

Supramolecular self-assembly at surfaces: climbing up the complexity ladder

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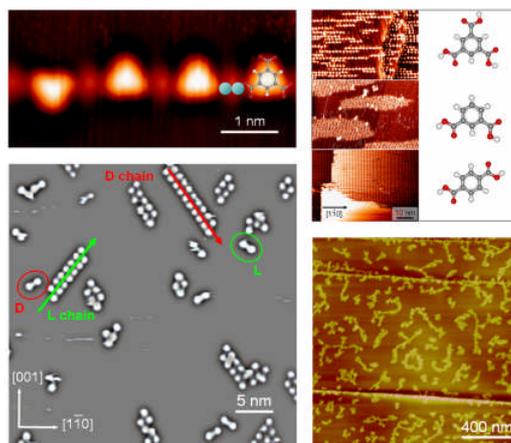
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Several advantages characterise the use of molecules as building blocks in the self-organised functionalization of surfaces: non-covalent interactions that allow to operate near equilibrium conditions where self-correction is active; directional interactions that intrinsically produce well-defined geometries and long-range periodicities; the possibility of manipulating organisation and functionality by chemical design. In this talk I will present some examples of this way of engineering surface nanostructures with increasing complexity of the fundamental building blocks.

Coordination bonding employing metal atoms as nodes and organic molecules as linkers has proven to be particularly successful in the fabrication of three-dimensional metal-organic frameworks with high structural stability and specific magnetic, electronic, or catalytic properties. The translation of these concepts to surfaces will be discussed with a special focus on the employment of benzenepolycarboxylic acids as basic molecular units [1]. In particular, x-ray photoelectron spectroscopy measurements will be presented providing a clear evidence for the existence of well-defined oxidation states and genuine charge transfer coordination in metal-organic networks at surfaces [2]. Further, I will show that the dimensionality of these nanostructures can be continuously and predictably tuned by combining hierarchical self-assembly with molecular design. A deep insight into the atomistic and electronic structure of such systems is provided by comparing highly resolved scanning tunnelling microscopy (STM) measurements with density functional theory (DFT) calculations [3].

The formation of many biological macromolecules is based on the polymerization of amino acids in the form of peptidic chains. Here I will discuss the surface deposition of the simplest peptide composed by two identical amino acids. Di-L-phenylalanine forms one-dimensional homochiral supramolecular structures through self-organization. Its co-deposition with the mirror imaged stereoisomer, di-D-phenylalanine, results in a chiral phase separation. By exploiting the atomic-level imaging capabilities of STM, the 2D chiral recognition process is followed in real time. The stereoselectivity of the process is evidenced by STM and rationalised on the basis of DFT calculations [4].

The talk will be concluded by an outlook on the development of novel experimental techniques for the ultra high vacuum deposition of labile biomolecules and nanoparticles [5].



[1] Nature 437, 671 (2005)

[2] J. Am. Chem. Soc., in print (2008)

[3] Angew. Chem. Int. Ed. 44, 6142 (2005)

[4] Angew. Chem. Int. Ed. 119, 4576 (2007)

[5] Small 2, 540 (2006)