7A/2006G364

Reactive adsorption of thiophene on Au(111)

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Introduction

The adsorption state of thiophene on Au(111) with vacuum deposition at room temperature was investigated by X-ray photoelectron spectroscopy (XPS) and near-edge X-ray absorption fine structure (NEXAFS). At first, Au(111) surface has been believed to be inert to thiophene molecules both experimentally and theoretically. A well-ordered monolayer was recently observed, however, by scanning tunneling microscopy (STM) for a sample prepared by immersion method. We had investigated the adsorption state of thiophene on Au(111) by immersion method, and confirmed that thiophene molecules do not molecularly adsorb, but are bound to the Au(111) surface in the form of Au-thiolate chemical bonding [1]. In this work, we have studied reactive adsorption mechanism of thiophene on Au(111) with high-exposure vacuum deposition.

Experiment

C K-edge NEXAFS and XP spectra were measured at BL-7A. Thiophene was adsorbed at substrate temperatures both below 130 K and room temperature by exposing the clean Au(111) surfaces to gaseous thiophene introduced with a gas doser. C K-edge NEXAFS measurements were carried out by the partial electron yield method with using a micro-channel plate. XP spectra were taken with a hemispherical electron energy analyzer at several photon energies.

Results and Discussion

Figure shows polarization dependence of the C K-edge NEXAFS spectra taken with three different incident angles, 90° (NI), 55° (MI), and 30° (GI) at (a) room temperature (RT) with high exposure (5000L) and (b) low temperature (LT) with low exposure (~2L).

The NEXAFS spectrum from the RT sample is quite different from those of LT sample. A characteristic peak due to transition to the π_1* orbital of thiophene (285.5 eV) is not clearly observed for the RT sample and the overall spectral shape is nearly identical to that of alkanethiolate adsorbed on metal surfaces, which has the σ*(C–H) peak at 288 eV and the σ*(C–C) resonance at 293 eV.

This reactive adsorption is similar with that observed with the immersion method [1], thus these specific conditions are needed to create Au - thiolate bonding from thiophene on Au(111).

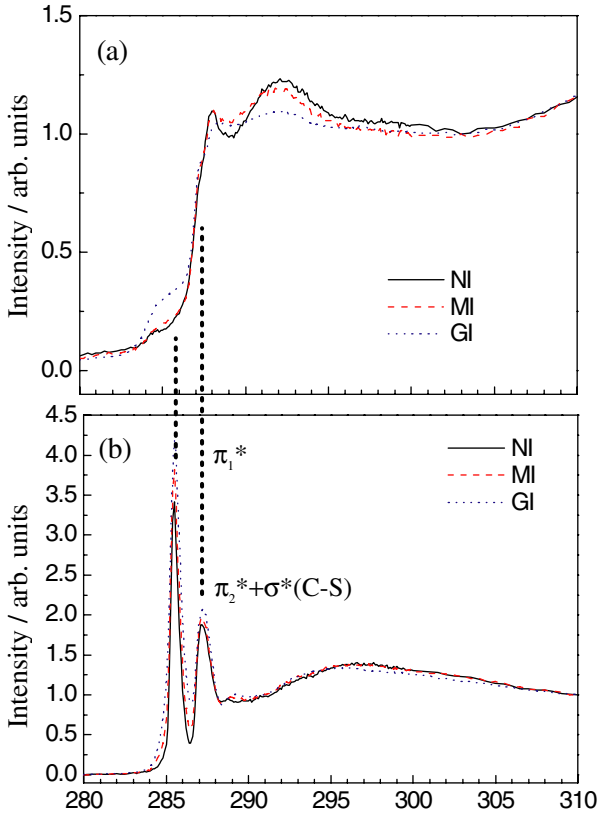

Figure NEXAFS spectra of thiophene on Au(111): (a)room temperature, 5000L ($1\times10^{-4}\times50$s) (b)low temperature, saturated.

References

[1] E. O. Sako, et al., Chem. Phys. Lett. 413 (2005) 267.

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