AEROSPACE & MECHANICAL ENGINEERING

2010 COLLOQUIUM 2011

SEMINARS ARE OPEN TO THE PUBLIC

INFORMAL COFFEE PERIOD BEFORE THE SEMINAR IN ROOM 365 FITZPATRICK HALL

UNIVERSITY OF NOTRE DAME, NOTRE DAME, INDIANA 46556

Founded 1842

MIDWEST MECHANICS SEMINAR

SPEAKER: **Professor William D. Nix**
Department of Materials Science and Engineering
Stanford University
Stanford, California

TOPIC: **SIZE DEPENDENCE OF STRENGTH OF METALS**

DATE: Tuesday, April 12, 2011

TIME: 3:30 p.m.

PLACE: 138 DeBartolo Hall

ABSTRACT

For more than 350 years, since the time of Galileo, the design of mechanical structures has been based on the principle that the strength of materials is independent of the size of the specimen. But now, as mechanical structures and devices are being created on a smaller and smaller scale, we are finding that this basic principle is beginning to break down. We are finding that "smaller is stronger." The mechanics community, in collaboration with the materials community, has contributed significantly to understanding some of these size effects through the development of strain gradient plasticity. Here we review the evidence for size dependent strength related to plastic strain gradients by considering the indentation size effect in nanoindentation and the geometrically necessary dislocations thought to be responsible for this effect. It is shown that Taylor's model of strain hardening can be used to derive a law for strain gradient plasticity that is expected to apply not only to indentation, but also to other situations where strong plastic strain gradients are present. Until recently, this was the accepted way to understand size effects in crystals without interfaces or microstructures. But now, within the past half-decade, we are finding that the strength of metal single crystals is size dependent even in the absence of strain gradients. Here we show that these size effects begin to arise when the specimen size approaches the spacing between dislocations, in the few micrometer regime, and becomes even more pronounced when the specimen size is much less that the dislocation spacing, in the sub-micrometer regime. In this size regime strength is dislocation source-limited, with fewer sources of dislocations is smaller specimens. Some support for the source-limited picture of strength and plasticity is found in recent pre-straining and annealing experiments on gold micropillars, wherein the micropillars are found to be weakened by pre-straining and strengthened by annealing, just the opposite of what occurs in bulk crystals.

NOTE: ***If you are interested in meeting individually with Prof. Nix, please contact Evelyn at 631-5431.***