Hydrogen-Induced Embrittlement in Dual-Phase Steel

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Abstract

Hydrogen embrittlement was first observed in 1875 during acid pickling of iron and steel. It leads to "extraordinary decrease in toughness and breaking-strain". In last 150 years, ¸˜ 50,000 publications came from the regime of hydrogen embrittlement. These publications originated from applied interests and unexplored science. The latter is of direct relevance to the present study. Till now, multiple theories/mechanisms related to hydrogen-induced embrittlement has been proposed. However, there are still scientific unknowns and experimental challenges on this topic. The present study is focused to understand the origin of hydrogen induced embrittlement in dual phase steel. Hydrogen was introduced through electrochemical charging. Subsequently, role of different martensite content on mechanical performance was studied through interrupted, albeit in-situ, tensile testing. Further, strain-localizations were quantified through microscopic digital image correlation (DIC) measurements. Later, multiscale molecular-dynamics (MD) and kinetic Monte Carlo (KMC) simulations were carried out. Our KMC-MD simulations showed hydrogen trapping in various defect sites.

Keywords: Hydrogen, Steel, Embrittlement, Microstructure, Atomistic Modeling.

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