Mechanical Behavior of Metals and Its Mathematical Modeling

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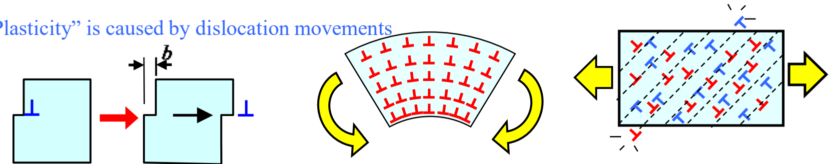
"Plasticity" is caused by dislocation movements



Geometrically necessary (GN) dislocations that contribute to size effects

Statistically-stored (SS) dislocations that never contribute to size effects

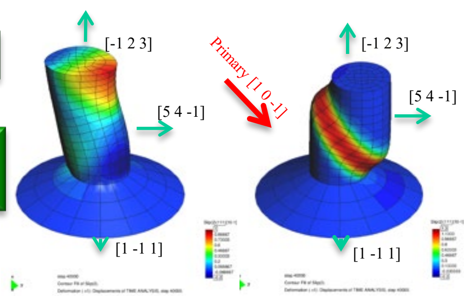
Distribution of GN dislocations

Self-equilibrium internal stresses

Incorporation into conventional continuum mechanics

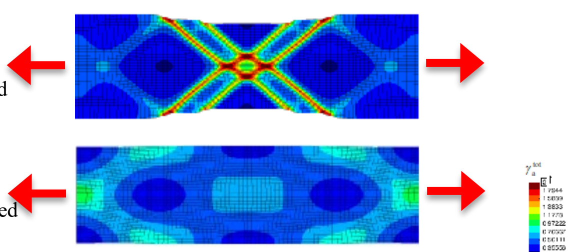
Higher-order gradient crystal plasticity

Compression of micropillar specimen



Millimeter-sized specimen   Micrometer-sized specimen

Dynamic tension: Interaction between inertial effect and intrinsic material length scale effect



$L_0 = 250\mu m$
$V_1 = 20 m/s$
$2V_1/c_d = 0.0068$

Content:

Conventional mechanics of materials does not account for intrinsic material length scales. When similarities exist in geometric dimensions and load conditions in two problems, the conventional theory gives the same stress and strain solutions regardless of the assumed dimensions. In reality, peculiar material behavior is observed at the micrometer scale, i.e., the size effect exists. In the present study, a theory of microscale plasticity is pursued, incorporating knowledge of accumulations and movements of dislocations. Using this theory, strengthening mechanisms of metallic materials, which have not yet been understood completely, are investigated. The phenomenon "smaller is stronger" generally is observed. But, its physical cause is not known completely. The developed theory is expected to be utilized in designing and developing new high-strength/high-ductility materials.

Appealing point:

Regardless of the long history that human beings developed the modern society with effective use of metals, we have a lot of unresolved problems about them. This study aims at theoretical modeling of mechanical behavior of metals, which enable us to simulate the phenomena from deformation to fracture in a digital computer.

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Research Interest: Mechanics of Materials

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