The relationship between microstructural characteristics and galvanic effect, SCC behavior of friction stir welded joint in as-welded and heat-treated conditions

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Abstract The effects of microstructural evolution on mechanical properties, macro/micro electrochemical corrosion behavior and stress corrosion cracking behavior of friction stir welding (FSW) AA6061-T6 joint after post-weld solution and aging treatments were investigated. The inherent microstructural gradients in FSW joint lead to dramatic degradation of mechanical properties and the presence of macro-galvanic effect [1], with the latter exacerbating anodic dissolution in heat-affected zone (HAZ) induced by micro-galvanic corrosion and inhibiting pitting corrosion in SZ. Post-weld heat treatment (PWHT) causes the formation of matrix precipitates with similar densities in different sub-regions, resulting in optimized precipitate distribution [2], comprehensive hardness recovery, and diminished macro-galvanic effect. Grain boundary misorientation angle, grain size and pre-existing dislocations synergistically influence the evolution of grain boundary precipitates (GBPs) and precipitation-free zones (PFZs) during the PWHT. As a result, pitting corrosion is the dominant corrosion form in SZ due to the narrowest PFZ width and dispersed GBPs, while intergranular corrosion is caused by continuous GBPs in other sub-regions. This study verified the dominant role of macro-galvanic effect and micro-galvanic effect in the corrosion process of FSW joint and FSW-PWHT joint, respectively. The maximum SCC susceptibility at HAZ in As-FSWed joint is dominated by enhanced anodic dissolution due to macro-galvanic effect. The SCC sensitivity of FSW-PWHT joint is higher than that of FSW joint due to high electrochemical activity and corrosion rate caused by the severe stress concentration between sub-grains and recrystallized grains at the TMAZ/SZ interface.

Keywords Aluminum alloys; Friction stir welding; Galvanic corrosion; Post-weld heat treatment; Microstructure evolution

Reference

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[2] Y. Tao, Z. Zhang, P. Xue,et al., J. Mater. Sci. Technol. 123 (2022) 92-112.