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Jinjin Ha, Jinwoo Lee, Ji Hoon Kim, Myoung-Gyu Lee, Frédéric Barlat

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Investigation of plastic strain rate under strain path changes in dual-phase steel using microstructure-based modeling

Jinjin Ha[1], Jinwoo Lee[2], Ji Hoon Kim[3], Myoung-Gyu Lee[4*], Frédéric Barlat[5*]

[1]Department of Mechanical Engineering Department, University of New Hampshire, Durham, 03824, USA

[2]Materials Deformation Department, Korea Institute of Materials Science, Changwon, 51508, Republic of Korea

[3]Department of Mechanical Engineering, Pusan National University, Pusan, 46241, Republic of Korea

[4]Department of Materials Science and Engineering, Korea University, Seoul, 02841, Republic of Korea

[5]Graduate Institute of Ferrous Technology, POSTECH, Pohang, 37673, Republic of Korea

*Corresponding authors

myounglee@korea.ac.kr (MG Lee), f.barlat@postech.ac.kr (F Barlat)

Abstract

Micromechanical-based finite element simulations were carried out to investigate the transient plastic strain rate evolutions of ferrite and martensite dual-phase steel during strain path changes. A representative volume element (RVE) was generated through a three-dimensional (3D) reconstruction of microstructure images which were acquired from sequential polishing of a small material volume. The 10 × 10 × 10 μm^3 3D RVEs consisted of martensite islands embedded in a ferrite base matrix. Each phase was assumed to exhibit distinct mechanical properties but the grain and phase boundary effects were ignored in this work. The effective mechanical properties for the constituent phases were assumed to be well defined by the von Mises or Hill 1948 yield criteria, the associated flow rule, and an empirical isotropic hardening equation based on chemical composition. This model was applied to investigate the transient behavior of the r-value (Lankford coefficient) in uniaxial tension when the loading direction changed. In addition to monotonic tension, compression-tension, and tension-orthogonal tension, sequences were considered. The simulation results captured well in a qualitative manner the experimental r-value evolutions in terms of a