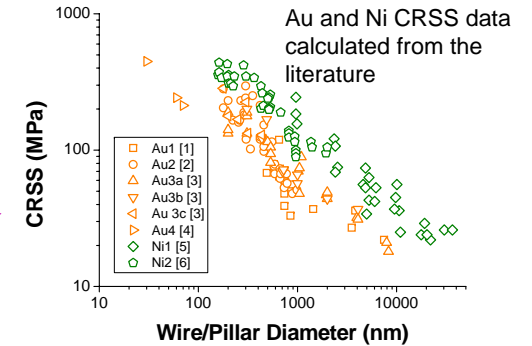
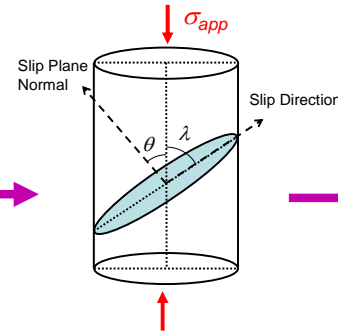
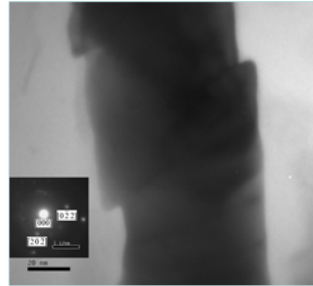
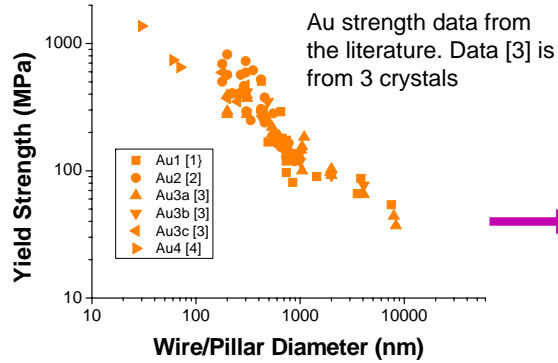


Universal Scaling Laws for the Strength of Metallic Nanowires

Rui Dou and Brian Derby



There is a pronounced size effect observed with the compressive deformation of metal pillars or wires at dimensions below 1000 nm.

But observations of deformed structures show severe slip localisation. More appropriate to measure critical resolved shear stress (CRSS) on the active slip system.

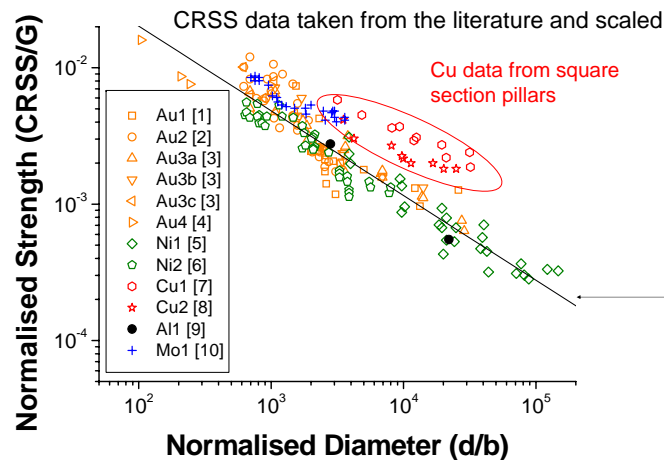
$$CRSS = \sigma_{app} \cos \theta \cos \lambda$$

Both Au and Ni nanowires show a strong similar size dependence when data from different crystals is resolved onto the highest Schmid factor slip plane.

Universal Scaling Law

Normalise the CRSS by the shear modulus (G)
 Normalise diameter by Burgers' vector
 Data for Au and Ni are colinear; data for Al in same region
 Data for Cu is displaced but these are from square section specimens – Au, Ni and Al are circular section (shape factor?)
 Trend line is from all normalised fcc data excluding Cu

Data for one bcc metal (Mo) is included and if slip is assumed to occur on $\{1\bar{1}0\} \langle 111 \rangle$ the CRSS is found to occupy the same parameter space as data for fcc metals



Conclusions
 After normalising the data the size effect in the compression deformation of Nanowires or Nanopillars is seen to follow a universal scaled behaviour with

$$\frac{\sigma_{CRSS}}{G} = A \left(\frac{d}{b} \right)^{-0.62}$$

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