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Hydrogen Diffusion Coefficients through Inconel 718 in Different Metallurgical Conditions

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Cathodic protection is widely utilized for corrosion prevention. However, hydrogen generation and incorporation at the cathodically protected metal surface, followed by diffusion through the metal, may cause hydrogen embrittlement and hydrogen induced stress corrosion cracking, both localized corrosion processes. Hydrogen-induced corrosion depends upon a complex balance between hydrogen uptake, permeation, diffusion and trapping.

Electrochemical hydrogen permeation studies were performed through Inconel 718 foils in three different metallurgical conditions: cold rolled, solutionized, and precipitation hardened. The effective hydrogen diffusion coefficient is considerably higher ($5.3\text{-}6.8 \times 10^{-11}$ cm^2/sec) for the solutionized Inconel 718 than for either the cold rolled ($3.3\text{-}4.2 \times 10^{-11}$ cm^2/sec) or precipitation hardened ($2.1\text{-}2.9 \times 10^{-11}$ cm^2/sec) specimens.

Microstructural studies indicate that the reduced hydrogen diffusion coefficients in the latter specimens arise from hydrogen trapping at dislocations and precipitates that are present at much lower concentrations in the solutionized specimens. In addition, differences between hydrogen transport during the first and subsequent permeation transients provide evidence for irreversible hydrogen trapping in the cold rolled and precipitation hardened specimens, but not in the solutionized specimens.

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