

Formation and study of isolated C₆₀ on Cu(111) realized by glycine nanomesh self-assembly

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The self-assembly of molecular species on single crystal surfaces provide a promising way for developing and creating highly ordered structures, such as well-defined 2D porous networks. Formation of such regular and open networks are interesting as a template for arranging guest atoms or molecules, which can be used for the construction of molecule-scale devices.[1] The C₆₀ molecule focused in this study is an important candidate for designing device structures because of its large electron-accepting property. However, on the terraces of metal surfaces they are mobile and easily diffuse towards the step edges at a low coverage. Thus it is difficult to obtain an isolated structure of C₆₀ molecule. In order to overcome such a problem, in this work, we first prepared a 2D glycine-based supramolecular self-assembly structure on a single crystal Cu(111) surface, which features a porous network structure. Then C₆₀ molecules were deposited on the glycine network. Stable adsorption of fullerenes within the 2D surface nanocavities was observed.

A Cu(111) surface was cleaned by repeated sputter-anneal (820K) cycles with Ar⁺ in ultra high vacuum. Glycine molecules were evaporated from an Al₂O₃ crucible (350K) on the Cu(111) surface kept at room temperature. Sublimation of the fullerene molecules was performed by heating the C₆₀ doser at 400°C. STM/STS measurements were performed at 5K using the constant current mode.

Figure 1(a) shows a dI/dV image of a glycine/Cu surface with a small coverage (< 0.2 ML) of C₆₀ molecules observed at 5 K. With the glycine molecular structures, isolated C₆₀ molecules were stably adsorbed on the terrace areas of the Cu surface. They were exclusively in the glycine nanomesh or the areas surrounded by molecular boundaries, indicating that adsorbed glycine molecules formed a barrier against the diffusion of C₆₀ molecules on the Cu(111) surface. Apparently, the C₆₀ molecules showed two different states with different brightness, as shown in the dI/dV image (Fig. 1(a)). The major numbers of the molecules are the darker ones, indicated by D in Figs. 1(b) and 1(c), which suggests that the darker state is more stable. In fact, the darker one shows a clear three-fold-rotational symmetry consisting of six-membered rings. Furthermore, as shown in Figs.1 (b) and 1(c), the brighter state could be transformed to darker state using STM tunneling current (threshold ~2.3 eV) at 5 K. However, it was difficult to induce a backward manipulation. These results suggest a stronger interaction of the darker state of C₆₀ with the substrate. Details will be discussed at the conference.

Reference

[1] Theobald, J.A., *et al.* nature, 2003, 424, 1029-1031.

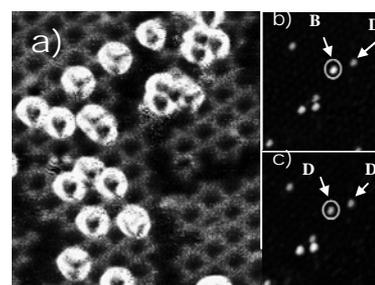


Fig. 1 (a) dI/dV image of C₆₀ (V_s = -1.5 V). (b and c) STM images showing the transformation of an individual C₆₀ molecule induced by the energetic excitation using STM: b) before and c) after excitation.