Università degli Studi di Brescia

DOTTORATO
MATERIALI per l'INGEGNERIA

Seminars 2012

prof. Christian F. Niordson

Department of Mechanical Engineering

Technical University of Denmark

Aula Riunioni, DICATAM
Facoltà di Ingegneria
Via Branze 43
25123 Brescia

November 5th 15:00 -16:00

Size effects in metal plasticity

Introduction to Strain Gradient Plasticity Theory

On the scale of tens of microns and below, metals exhibit non-trivial size-effects: 1) Micron size wires have a surprisingly large torsional stiffness, 2) measured hardness is larger for smaller indentations, and 3) thin films have larger normalized bending stiffness when compared to thicker films. These are just a few of the size-effects that have been revealed experimentally over the past two decades, and they all obey the simple principle that 'smaller is stronger'. In this lecture the experimental evidence of size-effect in metals is presented. The physical explanation for size effects is discussed, and the concept of higher order continuum theories is introduced as a means to model non-trivial size-effects. Numerical solution techniques are presented along with various numerical examples.

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Modeling size effects in single crystals

A new numerical method for modeling size-dependent behavior in single crystals is presented. The higher order model, which accounts for both energetic and dissipative gradient effects, is presented together with a mathematical solution procedure based on two minimum principles. Effective 2D-solutions valid for certain orientations of face centered cubic crystals are presented, where the effective in-plane material properties are derived based on the crystallographic properties. The benchmark problem of pure shear is analyzed, and results on growth of a circular void in an infinite medium and wedge indentation are presented.

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