

How hydrogen damages Ni-based alloys at elevated temperatures

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Abstract

Structural components in the fields of H energy applications (e.g. H₂ gas turbines) can be subjected to a wide range of exposure temperatures. Despite extensive research on H embrittlement at near room temperature, the H-induced damage behavior in Ni-based superalloys at elevated temperatures remains unknown. Here we study the influence of temperature on H-induced damage mechanisms in a Ni-based Inconel 718 alloy subjected to *in-situ* tensile testing under gaseous H₂ environment up to 600 °C. The detrimental effect of H on ductility was found to be pronounced at the temperature range from 25 to 400 °C, whereas such effect is moderate at 600 °C for the tested H₂ pressure and strain rate. At the temperature of 25 and 200 °C, both H-induced intergranular and transgranular fracture were observed, which are associated with δ/γ -matrix interface decohesion and δ phase cracking. A higher proportion of δ/γ -matrix interface decohesion due to H was observed at 200 °C compared with the cracking scenario at 25 °C, which can be attributed to the higher H diffusivity and thus more H accumulation at local microstructural trapping sites. The H-induced damage behavior is markedly different at 400 °C, at which Ti-based carbides cracking become the prevalent damage mode. Detailed characterizations indicate the H-induced transition of these carbides at this temperature. The underlying mechanisms and their impact on damage evolution are further discussed.

Keywords

H-induced damage; Ni-based superalloys; characterization.