VI-Q Desorption Induced by Electronic Transitions from Cryogenic Surfaces

Desorption process of particles from cryogenic surfaces are studied using synchrotron radiation in vacuum ultraviolet region. As a result of decay processes after an electronic excitation of surface layers by synchrotron radiation, various kinds of particles are released from the surface. Cryogenic substrates such as solid rare gases have particular excitation channels for the desorption of electronically excited neutral particles that are pronounced at the creation energy region of exciton. Experiments are performed at BL2B1 and BL5B of UVSOR. We discuss the mechanisms of excitation, energy and angular distribution of desorbed species, incident energy dependence of desorption yield, correlation between particle emission and photon emission, and so on.

VI-Q-1 Desorption of Excimers from the Surface of Solid Ne by Low Energy Electron or Photon Impact

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Desorption of excited dimers Ne_2^* in $^3\Sigma_u$ state from the surface of solid Ne initiated by the creation of a valence exciton was confirmed experimentally using low energy electron and monochromatic VUV light as excitation sources. The kinetic energy of desorbed excimer (Ne_2^* $^3\Sigma_u$) was (0.2 ± 0.1) eV, which is consistent with a recent quantum mechanical calculation. It is found that the vibrational relaxation of a molecular type exciton is a slow process compared to the time scale of desorption. Desorption of excimers at the excitation of the first order surface exciton was found to be inefficient compared to that by the creation of bulk excitons, which is in striking contrast to the case of the excited atom desorption. The mechanism of excimer desorption can be explained by a cavity ejection model as in the atomic desorption case.

VI-Q-2 Photon Stimulated Ion Desorption from Solid Rare Gases in the Core Excitation Region

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Ion desorption from solid rare gases was measured by the irradiation of synchrotron radiation in the core excitation region. Experiments were performed in a UHV chamber at BL-2B1. Solid rare gases were prepared on gold-plated copper substrate, which was attached at the end of a flow type liquid He cryostat. Partial electron yield (PEY) and total ion yield (TIY) spectra of condensed Ar and Xe were measured using an Auger electron-photoion coincidence spectrometer.

Typical PEY and TIY spectra of condensed Ar measured around the energy range of Ar 2p excitation exhibit very similar waveforms, and ion yield is relatively high compared to the intensity of emitted electrons. The measured electron corresponds to LMM Auger electron (~210 eV). The time of flight spectrum of desorbed ions in the coincidence with Auger electrons showed no observable peaks. We obtained similar results for condensed Xe at 3d excitation (~680 eV). These features suggest that ion desorption from solid rare gases in the core excitation region is dominated by the interaction between the secondary electrons and desorbing ions.

VI-R Structure and Vibrational Spectra of Molecules Physisorbed on Metal Surfaces

Molecular layers physisorbed on metal surfaces at low temperature show specific structures which depend on the interaction between molecules and substrate, and vibrational spectra for physisorbed molecules reveal the details of the interaction. We use dynamical analysis of low-energy electron diffraction (LEED) to investigate the structure of adsorbed layers, and high-resolution electron energy loss spectroscopy has been utilized for vibrational spectroscopy for adsorbed molecules. As a complemental method for vibrational spectroscopy of surfaces, infrared reflection absorption spectroscopy will be combined with our experimental system. A new cryogenic sample holder for surface vibrational spectroscopy is also under development in order to provide a substrate at less than 4.2K.

VI-R-1 Upgraded Infrared Beamline BL6A1 at UVSOR

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BL6A1, a far-infrared (FIR) beamline at UVSOR originally built in 1986, has been upgraded recently. The upgrade included the introduction of a second FT-IR spectrometer, and now it is possible to cover the entire FIR-IR range (3 cm^{-1} to 10000 cm^{-1}) in one sequence of measurements, without having to open the sample chamber; the beamline has become a more convenient and powerful experimental station than before. The upgrade is also expected to enable such experiments as IR studies of molecules adsorbed on the solid surfaces, and time-resolved IR spectroscopies.

VI-R-2 Development of High Sensitivity EELS

SAKURAI, Makoto

Electron energy loss spectroscopy (EELS) is a powerful tool for the structural analysis of molecules adsorbed on a solid surface. However, since ordinary EELS system uses a single channel electron analyzer, the measurement time for one spectrum usually amount to several minutes. This has been a disadvantage of EELS for real time analysis of surface reaction. We developed a new electron analyzer for EELS. The analyzer is a simulated hemispherical analyzer with a position sensitive detector. The components are made of aluminum, and mean radius of the deflector is 104 mm. The detector has CR chain type anode, and the signal is stored to a histogramming memory via position analyzer. The spectrum can be measured as frequent as every 10ms. This feature makes it possible to perform a time-resolved measurement of repetitive reaction processes. The analyzer and an cylindrical double pass monochromator are mounted on a rotatable stage, and they are installed in a vacuum chamber (600ϕ). Control program written in Visual Basic for the data acquisition system has been developed.

VI-S Structure and Vibrational Spectra of Molecules on Metal Surfaces

Adsorption structure of the adsorbed molecules is one of the most fundamental information to understand the reaction of the molecules on the surface, which is useful for calculating the electronic structure of the system and understanding the elementary processes such as desorption, dissociation or diffusion. Understanding the elementary processes further enables us to understand more complex reactions such as catalysis. Nitric oxide (NO) on the Pt(111) surface is a prototype of catalytic process of the exhaust gas of automobiles. In spite of many efforts, its adsorption structure has not been determined yet. Dynamical analysis of low-energy electron diffraction (LEED) and direct observation by scanning tunneling microscopy (STM) are utilized to investigate the structures of adsorbed molecules in various conditions. Vibrational spectra, which is closely related to adsorption structure, are also utilized to determine the structures correctly.

VI-S-1 Adsorption Structures of NO on Pt(111) Investigated by Scanning Tunneling Microscopy

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The adsorption structure of nitric oxide (NO) on Pt(111) was studied at 10 and 70 K by scanning tunneling microscopy (STM). The island growth modes at both temperatures are similar except for the domain size of the 2×2 structure. In these low temperature region, two phases can coexist at medium coverages. These phases are assigned to the two NO species occurring at different stretching-vibrational frequencies observed in the previous vibrational spectroscopic studies. The relative location of two different species observed by STM and its stretching-vibrational frequencies suggests that the adsorption sites of NO on the Pt(111) surface at low and high coverages correspond to the hollow and the on-top sites, respectively.

VI-S-2 Dynamical LEED Analyses of the Pt(111)-p(2×2)-NO Structures

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Adsorption structures of NO molecules on a Pt(111) surface at low temperatures have been studied using low-energy electron diffraction (LEED). At 150 K a 2×2 LEED pattern appears at exposures higher than 0.2 L. With increasing exposure, the LEED spots get sharper, indicating two-dimensional island growth of adsorbed NO. The LEED I-V spectra measured at 0.4 L are different from those at 3 L, suggesting the presence of two kinds of 2×2 structure. The LEED I-V analysis performed for the 2×2 at 0.4 L strongly supports that NO is adsorbed at a threefold fcc hollow site. For the I-V curves of 2×2 at 3 L, the fcc hollow site model calculation does not fit the experimental I-V curve, suggesting that a different 2×2 structure grows after the first 2×2 structure is completed.