Embrittlement of cathodically polarized 2205 duplex stainless steel: Role of hydrogen-assisted void growth

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Abstract Cathodic protection is commonly used for corrosion prevention of duplex stainless steel components in marine environments [1]. However, hydrogen evolution due to cathodic polarization tends to induce hydrogen embrittlement in duplex stainless steel [2]. In this regard, we employed in-situ cathodic protection slow strain rate tensile testing [3] to investigate the mechanical property degradation behavior of duplex stainless steel under different cathodic potentials. Moreover, microscopic characterization methods such as electron backscatter diffraction and theoretical models were employed to reveal the microscopic mechanism of hydrogen-induced mechanical properties degradation and the changes in fracture mode. Microstructural characterization and statistics of interrupted specimens revealed that hydrogen promoted the growth of voids along ferrite blocks. The increases in the misorientation and density of subgrain boundaries near the voids indicated that hydrogen-induced void growth was related to hydrogen-enhanced plastic deformation, as hydrogen can lower dislocation line energy and surface energy, thereby facilitating the emission of dislocations from void surfaces and subsequently reducing the critical stress for void growth, according to the established theoretical model of void growth, which was further supported by that the distribution of geometrically necessary dislocation density near the void fits well with the theoretical model.

Keywords Hydrogen embrittlement, void, duplex stainless steel, cathodic protection.

Reference

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