STM study of anisotropic free electron-like states realized in amino acids/Cu(100) interfaces

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Control of the novel low-dimensional electronic properties of self-assembled organic nanostructures on solid substrates is one of the most attractive goals of current researches. Their characteristics are originated from the interactions of functional groups in molecules with solid surfaces depending on the environmental conditions. For amino acids, for example, the amino and carboxyl groups are the candidates for the creation of novel two-dimensional (2D) electronic structures. In this study, as a first step for the investigation and future controlling of the 2D electronic states, we have performed scanning tunneling microscopy/spectroscopy (STM/STS) study on the self-assembled monolayers of glycine and β-alanine molecules adsorbed on a Cu(100) surface.

A clean Cu(100) surface was prepared by Ar^+ sputtering and annealing (820 K) cycles in ultra high vacuum. Glycine or β-alanine molecules were evaporated from an Al_2O_3 crucible (350 K) to a Cu(100) substrate kept at room temperature. STM/STS measurements were performed at 5 K.

Figures 1(a) and (b) are d*I*/d*V* maps of glycine/Cu(100) and β-alanine/Cu(100) structures obtained at +150 mV and +160 mV sample bias voltages, respectively. The standing wave patterns, which are formed in the *p*(2x4) structural areas for both cases, indicate the existence of 2D electronic gas states. As shown in Fig.2, the dispersion relations, which were obtained for the two samples from the analysis of their standing waves measured at various sample bias voltages, are both very anisotropic but different from each other. That is, the effective masses along [110] and [-110] directions for the cases of glycine and β-alanine molecules are 0.06 m_e and 0.6 m_e, and 0.09 m_e and 0.3 m_e, respectively. These results clearly demonstrate the high potential of organic molecules for forming and designing novel 2D electronic states, for example, through the control of their functional groups.

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

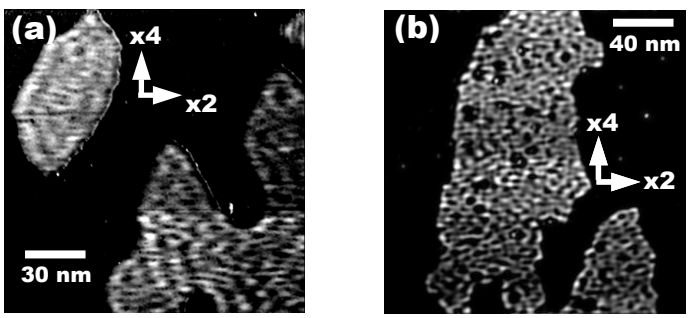

Fig. 1 d*I*/d*V* mappings of (a) glycine/Cu(100) *p*(2x4) structure at V_s = +150 mV, and (b) β-alanine /Cu(100) *p*(2x4) structures at V_s = +160 mV,

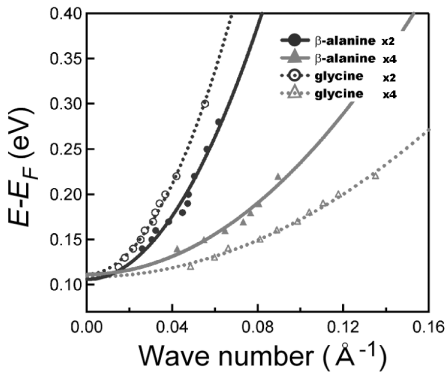

Fig.2 dispersion relations