A Study of the Corrosion Behavior of Inconel 718 after Electron Beam Welding (EBW)

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Abstract

In this paper, the galvanic corrosion behavior of as-received, solution- and precipitation-pretreated Inconel 718 sheets welded by using electron-beam welding (EBW) was studied in 3.5wt% NaCl at 30 °C Meanwhile, an easy and reliable specimen-preparation method of a weld for electrochemical test was proposed. Microstructures of the welds were investigated with optical microscope and transmission electron microscope (TEM) integrated with an energy-dispersive x-ray spectrometer (EDS) for chemical composition analysis. Experimental results show that galvanic corrosion could take place in an Inconel 718 weld when it was immersed in 3.5 wt% NaCl solution. Furthermore, difference in corrosion potentials among fusion zone, heat-affected zone and base metal in an Inconel 718 weld is the key factor for galvanic corrosion. Owing to having active corrosion potential and very small exposing area compared to those of its adjacent heat-affected zone and base metal, severe attack of the fusion zone could be observed in as-received and solution-pretreated welds when the welds were anodically polarized in 2.0 V for a few seconds. However, the galvanic attack of solution-pretreated weld can be prevented through post precipitation treatment, by which only a little difference in corrosion potentials between fusion zone, heat-affected zone and base metal could be achieved.

Keywords: Inconel 718, electron beam welding (EBW), heat-affected zone (HAZ), galvanic corrosion

Table 1 The results Tafel-plot experiment showing corrosion kinetic parameters: corrosion potential ($E_{corr.}$), corrosion current density (i_{corr}), and anodic Tafel slope (β_a), of BM, HAZ and FZ of each weld in 3.5wt% NaCl solution at 30 °C.

Specimens		$E_{corr.}$(mV)	i_{corr} (mA/cm^2)	β_a (mV)
As-received	BM	58	509	341
	HAZ	-92	572	366
	FZ	-156	626	417
Solution-pretreated	BM	-22	525	393
	HAZ	-161	541	401
	FZ	-182	560	422
Precipitation-pretreated	BM	-157	667	476
	HAZ	-177	635	433
	FZ	-195	610	412

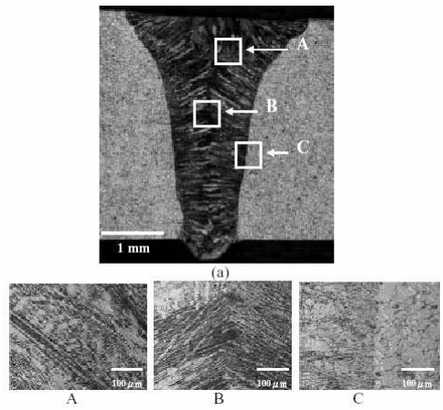
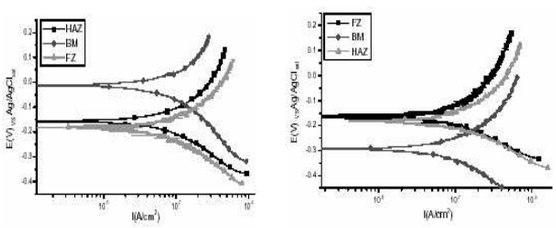


Fig. 1: Details of cross-sectional metallographic views of the solution-pretreated weld after EBW with welding parameter D. (OM micrograph)



(a) (b)

Fig. 2 The Tafel plots of the FZ, HAZ, and BM in 3.5wt% NaCl solution at 30°C; (a) Solution-pretreated and (b) precipitation-pretreated.

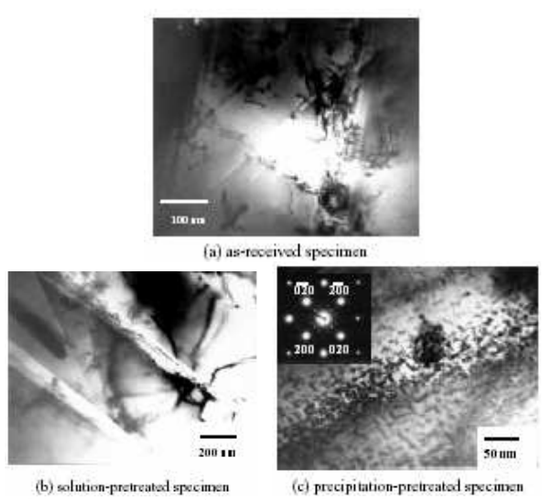
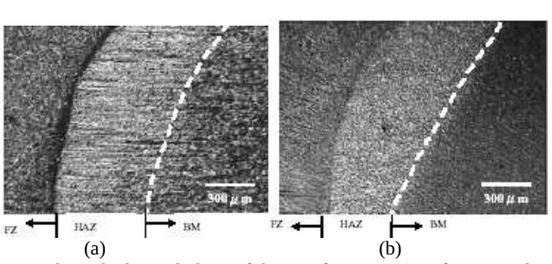


Fig. 3 TEM-micrographs of (a) as-received, (b) solution- and (c) precipitation- pretreated Inconel 718 specimens.



(a) (b)

Figs. 4 The etched morphology of the interface FZ/HAZ of pretreated weld after potentiostatic etching in 3.5wt% NaCl solution in 2 V at 30 °C for 120 s. (a) Solution-pretreated and
(b) precipitation-pretreated. (OM micrograph)