Study on the Mechanism of Hydrogen-induced Damage of TC4 Titanium Alloy

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Abstract: Hydrogen embrittlement is one of the important reasons leading to the failure of titanium alloy components. In order to better understand the hydrogen-induced damage and hydride formation mechanism in TC4 titanium alloy and its influence on the fracture behavior of the alloy, the electrochemical hydrogen charging in 3.5wt.% NaCl solution was performed to explore the effects of hydrogen charging current density and hydrogen charging time [1]. It is found that the hydrogen damage of TC4 alloy can be divided into three stages depending on the degree of hydrogen charging. Meanwhile, the preferential permeation path of hydrogen was determined by density functional theory (DFT) calculation [2]. The binding energy and the diffusion energy of H in α phase, β phase, α/β interface, α/α2 interface were revealed, and the effect of hydrogen on the stability of the two-phase interface was clarified. Furthermore, the possible mechanism of hydride formation at the interface was analyzed at atomic scale. Finally, synchrotron radiation was used to conduct in situ characterization and analysis of the deformation of different crystal faces during the tensile process of hydrogen-charged and uncharged TC4 samples, respectively. Combining with more DFT calculations, the effect of hydrogen charge on the mechanical properties of TC4 and its mechanism were analyzed.

Keywords: Hydrogen-induced damage, Hydrogen permeation, TC4 Titanium alloy, Synchrotron radiation characterization, DFT calculation

Reference

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