Table 1 Friction stir welding parameters

Sample	Travel speed (mm/min)	Spindle speed (rpm)
A	fast	slow
B	slow	fast
C	medium	medium
D	fast	fast
E	slow	slow

The Effect of Welding Parameters on Corrosion Behaviour of FSW 2024-T351 Aluminium Alloy

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High strength 2024 aluminium alloy is used for aircraft applications due to its high strength to weight ratio. Currently, the major joining process employed is riveting. Friction stir welding (FSW) is a new solid state joining technique invented by TWI in 1991, which offers substantial improvements over riveting in terms of weight saving and mechanical integrity [1,2]. However, FSW produces a heterogeneous microstructure in the weld zone, causing corrosion problems [3]. The variation of microstructure is caused by the different frictional heat input determined by welding parameters, especially travel and spindle speeds [4]. In the present study, the effect of welding parameters on corrosion behaviour of FSW 2024-T351 aluminium alloy is investigated by gel visualisation, immersion, microelectrochemical and hardness measurements.

AA 2024-T351 plates were friction stir welded by BAE SYSTEMS with five different sets of welding parameters as shown in Table 1. The experiments were carried out on the cross-sectioned surface of welds. The result from immersion test (Figure 1) indicates that the lower spindle speed welds (A and E) exhibit corrosion in the nugget while the higher spindle speeds (B, C and D) reveal corrosion area in HAZ, which is in good agreement with gel tests. Intergranular corrosion attack is found in both nugget and HAZ regions. The most corrosion-susceptible areas occur in regions where the heat input is sufficient to cause changes in the precipitation morphologies leading to formation of grain boundary precipitates and solute-depleted grain boundary regions. The corrosion areas show the minimum hardness value. The electrochemical properties across the weld were profiled using a micro-electrochemical device with a lateral resolution of 2.5-10 mm. The result (Figure 2) shows a higher anodic activity together with lower open circuit potential in the weld zone of all FSWs. The nugget regions of all FSWs exhibit the highest cathodic activity (Figure 3) due to the break-up of particles generated by stirring action. The amounts of anodic and cathodic activities as well as the width of reactive region vary with the welding parameters.

Keywords : Friction stir welding, aluminum alloy, corrosion

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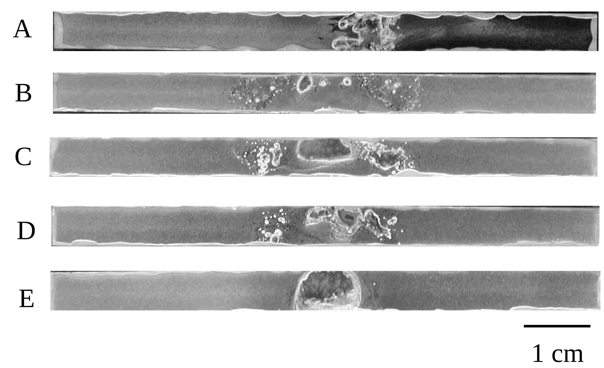

Figure 1 Immersion test on FSW 2024-T351 with different welding parameters after 24 hr exposure in 0.1 M NaCl.

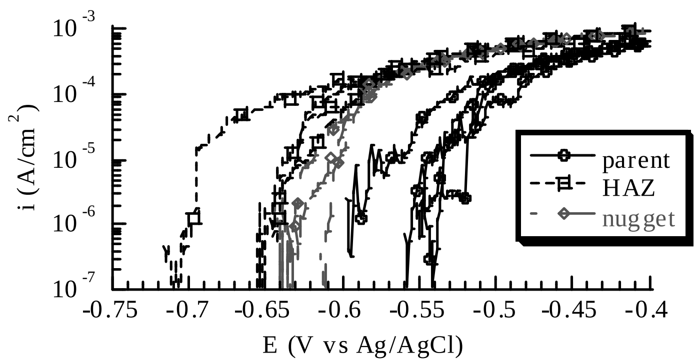

Figure 2 Anodic polarization curves for FSW B in 0.1 M NaCl across the weld using micro-electrochemical device.

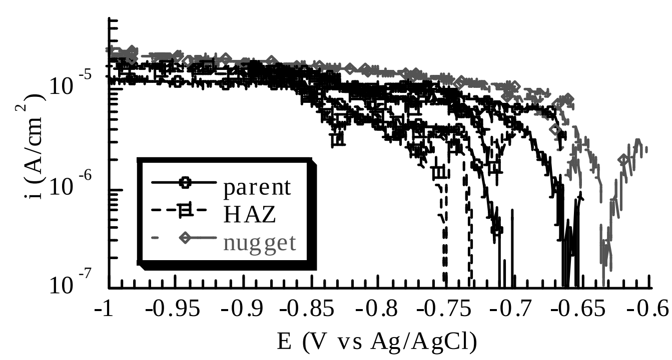

Figure 3 Cathodic polarization curves for FSW B in 0.1 M NaCl across the weld using micro-electrochemical device.