[V-20] [초청]

Surface State Electrons as a 2-dimensional Electron System

Yukio Hasegawa
Institute for Solid State Physics, The University of Tokyo, 7-22-1, Roppongi, Minato-ku, Tokyo 106-8666 Japan

Recently, the surface electronic states have attracted much attention since their standing wave patterns created around steps, defects, and adsorbates on noble metal surfaces such as Au(111), Ag(111), and Cu(111) were observed by scanning tunneling microscopy (STM). As a typical example, a striking circular pattern of "Quantum corral" observed by Crommie, Lutz, and Eigler, covers a number of text books of quantum mechanics, demonstrating a wavy nature of electrons. After the discoveries, similar standing waves patterns have been observed on other metal and semiconductor surfaces and even on a side plane of nano-tubes. With an expectation that the surface states could be utilized as one of ideal cases for studying two dimensional (2D) electronic system, various properties, such as mean free path / life time of the electronic states, have been characterized based on an analysis of standing wave patterns. For the 2D electron system, electron density is one of the most important parameters which determines the properties on it. One advantage of conventional 2D electron systems, such as the ones realized at AlGaAs/GaAs and SiO2/Si interfaces, is their controllability of the electron density. It can be changed and controlled by a factor of orders through an application of voltage on the gate electrode. On the other hand, changing the electron density of the surface-state 2D electron system is not simple. One way to change the electron density is to deposit other elements on the system. It has been known that Pd(111) surface has unoccupied surface states whose energy level is just above Fermi level. Recently, we found that by depositing Pd on Cu(111) surface, occupied surface states of Cu(111) is lifted up, crossing at Fermi level around 2ML, and approaches to the intrinsic Pd surface states with a increase in thickness. Electron density occupied in the states is thus gradually reduced by Pd deposition. Park et al. also observed a change in Fermi wave number of the surface states of Cu(111) by deposition of Xe layer on it, which suggests another possible way of changing electron density. In this talk, after a brief review of recent progress in a study of standing waves by STM, I will discuss about how the electron density can be changed and controlled and feasibility of using the surface states for a study of 2D electron system. One of the most important advantage of the surface-state 2D electron system is that one can directly and easily access to the system with a high spatial resolution by STM/AFM.