Stress corrosion cracking and crack healing in materials

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Abstract

Mechanism of Stress Corrosion Cracking (SCC) controlled by anodic dissolution has been extensively studied, but controversy still exists. Many researchers believe that corrosion process can facilitate local plastic deformation and suggest new SCC mechanisms. In this presentation, SCC process of a constant displacement specimen in solution observed in TEM was introduced, and the influence of corrosion process on dislocation emission and motion was analyzed according to dislocation morphology change before and after SCC, and also was the relationship between SCC crack nucleation and the change of dislocation morphologies. A new concept---corrosion-induced additive stress induced by passive film or dezincification formed on substrate surface during SCC process was emphasized.

Microcrack healing is an effective method to improve the safety and lifetime of a structure. It has been proven that a microcrack can heal completely after thermal or/and mechanical treatment. Here, in-situ TEM observation of crack healing in α-Fe crystal during heating was presented, and the results indicated that a crack in α-Fe could completely heal when the temperature increased to a critical value. The molecular dynamics method was used to simulate crack healing during heating or/and under compressive stress in Cu crystal. The simulation results showed that a center crack in Cu crystal would close under a compressive stress or by heating. The roles of compressive stress and heating in crack healing were additive. During the crack healing, dislocations generation and motion occurred. If there were pre-existing dislocations around the crack, the critical temperature or compressive stress necessary for crack healing would decrease, and the higher the number of dislocations, the lower the critical temperature or compressive stress. The critical temperature necessary for a crack healing depended upon the orientation of the crack plane.