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ABSTRACT

The use of austenitic stainless steels in harsh environments at elevated temperatures has increasingly become a global problem, these alloys can fail unpredictably when subjected to tensile stresses and chlorides. Hence the study was focused on understanding the environmentally assisted cracking of Ru enriched laser alloyed layers on 304L stainless steel in a corrosive environment at elevated temperatures. The Ru composition of laser alloyed samples was 0, 0.96, 1.96, 4.74 and 9.2 wt%.

Microstructural analysis and microhardness measurements were performed in order to understand the grain orientation and resistance to indentation respectively. The bend beam SCC test was conducted by stressing the samples to 350 MPa and exposing them to 50 ppm sodium chloride with 10 ppm dissolved oxygen at 160°C for 172 hours. The results revealed a significant improvement in the SCC resistance. The samples with lower Ru content (0, 0.98 and 1.96 wt%) were less susceptible to SCC when compared to as-received 304L stainless steel. Cracks initiated from pits and propagated transgranularly on the alloyed layer. The crack growth rate decreased as the Ru content was increased. The samples with 4.74 and 9.2 wt% Ru were immune to SCC. Electrochemical test results showed improved corrosion resistance when the Ru level was increased to 1.96 wt%. Thereafter, there was a gradual increase in corrosion rates for samples with 4.74 and 9.2 wt% Ru. However, these corrosion rates were lower when compared to as-received 304L stainless steel. Another SCC test was conducted to investigate fractography of vacuum remelted samples alloyed with Ru. The results showed ductile failure for most of the samples and the maximum stress threshold of 580 MPa was archived on samples with 1.07 wt% Ru. There was a sudden increase in failure time, % elongation and % reduction in area when the Ru content was increased to 1.07 wt%.

In essence, laser surface alloying 304L stainless steel with higher Ru content (more than 2wt%) improves SCC resistance, but does not improve the general corrosion resistance, therefore a careful selection for any application is necessary. However, the cost analysis revealed the laser surface alloying of 304L stainless steel with Ru to be more efficient over other corrosion resistant materials.