Stress corrosion cracking of sensitized AA5083 in a simulated dynamic seawater/air interface: effect of drying time

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Abstract Aluminum-magnesium (5xxx series) alloys have been widely used as structural materials in marine engineering equipment due to their high specific strength and excellent corrosion resistance [1, 2]. However, a challenging problem for 5083 aluminum alloy (AA5083) is that prolonged exposure at elevated temperatures (40~200 ℃) leads to the precipitation of the anodic Al_3Mg_2 phase (β phase) on grain boundaries (a phenomenon known as sensitization) [3-5], which increases the stress corrosion cracking (SCC) susceptibility of alloys.

The SCC susceptibility is greatly affected by different marine environments [6, 7]. In addition to seawater and marine atmosphere, the actual service environment of marine equipment also involves the seawater/atmosphere interfacial zone, which consists of three subzones: waterline, tidal, and splash zones [8]. Although all three subzones have similar environmental conditions, there is a significant difference in the wet-dry alternating time. However, there is limited research on the SCC mechanism of AA5083 under different wet-dry alternating time.

Here, a SCC simulation device for a dynamic seawater/atmosphere interfacial zone was established. The SCC behavior and mechanism of sensitized AA5083-O in the interfacial zone were investigated using slow strain rate tensile (SSRT) test and electrochemical test combined with constant load test. The results showed that SCC susceptibility of AA5083-O was mainly controlled by wetting and drying processes at the interfacial zone. Increasing single drying time in wet-dry cycles resulted in high SCC susceptibility and was the major factor degrading SCC resistance. This was attributed to the water evaporation and salt concentration in the electrolyte layer (TEL) on metal surface during drying process, promoting the initiation and propagation of cracks.

Keywords Aluminum alloys; Sensitization; Stress corrosion cracking; Dynamic seawater/air interface