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One-Dimensional Shell Effects in Thin Metal Films

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During epitaxial growth and thermal processing of metal thin films on semiconductors, the system often self-organizes into domains or islands of preferred heights. This extra stability for specific film thicknesses has an electronic origin; confinement of the electrons in the film causes the formation of quantum-well states, which cross the Fermi level periodically as the film thickness increases. These periodic Fermi level crossings give rise to one-dimensional shell effects, akin to the shell effects associated with the periodic table. As a result, large variations in film properties are expected, including the surface energy that determines the stability and preferred heights of the film, the work function and other surface properties, and the superconducting gap and transition temperature. This talk will present highlights in recent advances on this subject, including angle-resolved photoemission measurements of the electronic structure and experimental and theoretical determinations of the amplitude, damping, period, and phase relationships of the property variations. The roles played by the substrate and the effects of phonon scattering will also be discussed. See T. Miller, M. Y. Chou, and T.-Chiang, "Phase relations associated with one-dimensional shell effects in thin metal films," Phys. Rev. Lett. **102**, 236803 (2009), and references therein.