

## Development of a new liquid assisted healable AlMg 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 the crack closure [1]. Designing self-healing metallic materials is more challenging because of the slow diffusion of the healing agents at room temperature.

The aim of this research is to **develop a healable Al alloy produced for Laser Powder Bed Fusion (LPBF)**. To this end, elementary Al and Mg powders are mixed and the parts are manufactured by LPBF to produce a binary AlMg alloy composed of a low melting point magnesium rich phase dispersed in an aluminium matrix. Then, after damage of the material, a heat treatment triggers the melting of this low melting point phase, which can therefore flow to the free surfaces of the voids and heal them upon solidification. The composition was selected thanks to ThermoCalc and Rosenthal simulations in order to avoid hot tearing while optimising the percentage of low melting point phase. The LPBF parameters leading to homogeneous, dense and crack-free parts were investigated. The damage mechanism was highlighted using in-situ tensile tests. Finally, X-ray nano-holotomography experiments at ID16B beamline at the ESRF [2] demonstrated the healing potential of the designed alloy. Based on these results, the optimal healing temperature was selected and the contribution of Hot Isostatic Pressing (HIP) as healing treatment compared to heat treatments was evidenced.

### REFERENCES

- [1] Swapan Kumar Ghosh, *Self-healing Materials: Fundamentals, Design Strategies, and Applications*, Wiley, 2009.
- [2] GHEYSEN, J., MARIIA ARSEENKO, HANNARD, F., MAIRE, E., PYKA, G., SIMAR, A., & VILLANOVA, J. *Investigation by 3D nano-holotomography of the self-healability of an Aluminium alloy produced by additive manufacturing* [Data set]. European Synchrotron Radiation Facility. <https://doi.org/10.1515/ESRF-ES-449124708>