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Impact of hydrogen on a polycrystalline CoNiCr-based superalloy

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Hydrogen plays a crucial in the ongoing transformation of the energy and mobility sector and is expected to become increasingly significant as a fuel for gas turbines. Key components of gas turbines are constructed from superalloys, making it essential to understand the impact of hydrogen on these high-temperature materials.
In this study, hydrogen embrittlement in a CoNiCr-based superalloy is investigated using a combination of NanoSIMS measurements, synchrotron and neutron diffraction, and analysis of fractured tensile samples from hydrogen-charged specimens. NanoSIMS mapping revealed the highest hydrogen concentration localized within the grain boundary pinning μ precipitates, a finding corroborated by synchrotron diffraction measurements showing significant lattice expansion of the μ phase after hydrogen charging.
Neutron diffraction experiments further indicate that the γ' phase absorbs more hydrogen than the γ phase, resulting in greater expansion and an increased lattice misfit between the γ and γ' phases.
Tensile tests demonstrate a pronounced influence of hydrogen on the mechanical properties of samples charged with high-pressure hydrogen. The presence of hydrogen within μ phase particles and at the γ/γ' interface promotes considerable crack initiation at the boundaries of the μ phase and facilitates crack propagation along weakened γ/γ' interfaces.

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