Physics at Nanostructured Surfaces

Wolf-Dieter Schneider

Laboratory of Surface Physics, Institute of the Physics of Nanostructures, Ecole Polytechnique Fédérale de Lausanne (EPFL), CH-1015, Lausanne, Switzerland

The quest of a reliable method for fabricating ordered atomic-scale structures is a prequisite for future atomic-scale technology. The interest in such nanostructured materials, consisting of building blocks of a small number of atoms or molecules, arises from their promising new optic, catalytic, magnetic and electronic poperties, which are fundamentally different from their macroscopic bulk counterparts: small is different. Here we present two examples concerning supramolecular and atomic self-assembly investigated by low-temperature scanning tunneling microscopy (STM).

(i) The coverage-dependent self-assembly of the organic molecule 1-nitronaphthalene on the reconstructed Au(111) surface where the molecules become pseudo-chiral upon adsorption. With increasing coverage the molecules form trimers, tetramers, decamers and enantiopure one-dimensional molecular double chains. Modeling shows that hydrogen bonds cause the observed supramolecular self-assembly. A subtle interplay between the electrostatic interactions among the molecules and their interaction with the reconstructed metal surface is at the origin of a coverage-driven chiral phase transition in two dimensions.

(ii) The self-assembly of a two-dimensional array of individual Ce adatoms (the "ultimate" building block) on a metal surface based on long-range interactions between adatoms mediated by surface state electrons. STM images acquired at 3.9 K display a hexagonal superlattice, where the nearest-neighbor distance of 3.2 nm is near half the Fermi wavelength of the Ag(111) surface state electrons and corresponds roughly to the distance spanned by 11 Ag atoms in the substrate. Ce is a magnetic atom, and such a superlattice of magnetic adatoms might be useful for the development of future atomic-scale magnetic devices.

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E-Mail: wolf-dieter.schneider@epfl.ch
Website: http://ipn.epfl.ch/page38310.html