Friction stir welding of high strength Aluminium- Lithium 2050 alloy: computed X-rays tomography correlated to weld efficiency

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Abstract

In the frame of AALASA project (Advanced Aluminium Lithium Alloys for Space Applications, founded by ESA), the present work investigates the weldability of 2050 Al alloy. In particular, the weldability window of 3 mm thick plates is investigated and correlated to non-destructive inspection and classical tensile testing. Computed tomography is used for the detection and quantification of welding defects inside the weld structure, highlighting the critical defects leading to failure of the welds.

Keywords: Friction Stir Welding, Aluminium Alloy, Non-destructive Inspection, Computed Tomography

1. Introduction

Strength to weight ratio is of prime importance in aerospace industry. So forth, the ESA project AALASA aims to improve the welding knowledge on low density and high strength 2050 Aluminium alloy. This alloy contains Lithium, which is the lightest metal. The 2050 aluminium alloy has thus a lower density than conventional structural 2XXX and 7XXX aluminium alloys, keeping excellent mechanical properties. The integration of 2050 material into aerospace structures improves thus the buy to fly ratio. Friction stir welding of 2050 alloy is know to be feasible, as described in [1] for several plate thicknesses. Now, the investigated work focusses on welding 3 mm thick sheets of 2050 alloy. Classical characterization is coupled with non-destructive inspection, in order to define rules of thumbs for the design of parts made of 2050 aluminium alloy.

2. Methods, Results and Conclusions

The present work describes the 2050 alloy in as-received and friction stir welded configuration. The base material is received in T3 (solutionized and pre-stretched) state, 3 mm thickness. Welding is performed using a 3 mm long tri-flatted threated pin with 12 mm shoulder diameter. The effect of several welding parameters were investigated :rotational speed, advancing speed and welding forces / torque.

All investigated configurations are then evaluated by a non-destructive technique: computed tomography allows the quantification of the welding defects under a voxel size of 10 µm, see Figure 1. In that defected weld, the surface seems regular and defect-free, but the inner part of the weld contains defects.

Based on welded specimens and referent metal, aging heat treatment is then applied in order to reach the T8 state. Influence of the weld microstructure on mechanical performances is investigated by micro-hardness and tensile testing. Microstructural analysis is also performed.

Finally, the Mechanical behaviour of the material is related to the X-ray tomography results, in order to relate the welding conditions to the final mechanical properties. Applying suitable welding parameters gives a high weld efficiency, offering great potential for the development of light and high strength structures for aerospace applications.

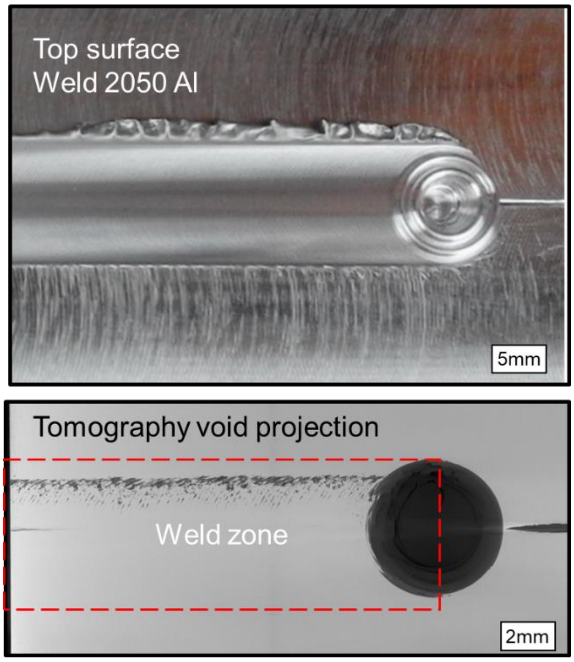

Figure 1: Example of weld surface VS computed tomography inspection revealing internal defects.

References

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