STM/STM study on the glycine/Cu(111) self-assembled structures

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1. Introduction

Formation and control of the novel low-dimensional structures and their electronic properties, based on the interactions between adsorbed organic nanostructures and solid substrates, is one of the most attractive goals of current researches. For this study, the Cu(111) surface, which has original two dimensional free electronic gas (2DEG) states around the Fermi energy level, is interesting as a substrate. On the other hand, as adsorbates, amino acid molecules are favorable, since interesting interactions of their amino and carboxyl groups with the substrate, as well as the remarkable molecular structures formed on the surface, are expected to be observed [1,2]. In this study, as a first step for investigation and future controlling of the electronic structures of organic films, we have performed scanning tunneling microscopy/spectroscopy (STM/STS) study on the self-assembled monolayers of the simplest amino acid, glycine molecules, on a Cu(111) surface.

2. Experiments

A clean Cu(111) surface was prepared by Ar^+ sputtering and annealing (820 K) cycles in an ultra high vacuum. Glycine molecules were evaporated from an Al_2O_3 crucible (350 K) to a Cu(111) substrate kept at room temperature. STM/STS measurements were performed at 5 K using an electrochemically sharpened tungsten tip (ϕ = 0.3 mm).

3. Results and discussion

Figure 1 shows a typical STM image of a glycine submonolayer observed at 5 K. Some molecules formed a periodic super structure, while some adsorbed independently. As indicated by the dotted circles in the high resolution images in Figs. 1(b) and 1(c), molecules have a trimer structure as a unit, regardless the place where they adsorbed. From this result, the self-assembled process is described as follows; the adsorbed molecules firstly form trimers to be stable, then the periodic structure is formed due to the interaction between the trimers. In this process, the inter molecular hydrogen bonds between functional groups in the glycine molecule seem to play an important role as a main driving force. STM images also show that six trimers form a circular structure. Although the area surrounded by the six trimers is a bare Cu surface as well as the original substrate, STS results measured on the surrounded area and the bare surface are different from each other. Especially, the 2DEG spectra observed for the bare Cu(111) surface for the sample bias voltages from -400 mV to –100 mV is completely modified in the area surrounded by the trimers. Details will be discussed at the conference.

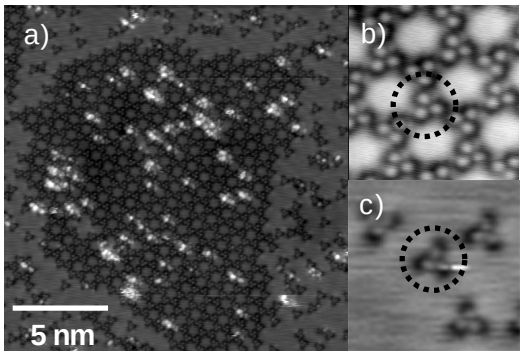

Fig. 1 STM image of glycine molecules adsorbed on Cu(111) surface (V_s = -0.5V I = 1.0 nA)

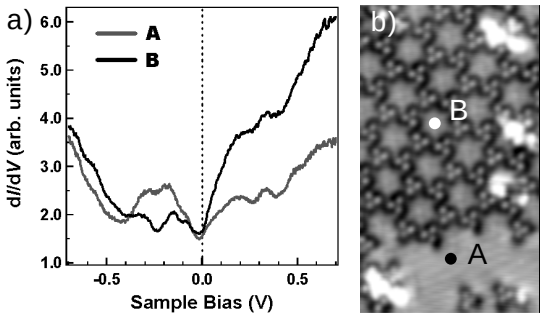

Fig. 2 (a): d*I*/d*V* measurements on Cu(111) substrate and Cu area surrounded by trimers in molecular structure indicated by A and B in the left image (b), respectively.

References

[1] K. Kanazawa *et al.*: Phys. Rev. Lett., 99 (2007) 216102.

[2] K. Kanazawa *et al.*: J. Am. Chem. Soc., 129 (2007) 740.