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A COMPARISON OF NANOWIRE YOUNG'S MODULUS OBTAINED VIA RESONANCE AND BENDING

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ABSTRACT

The prediction of the size-dependent nanowire Young's modulus has been a critical issue in experimental and computational nanomechanics. The experimental issues arise due to uncertainties related to handling, positioning, imaging, gripping, applying and simultaneously measuring the nanoscale forces and displacements that are needed to accurately characterize the Young's modulus of nanowires. The computational difficulties arise due to the lack of multiscale models that accurately capture surface stress and surface elastic effects on the nanowire mechanical properties. In this work we utilize the recently developed surface Cauchy-Born (SCB) model, which incorporates surface effects within a conventional three-dimensional nonlinear finite element formulation, to study the size-dependent Young's modulus of gold nanowires. In particular, we study fixed/fixed nanowire geometries, and use the SCB model to predict the nanowire Young's modulus through numerical bending and resonance tests. Differences that arise between the resonance and bending predictions will be explained within the surface elasticity framework, with comparisons to available experimental data, while the variations in nanowire modulus will be further characterized as functions of size, geometry and surface area to volume ratio.

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