys commonly contain highly volatile elements, which when interacting with the low beam spot sizes (<100 μm) of most common LPBF systems are very easily vaporized, leading to multiple issues such as porosity and cracks in the final printed part. In this work, a combination of physics-driven LPBF processing diagrams, beam path planning, and advanced material characterization equipment including X-ray computed tomography and surface profilometry are used to understand the effect of laser power, scan speed, and beam spot radius on the porosity of two aluminium alloys – AlSi10Mg and Scalmalloy®, with reported densities >99.98%. Additionally, the influence of the LPBF processing parameters on microstructure of these alloys and thereby on the surface roughness and mechanical properties such as hardness and tensile strength is highlighted.