PERFECT ORDERING OF MOLECULAR NANOSTRUCTURES

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The ability to create arrays of organic nanostructures on surfaces with long-range order and uniform size could have applications in micro- and optoelectronic devices. One of the most promising methods for making such arrays is to rely on the self-assembly of molecules on 'vicinal' surfaces that already possess long-range order in, for example, the form of terraces and steps. We present two different model systems showing the potential of the approach.

On Au(11,12,12) we demonstrate the ability to grow ordered arrays of fullerene nanochains. Each nanochain consists of just four or five fullerene molecules. Using scanning tunnelling microscopy and low-energy electron diffraction, we observed that the nanochains only formed at the lower step edges of the gold surface. The electron-rich regions near these edges preferentially adsorb the fullerene molecules, which are electron acceptors, leading to the formation of arrays that perfectly reproduce the periodicity of the gold template [1,2]. It is found that the actual position of the fullerene molecules in STM images appears shifted with respect to the geometrical position of the step edges due to electronic relaxation effects.

On Au(111) we constructed a regular array of hexa-peri-hexabenzocoronene at very low coverage. Scanning Tunneling Microscopy reveals a selective adsorption on monatomic steps in the fcc stacking regions with a specific orientation of 18° between the molecular axis and the step normal. Ab initio calculations for various adsorption sites reveal the lowest total energy for adsorption on a kink-site. Energy considerations and the excellent agreement between experimental and simulated images show that adsorption on kink-sites is responsible for the specific adsorption angle [3].

[1] Wende Xiao, Pascal Ruffieux, Kamel Ait-Mansour, Oliver Gröning, Krisztián Palotás, Werner A. Hofer, Pierangelo Gröning, and Roman Fasel, J. Phys. Chem. Lett. 110, 21394 (2006)
[2] Nature Nanotechnology, Research Highlights, October 27, 2006, see: http://www.nature.com/nnano/reshigh/2006/1006/full/nnano.2006.126.html
[3] Pascal Ruffieux, Krisztián Palotás, Oliver Gröning, Daniel Wasserfallen, Klaus Müllen, Werner A. Hofer, Pierangelo Gröning, and Roman Fasel, J. Am. Chem. Soc. (2007), in press