



Nanoindentation

Groma István

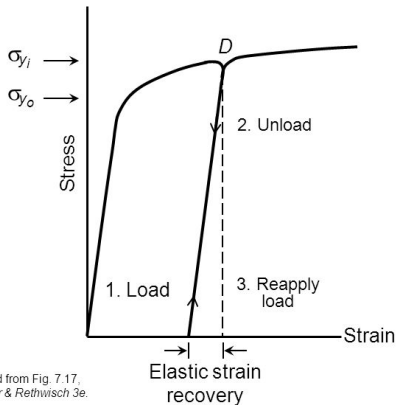
Eötvös Loránd University Budapest, Semilab

March 6, 2024





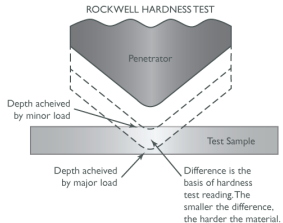
Elastic Strain Recovery



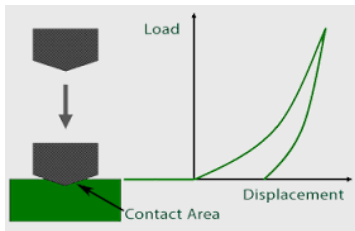
Adapted from Fig. 7.17,
Callister & Rethwisch 3e.

Traditional hardness measurement

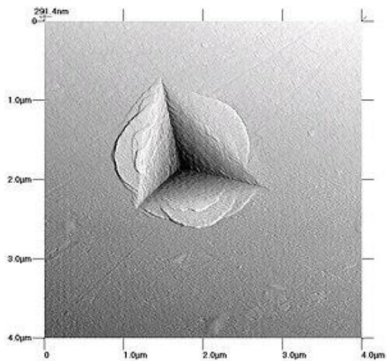
Old times: $H = F/A$



Dynamic hardness measurement

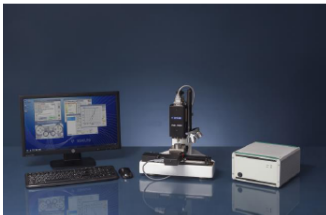


Shimadzu DUH-202



IND-1000

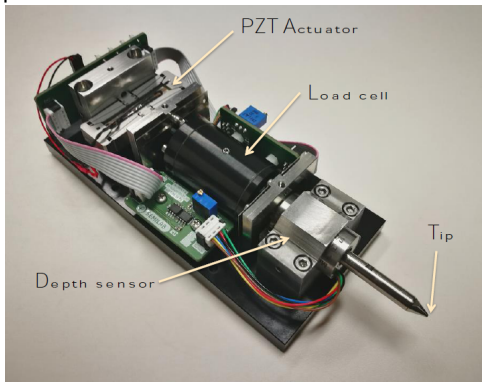
desktop base version



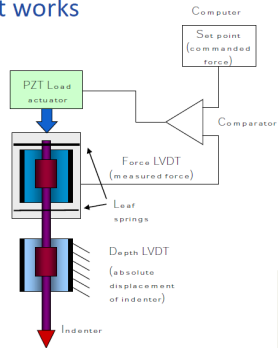
IND-1500

base version + better
vibration isolation

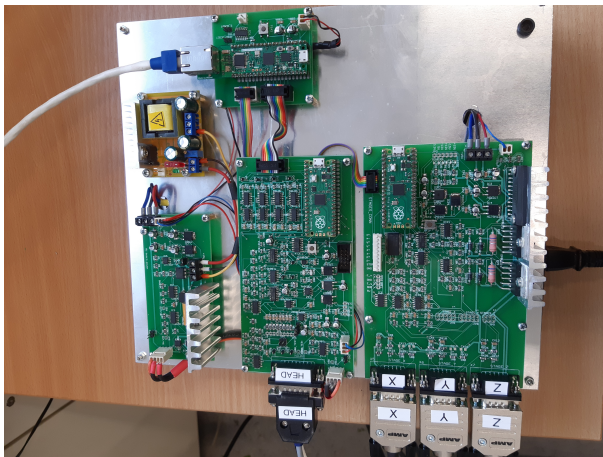




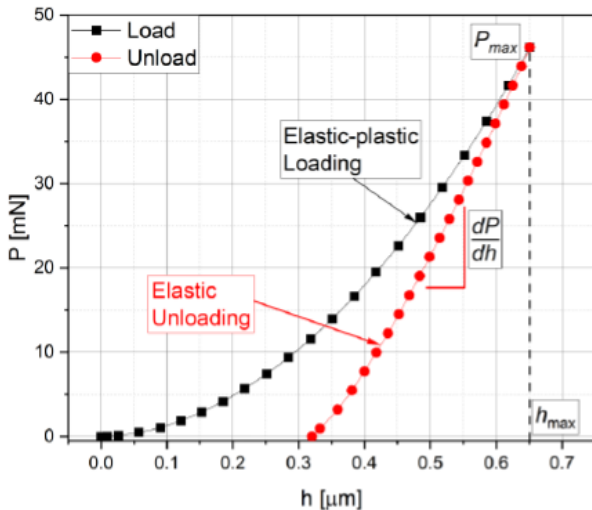
How it works



Current development

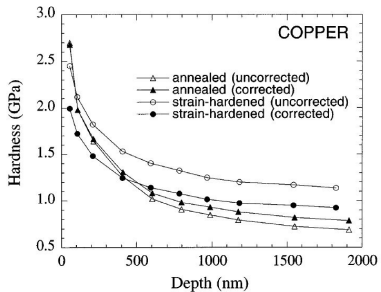


Properties of the hardness measurement



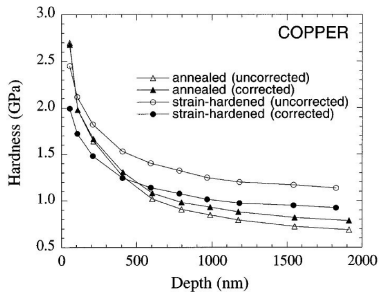


Size effect





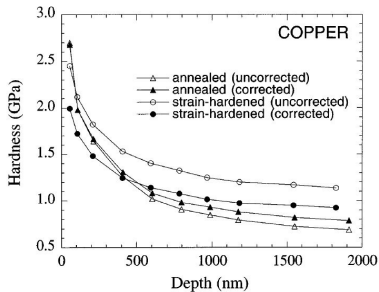
Size effect



Local plasticity

$$\tau_{class}(\gamma, \dot{\gamma}, \dots)$$

Size effect

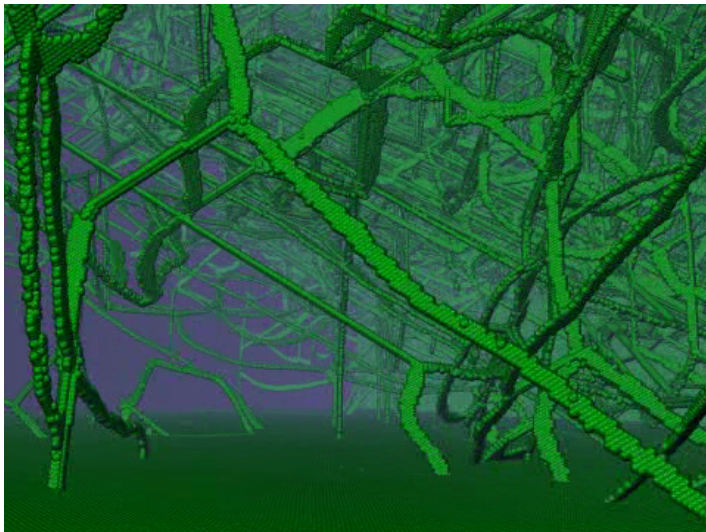


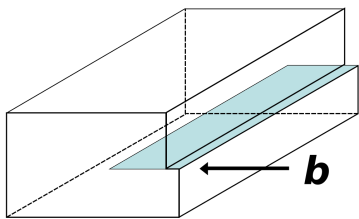
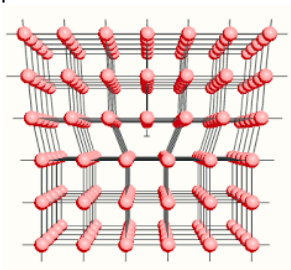
Nonlocal plasticity

$$\tau(\gamma, \dot{\gamma}, \dots) = \tau_{class}(\gamma, \dot{\gamma}, \dots) + l^2 \mu \frac{d^2}{d\bar{r}^2} \gamma$$



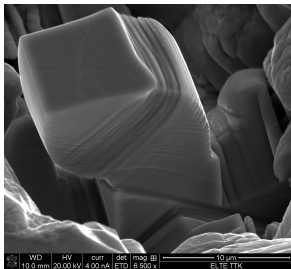
MD simulation



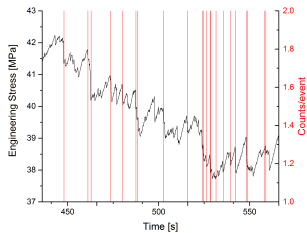
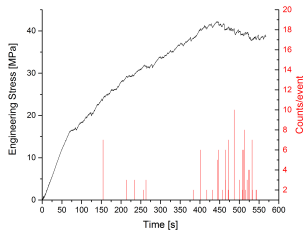
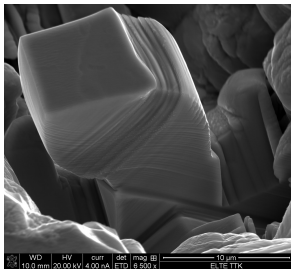


**Az elcsúszás nem egyszerre megy végbe
Ez csak akkor lehetséges, ha a kristály
tartalmaz egyméretű rácshibákat,
diszlokációkat.**

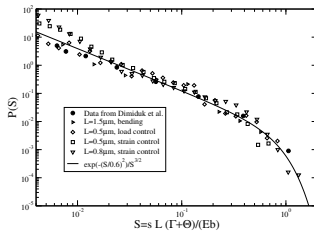
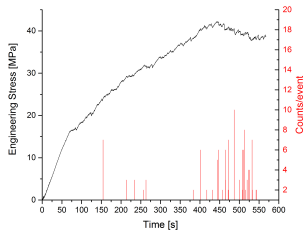
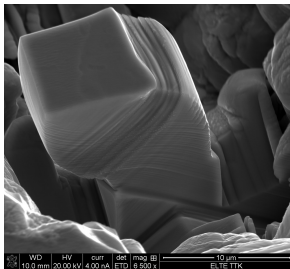
Pillar compression

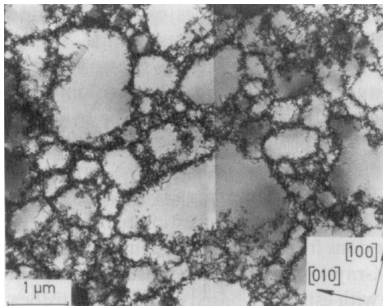


Pillar compression

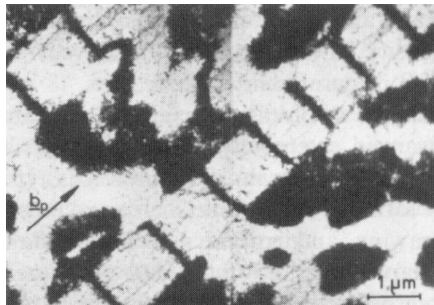


Pillar compression





Cell structure



PSB structure

In situ device

