

In Situ Raman Spectroscopic Investigation of Stainless Steel Hydrothermal Corrosion

J.E. Maslar, W.S. Hurst, W.J. Bowers, Jr., and J.H. Hendricks*

ABSTRACT

In situ Raman spectroscopy was used to investigate corrosion of Type 304L stainless steel ([SS] UNS S30403) in air-saturated water at a pressure of 25.2 MPa and temperatures up to 496°C in an optically accessible flow cell. The exposed Type 304L SS coupon also was characterized ex situ with Raman spectroscopy and scanning electron microscopy. After exposure, nickel(II) iron(III) oxide (NiFe_2O_4) and alpha chromium(III) oxide hydroxide ($\alpha\text{-CrOOH}$) phases were detected on the coupon surface. The NiFe_2O_4 phase was first identified after the coupon was heated to 247°C and was observed under all subsequent conditions. Upon heating from 247°C to 326°C, the crystallinity and possibly the thickness of the NiFe_2O_4 phase increased. The $\alpha\text{-CrOOH}$ phase was first identified after the coupon was heated to 326°C and was observed under all subsequent conditions. At least a portion of the $\alpha\text{-CrOOH}$ phase probably originated as a corrosion product released from the optical cell and/or flow system. In situ Raman spectra indicated that the NiFe_2O_4 phase was present in greater amounts and/or was more crystalline during cooling, while there was probably less of the $\alpha\text{-CrOOH}$ phase present in the Raman scattering volume during cooling than during heating.

KEY WORDS: aqueous environments, corrosion product release, general corrosion, Raman spectroscopy, stainless steel, nickel ferrite, temperature