Physics Ph.D. Thesis Defense

Monday, April 30, 2007

1:00pm

DeMeritt Hall, Room 209B

Self-Assembly on Strained Metallic Interfaces
and
Novel Collective Electronic Excitations on Be(0001)

Bogdan Diaconescu

Department of Physics, University of New Hampshire

Well-ordered misfit dislocation networks of thin metal films are a viable candidate for growth of two-dimensional ordered nanocluster arrays with specific symmetries, feature size and lattice spacing. Such bottom up processes can be very complex involving collective effects from large numbers of atoms. Understanding of these self-assembly processes requires detailed experimental information at the atomic level of large ensembles of hundreds to thousands of atoms and thus large scale VT-STM imaging is an essential tool for such studies. In the case of sulfur adsorption on submonolayer silver films on 0001 surface of ruthenium, the Ag's short herring bone rectangular misfit dislocation unit cell of 19(18)x16(15) Ag atoms reconstructs into a well-ordered triangular array of S filled Ag vacancy islands 18 Ag atoms apart. Atomically and time resolved variable temperature STM measurements from our home built STM correlated with 2D Frenkel-Kontorova models based on first principles interaction parameters show how a sequential process of Ag vacancy island formation, followed by annihilation of adjacent and opposite pairs of threading dislocation and glide of Shockley partial dislocations generates the uniform triangular array of Ag vacancy islands. We conclude that the strain in the Ag film is the driving force responsible for the surface self-assembly process.

Sound-like longitudinal plasma waves where thought to only exist in layered systems where spatially separated 2D electron plasmas are realized. Due to their low excitation energy and linear dispersion such waves were proposed as possible candidates to mediate the attractive interaction leading to the formation of Cooper pairs in high TC superconductors. A new type of collective excitation mode on metal surfaces has been found. In contrast to the usual surface plasmon, it has an acoustic dispersion. For Be(0001) the mode was observed using Electron Energy Loss Spectroscopy. Detailed first principle calculations show that it is caused by the coexistence of a partially occupied quasi-2D surface state band with the underlying 3D continuum in the same region of space. While it exists up to high energies for Be(0001), facilitating its observation, the mode as such has a very general character. For low energies it is expected to be present on many surfaces, profoundly affecting their electron and phonon dynamics.