

Metallurgical and Morphological Considerations for  
Seawater Crevice Corrosion of Alloy 625

F. J. Martin<sup>1</sup>, P. M. Natishan<sup>2</sup>,  
K. P. Cooper<sup>2</sup>, H. N. Jones<sup>2</sup>, K. E. Lucas<sup>2</sup>

<sup>1</sup> GEO-Centers, Inc.  
FT Washington, MD 20749

<sup>2</sup> U. S. Naval Research Laboratory  
Washington, DC 20375

Alloy 625 is a Ni-Cr-Mo alloy that has an established history of excellent general corrosion and pitting resistance in seawater, but has been shown to be susceptible to seawater crevice corrosion. In-depth studies of Alloy 625 seawater crevice corrosion mechanisms have revealed that crevice corrosion susceptibility is a function of several parameters including crevice tightness(1), seawater temperature(2), seawater chemistry(3), heat treatment(4), and surface finish(5). Recent work has also indicated that chemistry of the crevice former can also exert a strong influence on Alloy 625 crevice susceptibility, possibly inhibiting or accelerating seawater crevice corrosion(6). The disruption of Alloy 625 passivity in seawater and ensuing localized corrosion may result in corrosion rates on the order of 10µm per day at ambient temperatures, and more than 100µm per day at elevated seawater temperatures(2,6).

One of the proposed approaches to improving corrosion resistance of Alloy 625 at critical locations is to weld overlay a more corrosion-resistant Ni-Cr-Mo alloy material(7). To date there has been little work published on the crevice corrosion behavior of welded Ni-Cr-Mo alloy microstructures. Moreover, the morphology of Alloy 625 crevice corrosion does not seem to be completely documented. Our present paper investigates the seawater crevice corrosion behavior of simulated welds of Alloy 625 using parent-material arc melting, and attempts to more fully document the corrosion morphology of Alloy 625 in the wrought and simulated weld conditions.

#### Experimental

Crevice corrosion experiments followed the experimental methods of Martin, Lucas and Hogan(8). The present work utilizes Alloy 625 plate specimens in hot-rolled/solution annealed (HR/SA) condition, polished to a 600 grit finish. Natural seawater from the Naval Research Laboratory in Key West, FL was used at ambient and elevated temperatures, while (Electrochemical potentials of specimens were controlled by potentiostat, maintained at conditions known to rapidly initiate crevice corrosion of Alloy 625 in seawater.

Simulated weld specimens were prepared using a vacuum arc melter. One side of the Alloy 625 plate is melted by the arc over a wide area. The other side of the plate is in contact with the water-cooled hearth and remains solid. The molten volume solidifies rapidly once the arc is turned off. Melting leaves the surface rough so it is ground down to a flat to prepare it for crevice corrosion testing.

#### Results

Sites of seawater crevice corrosion damage on Alloy 625 are filled with a black powder corrosion product. Analysis of this powder reveals that it is a largely

Ni and Cr depleted with respect to the bulk alloy composition. The predominant bulk alloy constituents that remain in the corrosion product powder for Alloy 625 are Mo and Nb – elements are originally present in the microstructure as inclusions. Morphology of the corrosion product powder suggests that it is the result of a dealloying process. At the advancing crevice corrosion front, the bulk alloy matrix immediately surrounding inclusions is shown a higher degree of localized attack, and is depleted in beneficial alloying elements. This suggests that Mo and Nb-rich inclusions may be initiation points for crevice corrosion.

Crevice corrosion susceptibility tests showed that remelted surface performed worse than the as-wrought condition. Microstructural analysis of these rapidly solidified structures showed dendrites and greater degree of segregation of alloying elements: dendrites were rich in Nb and Mo.

#### References

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