APCOM & ISCM
11-14th December, 2013, Singapore

FTMP-based Simulation of Twin Nucleation and Substructure Evolution under Hypervelocity Impact

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The deformation twinning model based on Field Theory of Multiscale Plasticity (FTMP) utilizes the twin degrees of freedom via an incompatibility tensor, incorporating it into the hardening law of the FTMP-based crystalline plasticity framework, which is then further implemented into a finite element code. The FTMP-based model is adapted to a single slip-oriented FCC single crystal sample, and preliminary simulations are conducted under static conditions to confirm the model's basic capabilities. The simulation results exhibit nucleation and growth of twinned regions, accompanied by serrated stress response with softening. Simulations under hypervelocity impact conditions are also conducted to investigate the model's descriptive capabilities of induced complex substructures composing of both twins and dislocations. The simulated nucleation of twins is examined in detail by using duality diagrams in terms of the flow-evolutionary hypothesis.

Keywords: Deformation twinning, Twin nucleation, Hypervelocity impact, Crystalline plasticity, Multiscale modeling, Field theory