expresses the delayed control action using a truncated Taylor's series in terms of the current control action and its derivatives. The results of the stability and the time delay compensation are discussed using a numerical example.

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MS06: Effects of small size scales in materials modeling
10:50–12:50, Wednesday, 22 August
Horacio Espinosa, USA, Chair
Zhiping Xu, China, Chair
Room: Function Hall C

10:50–Function Hall C

Size matters: size-dependent mechanical properties of metallic systems

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When microstructural (intrinsic) or external material dimensions are reduced to nano-scale, they exhibit unique behaviors. We fabricate nanopillars with different initial microstructures ranging from 50 nm to 1 micron by using focused ion beam and E-beam lithography/electroplating approaches. Their strengths in uniaxial compression and tension are subsequently measured in in-situ mechanical deformation instrument, SEMentor. We discuss nano-mechanical behavior in four distinct metallic systems: single crystals, nano-crystalline metals, nano-twinned metals, and metallic glasses. We observe 'smaller is stronger' and dislocation nucleation controlled plasticity in single crystals and in nano-twinned metals while nano-crystalline metals exhibit 'smaller is softer' trend. Metallic glasses show strength increase and ductility when reduced to nano-scale. We discuss these phenomena in the context of nano-scale plasticity mechanisms.

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11:10–Function Hall C

Approaches to remove size effect due to indenter roundness in nano-indentation

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The results of indentation are hard to interpret because the effects of indenter roundness and material's intrinsic properties coexist, especially when the indentation depth is within one hundred nanometers. The effect of indenter roundness is inevitable and unpredictable due to imperfections from manufacture and abrasion during use. Therefore, the approaches to remove the effect of indenter roundness are carried out, so that the actual size effect of material can be revealed. Applications of these ideas also lead to guidelines of minimize the influence of false size effects by the tip roundness.

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11:30–Function Hall C

Defects interaction conditions in near-field of grain boundaries

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A new condition of dislocation-grain boundary interaction was proposed to describe the experimental results of nanoindentation in the inhomogeneous near-field of GB. The conventional conditions proposed so far were also calculated for ideal bicrystal model with < 110 > symmetric tilt GB of copper. It was found that the already proposed M-value, which considers the geometric intersection between slip plane and GB, was more sensitive to misorientation angle Φ than the N-value of stress tensor transformation between two grains. Change of the magnitude of residual Burgers vectors between incoming and outgoing Burgers vectors for GB (so called LRB-condition) is much correspondent to M-value. The newly defined L'-value, which considers the superposition of slip transfer and dislocation nucleation contributions, was obtained for the previous bicrystal model under uniform compression on (110) surface, and the result suggests that $\Sigma 3A\{111\}$ (Φ=70.52 deg.) is easiest for nucleation of plasticity in the near-field of < 110 > tilt GB.

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11:50–Function Hall C

Modeling of inelastic microstructure development and inhomogeneous material behaviour via non-convex rate-dependent gradient plasticity

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The formulation of gradient inelasticity models has generally been focused on the effects of additional size-dependent hardening on the material behavior. Recently, the formulation of such models has taken a step in the direction of phase-field-like models in the sense that energetic microstructure interaction and development is accounted for via non-convex contributions to the free energy of the system. In the current work, the formulation of such free energy models and the corresponding IBVP using rate variational methods are briefly discussed. With the help of two simple models for such interaction non-convexity, it is shown that phenomena like stress relaxation after yielding as well as PLC-like serrated flow result from the corresponding inelastic deformation microstructure development and non-convexity.

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