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Nonlinear structural dynamics in metal nanowires

JÉRÔME BÜRKI, University of Arizona

Most atoms in a metal nanowire are surface atoms with low coordination number. Classically, surface effects are expected to dominate their stability and structural dynamics, leading in particular to wire break-up due to the Rayleigh instability. On the other hand, long gold [1] and silver [2] nanocylinders have recently been observed using transmission electron microscopy, pointing to the presence of an additional stabilizing mechanism. Evidence of electron-shell filling effects [3] have been found in conductance histograms for various metals, suggesting that this mechanism comes from the transverse confinement of the electrons within the nanowire. Using the nanoscale free-electron model, a continuum model of the structural dynamics of simple-metal nanowires, I will discuss how the interplay of surface and electron-shell effects explains the stability and long lifetimes of nanowires, and favors the formation of kinks connecting cylindrical segments of the wire. A rich dynamics involving kink interactions and kink/antikink pair-creation and annihilation is uncovered, and is shown to explain the observed step-by-step thinning mechanism of Au nanowires [4].

[1] Y. Kondo et al., Science 289, 606 (2000).
[2] V. Rodrigues et al., Phys. Rev. Lett. 85, 4124 (2000).
[3] A. I. Yanson et al., Phys. Rev. Lett. 84, 5832 (2000).
[4] Y. Oshima et al., J. Electron Microsc. 52, 49 (2003).