

# Alan Needleman

## “Discrete Defect Plasticity and Implications for Dissipation”

Inelastic deformation of solids is almost always, if not always, associated with the evolution of discrete defects. As the defect structure evolves, a portion of the mechanical energy expended in deforming the solid increases the stored elastic energy and a portion is dissipated. The partitioning between energy storage and dissipation plays a key role in a variety of mechanical processes including crack growth resistance, hysteresis in cyclic loading and the thermal softening behavior that promotes mechanical instabilities. The predictions of a mesoscale continuum mechanics framework for this partitioning will be discussed with attention restricted to discrete dislocation plasticity for crystalline solids and to shear transformation plasticity for amorphous solids. The dislocations are modeled as line defects and the shear transformation zones are modeled as Eshelby inclusions, along with kinetic equations for their evolution. The kinetic relations must satisfy the second law of thermodynamics which, in the context of a purely mechanical theory, requires that the dissipation rate is non-negative. Restrictions on kinetic relations for non-negative dissipation (a necessary but not sufficient condition) and of non-negative dissipation rate will be presented. The implications of the restrictions imposed by such kinetic relations will be discussed along with open questions.



Alan Needleman

Alan Needleman completed his Ph.D. at Harvard University in 1970 and then spent five years in Applied Mathematics at MIT before joining Brown University where he became Florence Pirce Grant University Professor. In 2009 he moved to the University of North Texas and in 2015 joined Texas A&M University where he is a University Distinguished Professor and holder of the Royce E. Wisenbaker '39 Chair II in the Department of Materials Science and Engineering. Professor Needleman is a Member of the US National Academy of Engineering and of the American Academy of Arts and Sciences, and is an Honorary Member of ASME. He was awarded the Prager Medal by SES and the Drucker and Timoshenko Medals by ASME. He also holds honorary doctorates from the Technical University of Denmark and Ecole Normale Supérieure de Cachan (France), and is an Honorary Professor of Dalian University of Technology (China).