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Abstract

CORROSION STUDY OF LASER-WELDED STAINLESS
STEELS

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Laser welding of austenitic stainless steels (S30400 and S31603), duplex stainless steel (S31803) and super duplex stainless steel (S32760) was achieved by a 2-kW CW Nd:YAG laser. The microstructure and the phases present in the fusion zone of the specimens after laser welding were analyzed by optical microscopy, scanning electron microscopy and X-ray diffractometry respectively. The mechanical properties of the specimens were also measured by a tensile testing machine and a Vickers microhardness tester. The corrosion characteristics of the laser-welded stainless steels in 3.5 % NaCl solution at room temperature were studied by potentiodynamic polarization technique. Immersion test, galvanic corrosion and stress corrosion cracking (SCC) tests were also conducted for investigating the pitting corrosion, galvanic corrosion and SCC behavior.

From the X-ray diffraction spectra, laser-welded S30400, S31803 and S32760 contained duplex structure with austenite and ferrite while laser-welded S31603 kept the original austenitic structure. The tensile strength, yield strength, ductility and strain energy of the laser-welded specimens are lower than the unwelded specimens due to the presence of weld defects and δ -ferrite.

Although the laser-welded stainless steels exhibit passivity in 3.5 % NaCl solution, their pitting resistance is deteriorated as evidenced by lower pitting potentials and higher passive corrosion current densities compared with the unwelded specimens. The ranking of pitting resistance of the laser-welded stainless steels in both 3.5 % NaCl solution and 6 % FeCl₃ solution are consistent. In addition, stress corrosion resistance of laser-welded stainless steels in 6 % FeCl₃ solution are lower than that of unwelded stainless steels. All laser-welded specimens failed by ductile fracture. The weld defects and δ -ferrite act as the initiation sites and accelerate the corrosion rate of the laser-welded specimens without and with stress. However, the galvanic effect on the laser-welded specimens in 3.5% NaCl solution is not significant as evidenced by low galvanic current in the range of nA/cm².