EFFECT OF CREVICE FORMER ON CORROSION DAMAGE PROPAGATION

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A necessary condition for crevice corrosion is that a crevice former must create a restricted geometry on the metal surface. Crevice corrosion is affected by the crevice geometry and properties of the crevice former. The objective of this project is to determine the effect of the crevice former on the localized corrosion-damage propagation.

Our approach is a combination of experimental measurements of localized corrosion with various crevice formers, and analytical computations of the crevice damage profile as a function of crevice geometry, environment, and corrosion resistance of the metal. Standard crevice corrosion test methods are modified by (a) the use of metal, polymer and ceramic materials as crevice formers and (b) the variation of size and shape of the crevices. This project addresses factors that may limit the initiation of localized corrosion and also slow or stop the continued propagation of corrosion. The affects are important to the determination of the penetration rate and extent of corrosion damage by localized corrosion.

To make head-to-head comparisons, crevice corrosion tests are run with different crevice formers on each metal specimen in the same exposure. The crevice-corrosion damage is monitored throughout the test by corrosion current measurements, and post-test examination determines the depth and distribution of corrosion damage. The initial tests are run on 316L stainless steel, and the effect of alloy composition will be extended to the highly corrosion-resistant nickel-chromium-molybdenum (Ni-Cr-Mo) alloys. The critical crevice chemistry to support crevice corrosion becomes more severe, e.g. higher chloride concentration and lower pH, as the corrosion resistance of the metal increases. A tighter crevice is required to develop and sustain the more aggressive crevice chemistries.

Significant differences in the extent of damage are shown in Figure 1. The polymer/metal crevice resulted in more damage (deeper and over a wider area) than the damage from a ceramic/metal crevice (shallower). Insights into the evolution of the corrosion damage are gained by stopping tests after different degrees of damage based upon current measurements during the exposures. In the analytical task, the evolution of the crevice profile with time is modeled for the corroding area within the crevice. Figure 2 presents the potential and current distributions along the crevice at an early stage in the process. For this scenario, crevice corrosion was initiated at a single location within the crevice, and no chemical changes were considered within the crevice. The potential-current behavior was calculated. The damage propagates from the initiation site within the crevice, and the crevice damage extends more rapidly toward the crevice mouth than into the metal (penetration). For a condition that requires a tight crevice, the crevice corrosion would stop and further corrosion damage would cease after the crevice mouth opened wide enough to allow dilution of the critical crevice chemistry.

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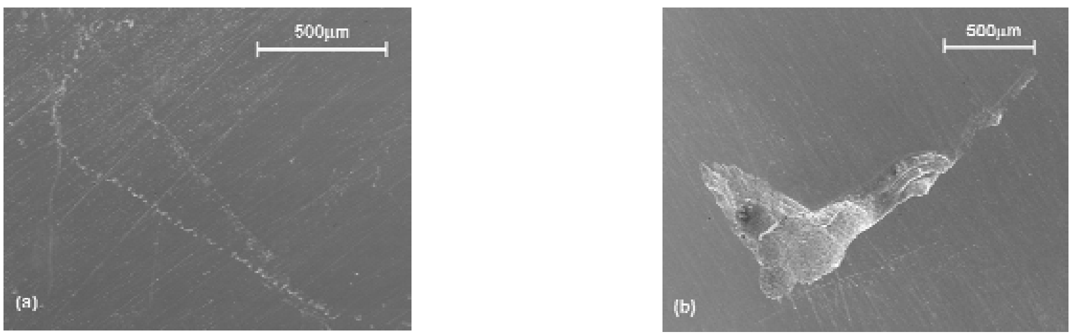

Figure 1. Comparison of corrosion damage (a) beneath a ceramic/metal crevice and (b) beneath a polymer/metal crevice (more severe) on 316 stainless steel in 0.5M NaCl at room temperature polarized to 0.1 V_{SCE}. The test was terminated after a total charge of 10 coulombs was passed to the specimen, and the total test time was less than 3 hours.

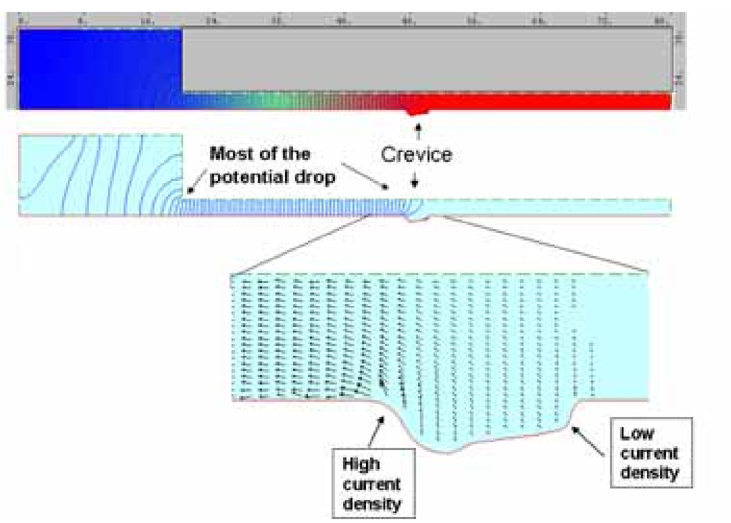

Figure 2. Analytical model for the evolution of the profile of crevice-corrosion damage indicates greater lateral growth than penetration of the metal.