Understanding the deformation behaviour of single and multi-phase alloys using crystal plasticity finite element method

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For different single-phase and multi-phase alloys, an intensive investigation has been carried out for understanding the deformation behaviour and the resultant damage mechanism. Despite the attempts by many researchers, a methodical numerical simulation capturing the role of various slip and twin systems inducing the accumulation of stresses and strains at the mesoscale leading to damage is missing in literature.[1] So here, we try to establish the same for single phase FCC and dual-phase FCC + BCC alloys by employing the synthetic microstructures followed by their deformation using crystal plasticity simulations.[2] By using Neper software, both single-phase and dual-phase microstructures having different morphologies namely; equiaxed, bimodal, elongated, and gradient were synthetically generated.[3] Then the finite element software package of FEpX was used to perform the deformation and the results were post processed to obtain mechanical response, evolution of texture as well as distribution of stress and strain at the grain scale. [4] Due to the provision, to include complicated boundary conditions, constitutive laws for plasticity-hardening across the length scale alongside scrutinizing the micro-mechanical response for multiple deformation mechanisms, Neper-FEpX has been proficient in replicating experimental results. To perk it up, an attempt is being made to incorporate the effect the grain size onto deformation behaviour by appending Hall-Petch relation in the source code of FEpX.

Keywords: Crystal Plasticity Finite Element Method, Synthetic Microstructures, Neper, FEpX, Hall-Petch relation

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