Dissimilar friction stir welds of L-PBF Zr-modified Al7075 and wrought Al7075 and improvements of L-PBF Zr-modified Al7075 using pre-alloyed powder

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Abstract

With Scalmalloy®, A20X™ and other new commercial high strength aluminium alloys, the peculiar trend for new Al alloys specifically designed for L-PBF is currently evolving at a rapid pace. However, 7xxx series aluminium alloys are not in the spotlight due to their L-PBF processing difficulties, especially Zn and Mg evaporation. However, 7xxx alloys present a huge potential for reaching even higher strength after L-PBF processing compared to commercial alloys. Furthermore, 7xxx alloys are widely used in the aerospace sector in their wrought form making them interesting candidates to build additive manufacturing parts in this field.

Our study is based on preliminary results on a Zr-modified Al7075 alloy obtained by powder mix and processed by L-PBF. After a careful process optimisation, a relative density of 99.9% was achieved, along with an exceptional 515 MPa yield strength following the application of a tailored post-L-PBF heat treatment. In this work, two different related topics are explored.

Firstly, the friction stir welding (FSW) of L-PBF Zr-modified Al7075 with wrought Al7075 is analysed in depth. Usually, welding of L-PBF manufactured alloys with wrought parts by classical fusion welding techniques causes unacceptably large porosities. There is thus a real need to make sound reliable dissimilar welds, what will be done by FSW in this work. Welding L-PBF Zr-modified Al7075 to wrought Al7075 parts is indeed required for industrial applications. Static mechanical behaviour of these FSW welds were obtained and analysed using Digital Image Correlation (DIC) technique.

Secondly, preliminary results show the improvement of the Al7075+1.8%Zr alloy will be discussed. The improvement is obtained by pre-alloying the powder itself and by compensating the Zn and Mg losses during L-PBF. The characterization of the new improved alloy has led to a hardness above 200HV, significantly higher than wrought 7075 T6 material.