L.6: A Novel Surface Thermo-mechanical Treatment Enhances Corrosion Resistance of Type 304 Stainless Steel

A novel surface thermo-mechanical treatment (STMT) approach of micro-structural engineering has been developed to enhance the corrosion resistance of type 304 stainless steel (SS). The surface treatment involved shot blasting, followed by laser surface heating to effect surface recrystallization, as shown in Fig.L.6.1.

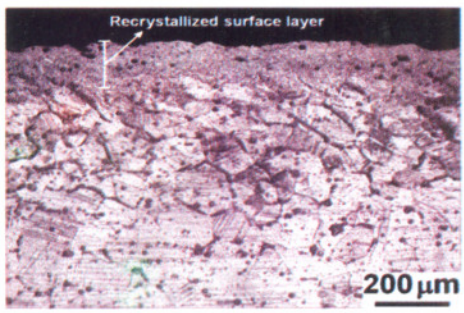

Fig..L.6.1: Cross-section of thermo-mechanically treated type 304 SS specimen.

Surface thermo-mechanical treatment of type 304 SS brought about significant improvement in its resistance against uniform and pitting corrosion, as shown in Fig. L.6.2. The improved overall corrosion resistance of thermo-mechanically treated surface was attributed to dispersion and redistribution of inclusions and grain refinement with significant improvement in stability of the passive surface film.

Surface thermo-mechanical treatment has also been found to be effective to enhance inherent resistance of type 304 SS against sensitization and intergranular corrosion (IGC) during its subsequent exposure to susceptible temperature regime. A sensitization heat treatment at 923 K for 30 mins. introduced significantly lower degree of

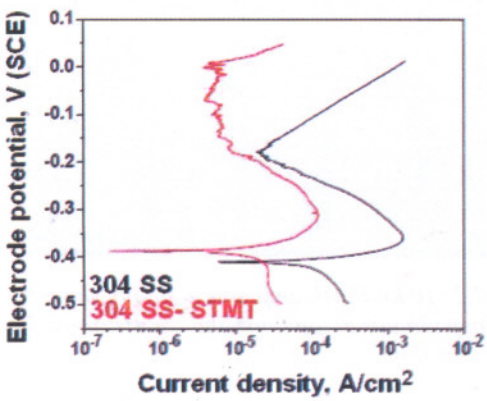

Fig.L.6.2: Potentio-dynamic polarization plots of untreated & thermo-mechanically treated type 304 SS specimens (both heat treated) in 0.5 M NaCl.

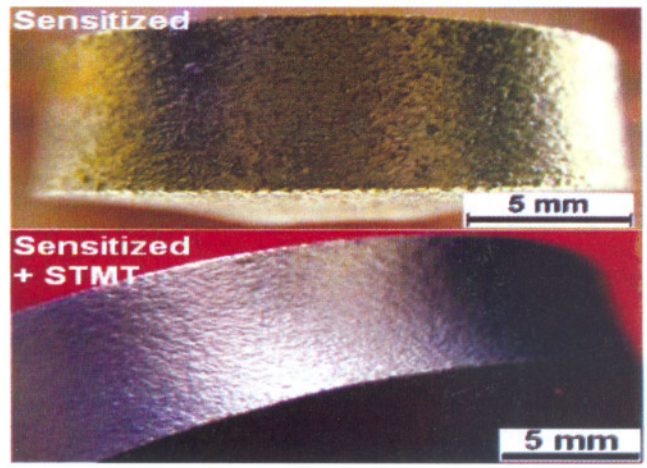

Fig. L.6.3: Sensitized & sensitized + surface thermo-mechanically treated type 304 SS specimens after undergoing IGC test as per ASTM A262 practice E.

sensitization (DOS) in thermo-mechanically treated SS specimen (0.26%) than in untreated specimen (10.3%). Thermo-mechanically treated specimens displayed reduced IGC susceptibility than untreated specimens in the same heat treatment condition.

Surface thermo-mechanical treatment also suppressed IGC susceptibility of pre-sensitized type 304 SS specimens, as shown in Fig. L.6.3. This is attributed to frequent disruptions in otherwise continuous chromium carbide network in thermo-mechanically treated specimens, as shown in Fig. L.6.4.

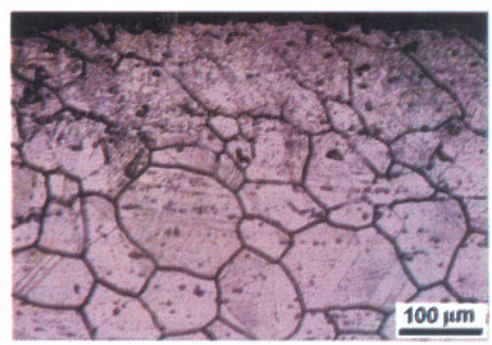

Fig.L.6.4: Cross-section of sensitized and surface thermo-mechanically treated type 304 SS specimen.

The proposed surface treatment approach has a potential for in-situ application for life enhancement of unexposed and in-service austenitic SS components operating in susceptible corrosive environments. Unlike conventional thermo-mechanical treatment, proposed STMT can be effectively applied on formed SS components.

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