Dislocation density-based finite element analysis of large strain deformation

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In general, simple continuum-based FEM simulations of plastic deformation provide information on deformation geometry and solid mechanics variables. Important outcomes of FEM simulations of SPD processes [1,2] are the information on the evolution of microstructural features (dislocation density, grain size, grain misorientation, etc.) on top of the mechanistic characteristic. In this study, FEM analysis of the HPT process that employed a mechanism-based constitutive model for dislocation cell-forming materials [3] was carried out. Due to the microstructural underpinning of the constitutive model used, it was possible to obtain information about the evolution of dislocation density and dislocation cell size as additional output of the simulations. The simulation results were verified experimentally by using synchrotron X-ray diffraction measurements and Convolutional Multiple Whole Profile analysis.

Keywords: High-pressure torsion, X-ray synchrotron diffraction, Dislocation density, Finite element method, Convolutional Multiple Whole Profile

References:

[1] HS Kim, MH Seo, SI Hong, On the die Corner Gap in the Equal Channel Angular Pressing, Mater. Sci. Eng. 291A, 2000, 86
[2] SC Baik et al., Dislocation Density-Based Modeling of Deformation Behavior of aluminium under Equal Channel Angular Pressing, Mater. Sci. Eng. 351A, 2003, 86

[3] DJ Lee et al., Dislocation density-based finite element analysis of large strain deformation behavior of copper under high-pressure torsion, Acta Mater. 76, 2014, 281