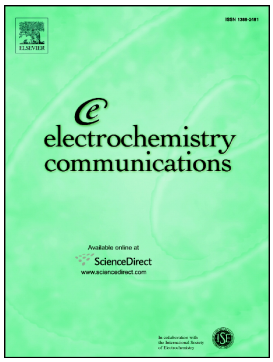

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Nanoindentation study of corrosion-induced grain boundary degradation in a pipeline steel

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Intergranular corrosion, dissolution-induced degradation, stress corrosion cracking, grain boundary softening, nanoindentation.

Abstract

High-strength low-alloy steels used for oil and gas pipelines are vulnerable to intergranular stress corrosion cracking in moderately alkaline soils. The mechanism of corrosion-induced embrittlement under such conditions is not yet understood. Nanoindentation was used to detect localized degradation of mechanical properties near internal grain boundaries of X-70 steel undergoing intergranular corrosion at active dissolution potentials at pH 8.2. The measurements identified a one-micron thick mechanically-degraded layer with 25% reduced hardness near corroded grain boundaries. It is suggested that the corrosion process may introduce an active softening agent, possibly non-equilibrium lattice vacancies generated by oxidation.