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Hydrogen Economy vs. Hydrogen Embrittlement: Indirect Electrochemical Determination of Hydrogen Diffusion in Steel

Hydrogen has reemerged in recent years as a promising environment-friendly energy carrier that can help reduce the world's dependence on fossil fuels. Despite its unique advantages, there are still challenges regarding the storage and transportation of hydrogen. Specifically, the phenomenon of hydrogen embrittlement (HE) in metals can hinder the widespread use of hydrogen. This study focuses on the analysis of hydrogen embrittlement and hydrogen permeation through metals, with an emphasis on high-strength and duplex-steels. Various steel types were evaluated for their hydrogen permeation properties using a simplified version of the Devanathan–Stachurski permeation cell to measure the diffusion constants and breakthrough times in different steel grades. In combination with Extended X-ray Absorption Fine Structure (EXAFS) analysis, the results indicate that hydrogen embrittlement is dependent on the steel grade and that the manufacturing method plays a key role. Our methodology using indirect electrochemical determination offers rapid and reproducible hydrogen diffusion, providing insights for the development of efficient hydrogen storage systems utilizing steel.

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