[Nano device]

Adsorption, manipulation and reaction of molecules

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Adsorption, manipulation and chemical reaction can be studied with atomic resolution with Scanning Tunneling Microscope (STM). A cryogenic scanning tunneling microscope is ideal to perform this experiment since surface diffusion can be frozen. Two systems were studied: Xe and bromo-benzene on Cu(111). Electron standing waves were observed on 1 ML Xe-covered Cu(111) as well as on bare Cu surface. By carefully controlling the Xe coverage, standing waves on both bare Cu surface and 1 ML Xe-covered Cu surface could be observed simultaneously in one STM image. The wavelength of standing waves on Xe layer is ~15% longer than that on Cu surface at sample bias as low as 10meV. By performing scanning tunneling spectroscopy on this surface, dispersions of the surface state both on Xe layer and bare Cu surface are determined. It was found that the onset of the surface state is shifted towards Fermi level by (130±20) meV and the effective electron mass is slightly larger on Xe layer than on bare Cu surface. The electronic lifetime, the multilayer effect, and the effect of image states will also be discussed. Benzene and its derivatives, bromobenzene, were imaged on transition metal surfaces (Cu and Pd). At room temperature, these molecules are highly mobile so that it is difficult to study low coverage behaviors. On the other hand, they form close-packed ordered structure with three different domains at saturation coverage, as observed with STM. At low temperature, the mobility of molecules is reduced that single molecules can be studied. With high-resolution imaging capability of our STM, internal structures of molecules are revealed. The molecules can be rotated, translated and dissociated with the tunneling current of the STM. The halogen atoms and the phenol ring are differentiated with the voltage dependent images and the tunneling spectra. Possible mechanisms of different manipulation modes will also be discussed. The possibility of STM-induced molecular reaction will also be presented.