NANO HIGHLIGHT
Deformation Mechanisms and Manufacturing of Nanostructured Materials Processed by Severe Plastic Deformation (SPD)

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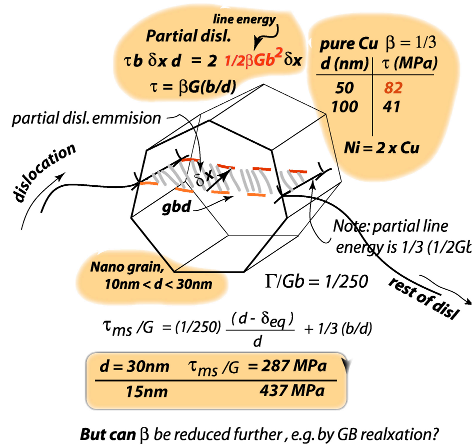
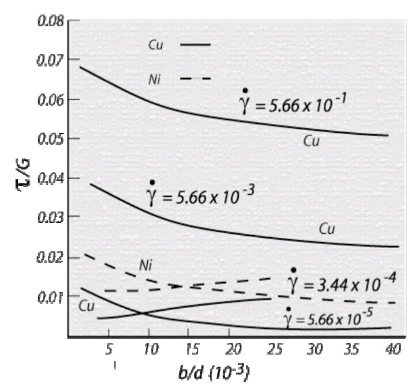
Deformation Mechanisms: When grain sizes fall below approximately a micron the mechanisms of deformation no longer simply involve the processes of slip as is now well established for ductile metals and alloys with traditionally larger grain sizes. We have developed a perspective and framework for describing what turn out to be alternative deformation mechanisms and, indeed, for transitions between alternative mechanisms. Figure 1 illustrates the issue. We have determined that when grain sizes fall much below, say, 50nm traditional dislocation slip, involving the generation and propagation of intra-grain dislocations. The figure, and the analysis underlying it, illustrates that at such fine grain sizes perfect dislocation emission, from grain boundary triple points, is superceded by the emission of stacking faults (*i.e.* partial dislocations) that traverse the grains as discrete units causing "slip". The process creates stacking faults, and the energetics of this reveals the significance of stacking fault energy as an important parameter in determining the resistance to deformation and thus strength. We have developed a rigorous constitutive framework for describing this process and are in the process now of implementing our new theories in computational models. We plan to specifically compare our simulated results with detailed measurements made on nanocrystalline Ni.



We have additionally used this new approach to analyze the important phenomena of transitions in deformation mechanisms, in particular transitions between mechanism involving fault emission and grain boundary sliding. Figure 2 illustrates one set of results for Cu and Ni which maps the transitions as functions of strain rate and grain size.



For further information about this project email rasaro@ucsd.edu. Also, see: hogwarts.ucsd.edu/~nirt.

References :

[1] Asaro, R. J., Krysl, P. and Kad, B., "Deformation Mechanism Transitions in Nano-Scale FCC Metals", to appear in Phil. Mag. Letters

[2] Asaro, R. J., Krysl, P. and Kad, B., Transitions in Deformation Modes in FCC Nanocrystalline Metals, in preparation for publication.

[3] Yuntain Zhu, Asaro, R.J. *et al.*, "Development of Repetitive Corrugation and Straightening", in press, Materials Science and Engineering, January 2003.