11th International Conference on Advanced Materials
ICAM 2009
Rio de Janeiro Brazil
September 20 - 25

MICROESTRUCTURAL CHARACTERIZATION AND EVALUATION OF MECHANICAL PROPERTIES OF AA 2198-T8 FRICTION STIR WELDED

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Abstract – The properties of AA 2198-T8 butt joined by friction stir welding (FSW) are directly related to the material flow and the temperatures achieved. In the present work, to determine optimal processing parameters for producing a defect free weld, the material microstructure is investigated by traditional metallography as well as the mechanical properties was evaluated by means of microhardness tests. The parameters investigated were transversal and rotation speed of the tool. Moreover, the microstructure was correlated with data of temperature in the plate and torque of the tool.

The modern aerospace industry requests for materials with high performance structural applications. Therefore, AA 2198-T8 is being investigated because of its high strength and low density, despite high processing cost. FSW provides quality joints at acceptable cost, for the reason that is faster than riveting, more efficient energy and does not require filler metal like conventional welding processes [1].

The process is based on friction heating at the facing surfaces of two sheets to be joined, where a cylindrical tool with a properly designed rotating probe along the contacting metal plates, produces a highly plastically deformed zone by the stirring action. The microstructure evolution and the resulting mechanical properties depend strongly on the variation of the processing parameters like transversal and rotation speed of the tool. The thermo-mechanical affected zone (TMAZ) is produced by friction between the tool shoulder and the plate top surface, as well as plastic deformation of the material in contact with the tool. The FSW process is a solid state process, therefore the low mechanical properties microstructure resulting from melting and re-solidification are absent in produced welds, leading to improved mechanical properties such as ductility and strength alloys with low residual stresses [1,2].

In this present work, AA 2198-T8 plates were joined by FSW changing the rotation and transversal speed of the tool. Another important parameter is the ratio between rotation speeds and transversal speed, Weld Pitch (WP). It was observed by optical microscopy that the area of the Stir Zone grows when the rotation speed decreases because the thermal input is lower in the interface between the thermo-mechanical affected zone and the Stir Zone. The occurrence of flaws is directly dependent on WP. Low WP does not plasticize properly the metal, which causes the formation of volumetric defects.

The strength of the AA 2198-T8 is due to age hardening, hence is important to control thermal cycles during the welding process. From microhardness data it was observed a decreasing value in the Stir Zone but more in the thermo-mechanical affected zone. The reason behind this fact is that in the Stir Zone the precipitates are solubilized and precipitated. So the ideal parameters are able to plasticize the metal with the minimum lost in mechanical properties.

Figure 1 – FSW Tricept Robot 805 and Siemens Sinumeric 840D controller

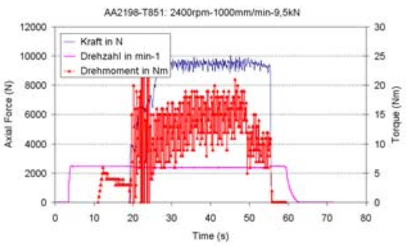

Figure 2 – Downforce, rotational speed and torque versus welding time (2400 RPM – 1000mm/min – 9,5KN)

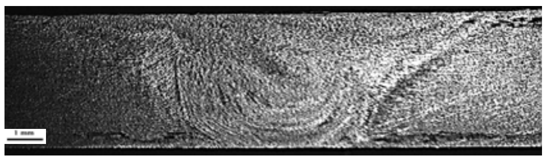

Figure 3 – AA2198-T8 welding macrostructure (2400rpm – 1000 mm/min – 9,5 KN)

[1] Mishra RS, Ma ZY. Friction stir welding and processing. Mater Sci Eng 2005;R50:1–78.
[2] P. Cavaliere , A. De Santis , F. Panella , A. Squillace . “Effect of anisotropy on fatigue properties of 2198 Al–Li plates joined by friction stir welding” 2008.