Strength-healability trade-off in L-PBF additively manufactured Al-Mg alloys: Effect of Zr addition

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Aluminum alloys can be processed by additive manufacturing, enabling the production of parts with complex architectures without the need for subsequent machining. However, the resulting components often contain micrometric pores and cracks that significantly degrade their mechanical properties [1]. To address this issue, healable additively manufactured Al–Mg alloys have been developed. A first binary Al–Mg alloy showed that micrometric pores and cracks can be filled by a liquid phase originating from the melting of the eutectic compound Al_3Mg_2 during heat treatment [2]. In this study, we investigate the effect of Zr addition in a healable Al–Mg alloy, with the aim of improving the mechanical properties without degrading its healing capability. Our results show a significant improvement in mechanical properties, with the yield strength increasing by 170 MPa in the as-built condition, which can be explained by a strong reduction in grain size. At the same time, the alloy retains acceptable healing capability during heat treatments, although it is less effective than that of the binary Al–Mg alloy [2]. Microstructural and chemical analyses at very fine scales, notably using STEM-EDX and atom probe tomography, reveal that Zr addition strongly reduces the formation of the eutectic compound Al_3Mg_2, which explains the lower healing capability of the Al–Mg–Zr alloy. The effects of Zr addition on the formation of the Al_3Mg_2 compound are discussed from both thermodynamic and kinetic perspectives. It is shown that Zr addition does not modify the eutectic Al_3Mg_2 compound nor its stability, but affects the kinetics of the eutectic transformation.

References

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