

Characterization of a newly developed liquid assisted healable Al alloy produced for Laser Powder Bed Fusion (LPBF)

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Aluminium alloys are widely used in aerospace and aeronautic industries because of their excellent strength-to-weight ratio. In these applications, overloads can occur, damage the part and lead to its replacement. In order to increase the part's lifetime, a solution would be to use a material able to heal its damage and restore its continuity. The most advanced man-made self-healing materials are polymers. They are composed of encapsulated healing agents, which are released when a crack propagates, leading to crack closure [1]. While polymer-based systems have dominated the field of self-healing materials, self-healing of metals remains an important challenge because of the limited mass transfer at room temperature.

The aim of this research is to **develop a healable Al alloy manufactured by Laser Powder Bed Fusion (LPBF)**. To this end, elementary powders are mixed to produce a binary alloy composed of a low melting phase dispersed in a high melting point phase. After an overload, damage initiates in the material. A heat treatment is then applied to trigger the melting of the low melting point phase, which can therefore flow in the material towards the voids and fill them. Upon solidification, these voids are thus healed.

After composition selection and LPBF parameters optimisation, the healing potential of this newly developed alloy has been analysed. The volume of the defects inside the damaged alloy and after its healing treatment was observed by X-ray nano-tomography experiments at ID16B beamline at the ESRF [2]. This 4D nano-imaging highlighted the progressive filling of the damage sites, allowing to optimise the healing temperature and showing the potential of this healable aluminium alloy. A statistical analysis is then used to determine the fraction and the maximum size of the healed damage sites. Finally, the healing microstructure, and so the filling of the voids was further investigated with the correlative multiscale imaging approach. Precisely allocated, based on the nano-tomography ESRF data, sample sub-volume containing the healed damage, has been further investigated using PFIB-SEM serial sectioning scanning combined with the EDX elemental material composition analysis. The multi-modal tomography data has afterwards been spatially correlated

providing multi-resolution overview of the microstructural features confirming the healing mechanism.

REFERENCES

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