INFLUENCE OF □/□ LATTICE MISFIT ON HYDROGEN EMBRITTLEMENT MECHANISM OF SINGLE-CRYSTAL NICKEL-BASED SUPERALLOY CMSX-4

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Hydrogen embrittlement (HE), in which hydrogen (H) penetrates metals to cause a brittle fracture, is primarily influenced by microstructural factors. Nevertheless, the correlation between the interfacial lattice misfit of □ precipitates and □matrix, which is one of the main microstructural factors of nickel-based superalloy, and the HE behavior has not been experimentally clarified. Therefore, the single-crystal superalloy CMSX-4 was utilized to focus on the lattice misfit effect, excluding the typical H-trapping effect of grain boundaries and C-vacancies in carbide. The □/□ lattice misfit was controlled by coarsening of □ precipitates while maintaining a fully coherent interface and a volume fraction of 70% of □ precipitates. The effect of □/□ lattice misfit on HE mechanisms was investigated by correlating the results of digital image correlation (DIC), thermal desorption spectroscopy (TDS), silver decoration, focused ion beam (FIB), and high-resolution transmission electron microscopy (HRTEM). With the increase of □/□ lattice misfit, the HE mechanism of single-crystal nickel-based superalloy with active slip behavior transitioned from HELP mechanism to multiple cooperation of HELP and HEDE mechanisms, increasing HE sensitivity. As the H-trapping ability of □/□ interface enhances by strengthening of interfacial stress field due to the increase in lattice misfit, more H is concentrated at the □/□ interface. During this process, the H-enhanced slip behavior actively transferred H on the □/□ interface to cause HE synergistically.