Macroscale-based approaches for assessing the influence of hydrogen on the deformation behavior of polycrystalline Ni

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Abstract

Our study seeks to leverage macroscale-based, but microstructurally-sensitive approaches to probe the influence of hydrogen on the deformation behavior of Ni-based alloys. Uniaxial tension experiments on Ni-201 charged to hydrogen contents ranging from 0 to 5000 appm are coupled with crystal plasticity simulations to specifically evaluate the effect of hydrogen on texture evolution and work hardening behavior. Results indicate that, for the strains of interest for hydrogen-assisted fracture (< 0.15), texture-based approaches are insensitive to anticipated hydrogen-induced modifications in deformation behavior. Conversely, the work hardening behavior of Ni-201 is found to be sensitive to hydrogen content, indicating that such frameworks may be useful for developing mechanistic understanding as was previously demonstrated in precipitation-hardened Ni-base alloys. In particular, both the dislocation storage and recovery rates are found to increase with hydrogen content, with the latter increasing strongly for concentrations greater than 4000 appm. These observations are considered in the light of previously proposed mechanisms for hydrogen embrittlement.