Chapter 4
Conclusions

STM was utilized to study the system of Pb deposited on the Si(111) surface. The phase transition of nearly one monolayer of Pb deposited on Si(111) is very complicated and depends on both the coverage and the temperature. A new “devil’s staircase” phase diagram, which is determined from the phase and corresponding stability, is obtained experimentally. However, the existence of defects strongly affects the phase diagram. The defects act as traps of adatoms. Accordingly, the phase transition that follows from the release of stress begins at the defects. The coverage of the deposit strongly affects the stability of the phase, and the homogeneity of the stress in the system varies with the temperature.

The growth behavior of Pb deposited on the Si(111)7×7 surface has also been studied. From nucleation to growth, a unique 3D-to-2D transition pathway is found for each thickness of the Pb islands. However, the variation in the timing of the transition from 3D clusters into 2D islands causes the distribution of the thickness of Pb islands grown on a Si(111)7×7 surface to be distributed over a wide range. Given the same coverage, the thickness of Pb islands is not the same as that on the incommensurate phase of the Pb/Si(111)1×1

surface. The different electronic properties of the Pb-Si interface can explain these results.

Pb islands that grow on the incommensurate phase exhibit two patterns of different contrast. They are associated with different stackings at the Pb-Si interface and the subsequent electron scattering associated with the phase shifts that are related to the potential variations at the interface. The patterns of electronic origin can serve as a template for fabricating an ordered array of nanopucks. Ag nanopucks grow on the pattern spontaneously in a highly ordered array. The trapping power obtained from a quantitative calculation reveals different binding energies of Ag atoms in the nanopucks on Type I and Type II islands. The growth clearly shows a bi-layer oscillation in the electronic property as well as interlayer spacing of the Pb islands. Additionally, the *dI/dV* measurements also show an oscillatory characteristics of the bi-layer. The *dI/dV* spectra indicate that lateral confinement influences the electronic characteristics of the Ag nanopucks. The electronic properties depend on the sites, sizes and shapes of the Ag nanopucks. A detailed examination of the electronic properties of Ag nanopucks reveals the effect of the substrate on the electronic properties of the metal Ag adsorbates on the surface of the Pb overlayer.