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Interplay between Quantum Size Effect and Strain Effect on Growth of Nanoscale Metal Thin Film[1] MIAO LIU, University of Utah, YONG HAN, Iowa State University, FENG LIU, University of Utah — Quantum Size Effect (QSE) has been shown to be a dominant factor in the growth of metal nanofilms on semiconductor substrates in the so-called electronic growth regime. On the other hand, the strain effect is ubiquitous in heteroepitaxial growth of semiconductor and metal thin films. Most time, however, these two important effects have been studied separately focusing on one while neglecting the other. Here, we develop a theoretical framework to investigate the interplay between QSE and strain effect on the stability of metal nanofilms. The QSE and strain effect are shown to be coupled through the concept of "quantum stress". First-principles calculations reveal large quantum oscillations in the surface stress of metal nanofilms as a function of film thickness, which adds extrinsically additional strain-coupled quantum oscillations to surface energy of strained metal nanofilms. Our theory enables a quantitative estimation of the amount of strain in experimental samples from the measured stability patterns, explaining a possible origin for some outstanding discrepancies between the existing theories and experiments.

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