From ligands to coordinated complex architectures: a molecular engineering with scanning tunneling microscopy

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从配位体到配位络合物结构：扫描隧道显微学的分子工程

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With the development of modern coordination chemistry, various metal-ligand complexes with elaborate structures have been synthesized.[1] The structural complexities as well as the coordination processes of these metal-ligand complexes can be partially comparable to those in biology system formed by self-assembling with the weak intermolecular or intramolecular interactions. These complexes in different shapes and geometries from simple planar shaped rhomboid to higher symmetry polygon cages, usually present interesting electronic, optical, magnetic properties and show potentials in the fabrication of nanometer scale devices. One of the prerequisites for employing the properties with these molecules in nanotechnology is to fabricate ordered and controllable molecular nanostructures at solid surfaces. For this purpose, the technique of self-assembly or self-organization has been widely used, which is proven to be a powerful "bottom-up" approach for nanodevice fabrication. The self-organized or self-assembled technique is of great importance in chemistry and material science, especially in the construction of molecular nanostructures on solid surfaces. On the other hand, as a common interest, after achieving a self-organization, the assembly structure should be understood. Now, researchers can directly obtain structural information on various self-organizations at atomic or submolecular scale with the well-established STM technique, which is one of the most powerful tools in surface or interfacial analysis and has been successfully used in characterizing surface molecular architectures under various environments. Moreover, the information from STM images can directly provide structural evidence of complicated supramolecules, from which the molecular structures prepared by coordination chemists could be further confirmed. In this presentation, the molecular architectures by ligands and coordinated complexes are investigated by STM. (1) Calix[8]arene derivative and C60/Calix[8]arene adsorb onto Au(111) surface and self-organize into 2D adlayers.[2] Figure 1 is the STM images and proposed structural models for calix[8]arene and C60/Calix[8]arene. (2) The structure and conformation of three self-assembled supramolecular species, a rectangle, a square and a three-dimensional cage on Au(111) and HOPG surfaces.[3-5] Figure 2 is an STM image of the supramolecular rectangles on Au(111) surface. The structural details are clearly revealed by STM.

These results provide direct evidence of the non-crystalline solid state structures of these assemblies and information about how they self-organize on solid surfaces and are significant to nanoscience and nanotechnology.

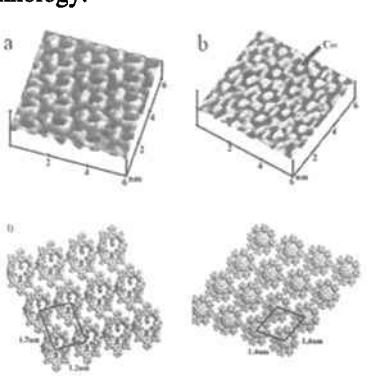

Figure 1 STM images of Calix[8] arene (a), C60/Calix[8] arene (b) and their models.

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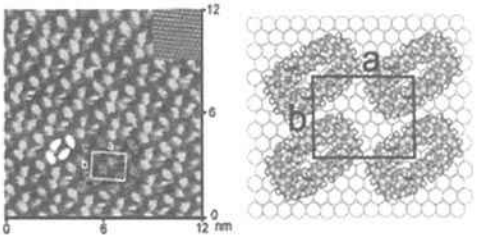

Figure 2 STM image of supramolecular rectangles and structural models.

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Development of high-resolution bio phase TEM based on defocus image modulation processing[1]

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基于欠焦像调制处理的生物高分辨透射电镜的发展

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Biological samples which are composed of light atoms show very little contrast in transmission electron microscopy (TEM), and only small amount of electron dose is allowed to take the image because they are easily damaged by the electron beam irradiation. Therefore, to achieve high-resolution observation of the biological samples, it is crucially important to improve the instrument so as to obtain higher image contrast and to use the total electron dose as efficiently as possible.

We have now involved in a new instrumentation project called "Super-coherent bio phase TEM", which enables high-resolution aberration-free phase observation by installing an image processing system based on three-dimensional Fourier filtering method (3DFFM) [1]. In the method, a 3D Fourier transform is performed for a number of recorded through-focus images and a filtering shape function with aberration correction factors is applied to the obtained 3D Fourier spectrum. The phase image is finally obtained by performing an inverse 3D Fourier transform on the corrected 3D Fourier spectrum. Since the filtering shape function extracts only the linear image components that possess the structure information and appear on a so-called Ewald sphere, the image processing works well for improving the S/N ratio by excluding the non-linear image components and quantum noise in the images, resulting in higher contrast observation of biological samples on a molecular scale. Although it is a disadvantage for observing radiation-sensitive materials that many images are required in the processing, the phase contrast image can easily be reproduced by post-processing after taking a series of images. This is an important advantage when only one opportunity to take the image is available.

Figure 1 (a) and (b) show the exterior and a sche-

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