Design of a new high strength liquid assisted healable AlMg alloy produced by Laser Powder Bed Fusion (LPBF)

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Aluminium alloys are used in aerospace and aeronautical fields where damage may occur due to overloads experienced in service. To avoid the replacement of damage parts and the production of new ones, materials able to heal their damage sites present great potential.

The goal of this research is to develop a new high strength healable Al alloy manufactured by Laser Powder Bed Fusion (LPBF). Alloying elements are introduced into an Al-Mg alloy to form strengthening precipitates and obtain a high strength alloy. The microstructure is composed of an Al matrix surrounded by a low melting point eutectic network rich in Mg. After damage nucleation, a healing heat treatment (HHT) with or without additional pressure (Hot Isostatic Pressing) is applied to trigger the melting of the eutectic phase which flows into the voids and seal them during solidification. A post-treatment can be applied to promote the nucleation of strengthening precipitates and restore the initial strength.

In this work, the healing potential of the designed alloy, and the influence of pressure during HHT has been characterized in 3D by a correlative X-ray tomography and electron microscopy methodology. X-ray nano-tomography technique at beamline ID16B ESRF allowed to image the damage regions before and after healing (35nm pixel size). In a second time, based on the ESRF data, selected sample sub-volume containing the healed damage has been resected and prepared to be further investigated using PFIB-SEM serial sectioning tomography combined with EDX elemental material composition analysis.