COMPUTATIONS OF DISLOCATION STRUCTURES AND DEFORMATION TEXTURES IN NANO-STRUCTURED METALS

M. Ortiz[a] and **S.M. Sivakumar**[b]

[a]Graduate Aeronautical Laboratories
California Institute of Technology
Pasadena, CA 91106.
ortiz@aero.caltech.edu

[b]Department of Applied Mechanics
Indian Institute of Technology Madras
Chennai 600 036. INDIA
mssiva@iitm.ac.in

Equal-channel angle extrusion (ECAE) processing of metals has recently been developed [1] to obtain fine / ultra fine grain sizes (10 to 1000 nm). The high shear deformations introduced in ECAE processing lead to nano-structures in metals.. The result is very high ductility without loss of strength - an extremely attractive combination of properties. The sequencing of ECAE passes is very important in two ways: one in obtaining fine grain sizes and the other in obtaining specific texture of the material thus controlling the specific properties of the material.

We wish to present the results of our work on computations related to the prediction of salient features of micro-structures resulting from large shear deformations that metallic materials undergo during equal channel angular extrusions. The theory of crystals with microstructure proposed by Ortiz et al. [2,3], extended to accommodate for strain path changes, is used for the simulation. The evolution of texture for polycrystalline materials is studied by taking recourse to the Taylor's approach.

Issues related to the following will also be discussed in the presentation:

1. effectiveness of use of rank-one convexification solutions proposed by Kohn [4] as effective minmizers for the nonconvex incremental potential obtained in the proposed theory.
2. Branching constructions to capture dislocation pileups at the grain boundaries and dislocation walls.
3. the situations leading to grain subdivisions or creation of new grain boundaries.
4. simulation at different length scales associated with non-uniformity of deformation.

References:

[1] V.M. Segal, Material Processing by Simple Shear, *Mater, Sci. Eng.* A197: 157-164, 1995.

[2] M. Ortiz and E. A. Repetto. Nonconvex energy minimization and dislocation structures in ductile single crystals. *J. Mech. Phys. Solids*, **47**(2):397–462, 1999.

[3] S. Aubry and M. Ortiz. The mechanics of deformation-induced subgrain dislocation structures in metallic crystals at large strains. *Proc. Royal Society of London,* in press, 2003

[4] R.V. Kohn. Relaxation of a double-well energy. *Cont. Mech and Thermodyn.*, **3**:193–236, 1991.