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A Crystal Plasticity Approach to Model Dynamic Strain Aging

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Abstract : Dynamic strain aging (DSA), resulting from the reorientation of C-Mn clusters in the core of dislocations, can provide a strain hardening mechanism. In addition, in Hadfield steel, negative strain rate sensitivity is observed due to the DSA. In our study, we incorporated dynamic strain aging onto crystal plasticity computations to predict the local instabilities and corresponding negative strain rate sensitivity. Specifically, the material response of Hadfield steel was obtained from monotonic and strain-rate jump experiments under tensile loading. The strain rate range was adjusted from 10^{-4} to $10^{-1}s^{-1}$. The crystal plasticity modeling of the material response was carried out based on Voce-type hardening law and corresponding Voce hardening parameters were determined. The solute pinning effect of carbon atom was incorporated to crystal plasticity simulations at microscale level by computing the shear stress contribution imposed on an arrested dislocation by carbon atom. After crystal plasticity simulations with modifying hardening rule, which takes into account the contribution of DSA, it was seen that the model successfully predicts both the role of DSA and corresponding strain rate sensitivity.

Keywords : crystal plasticity, dynamic strain aging, Hadfield steel, negative strain rate sensitivity
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