Microsymposium

MS15.O01

Are Dislocations Possible in Nanoparticles?

P. Ferreira[1]

[1]*University of Texas at Austin, Materials Science and Engineering Program, Austin, TX, USA*

The deformation behavior of nanoscale metals continues to be an exciting area for materials research. However, in the case of single crystal 0-D nanoscale metals, no deformation experiments, to our knowledge, have been performed at the nanoscale. The one experiment closest to the nanoscale was an in-situ TEM compression of ~200 nm Si nanoparticles. However, the particle tested was too large to extract relevant information at the nanoscale and the mechanical deformation of Si is also expected to be different from that of metals. For nanoparticles it is claimed there is a conspicuous lack of dislocations, regardless of the materials processing history, even after significant deformation. Therefore, it has been suggested that dislocations cannot exist or/ do not play a role on the deformation of 0-D nanomaterials. To address this issue of the role played by dislocations in the deformation of 0-D nanomaterials, nanoparticles with diameters <20nm were compressed in-situ under phase-contrast in a transmission electron microscope (TEM). Two phase-contrast TEM experiments were done, one in a conventional TEM and the other in an aberration corrected TEM. Evidence for nucleation of dislocations and dislocation motion was observed during in-situ TEM nanoindentation, but upon unloading dislocations were no longer visible. A new model for explaining dislocation instability is introduced. In this model we consider the change in Gibbs free energy of an edge dislocation, as it moves through the nanoparticle, towards the surface. The nanoindentation experiments seem to confirm the model proposed.

[1] *C.E. Carlton, P.J.Ferreira, "In-situ TEM Nanoindentation of Nanoparticles", Micron, Special Issue, Vol. 43, pp. 1134-1139, (2012)*

Keywords: Dislocations, Nanoparticles, Transmission Electron Microscopy