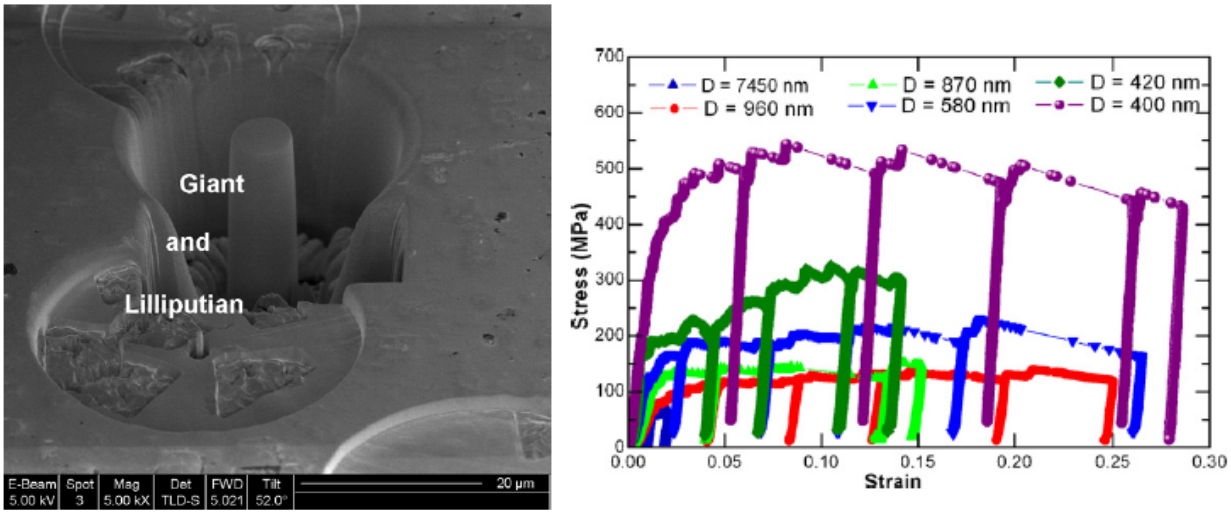
Mechanical Properties of Materials with Nanoscale Microstructures
W.D. Nix et al., Stanford University

Supporting/Contributing Agencies: DOE/NSF

The newly developed nanopillar compression technique for studying the mechanical properties of materials at extremely small length scales has led to the discovery of a new strategy for strengthening materials. Whereas most crystalline materials are strengthened by introducing defects within the crystalline lattice, nanopillar compression experiments have led to the suggestion that crystalline materials in small dimensions can be hardened by a process called "dislocation starvation," wherein defects are gradually removed from the crystal by deformation. Direct visual evidence for this new hardening process has now been found using *in situ* transmission electron microscopy. This discovery indicates that strengthening of nanoscale metal crystals by plastic deformation is caused by making removing defects and not by adding them, as is the case in bulk metals.



Left: Two representative gold pillars made by focused ion beam machining a <001> single crystal. Right: Stress–strain relations for <001> gold pillars of different sizes showing the strong size effect for this kind of deformation.

References/Publications

W. D. Nix et al., *Thin Solid Films*, **515**, 3152-3157 (2007).