SHOCK17-2016-000002
T

Abstract for an Invited Paper
for the SHOCK17 Meeting of
the American Physical Society

Modeling the nonlinear finite compression response of crystalline solids with generalized Finsler-geometric continuum mechanics

JOHN CLAYTON, US ARL Impact Physics

A continuum theory based on Finsler differential geometry [1] and phase field dynamics is presented. A director component of pseudo-Finsler space is treated as an order parameter; volume dependence obeys a conformal transformation. Applications demonstrate predictive capabilities with little, if any, parameter fitting.
The first application addresses shock compression of magnesium along the c-axis. The order parameter quantifies pyramidal slip and dislocations. Jump conditions for planar shocks are solved. Unlike usual crystal plasticity models [2], no flow rule is required, with slip found from order parameter equilibrium [1].
The second application addresses shear and compression of boron carbide. Two order parameters enter a generalized Finsler state vector: the first accounts for twinning and/or amorphization, the second for fracture. Numerical solutions elucidate failure kinetics, and mesoscale simulations probe effects of polycrystal morphology.

[1] J.D. Clayton. Finsler geometry of nonlinear elastic solids with internal structure. Journal of Geometry and Physics 112:118-146, 2017.
[2] J.D. Clayton and D.L. McDowell. A multiscale multiplicative decomposition for elastoplasticity of polycrystals. International Journal of Plasticity 19:1401-1444, 2003.