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First insight in the development by SLM of a healable aluminium alloys

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 by SLM. Indeed, SLM is used to finely disperse healing agents in the aluminium matrix. Then, after damage of the material, a heat treatment should allow the diffusion of these healing agents to the free surfaces of the voids and restore the metallic continuity. To this end, elementary powders are mixed with commercial AlSi12 powder. The compositions were optimised thanks to ThermoCalc and Dictra simulations in order to avoid hot tearing and allow diffusion of healing agents. The optimal parameters leading to homogeneous, dense and crack-free parts were investigated thanks to single tracks analysis. The damage mechanism was highlighted. Finally, a microtomography experiment showed a decrease in voids volume after healing treatment, demonstrating the potential of the designed alloys.

Reference :

[1] Swapan Kumar Ghosh, "Self-healing Materials: Fundamentals, Design Strategies, and Applications", Wiley, 2009.