SELF–ASSEMBLY OF DNA MOLECULES ON SURFACES STUDIED BY STM: DYNAMICS, SELF-ORGANIZATION, WC BASE PAIRING, AND DNA DOLPHINS

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Adsorption and organization of organic molecules on solid surfaces is central to self-assembly and bottom-up fabrication within nanoscience and technology. The Scanning Tunneling Microscope allows exploration of atomic-scale phenomena occurring on surfaces: Dynamic processes can be followed by fast-scanning STM, and from data acquired at a range of temperatures; detailed information on kinetic parameters can be extracted such as diffusion, chiral recognition and chiral switching [1-4].

The self-assembly of Nucleic Acid (NA) base molecules on solid surfaces has been investigated thoroughly. I will discuss the fact that Guanine molecules form the so-called G-quartet structure on Au(111) that is stabilized by cooperative hydrogen bonds [5] whereas cytosine molecules only form disordered structures by quenching the sample to low temperatures, which can be described as the formation of a 2D organic glass on Au(111) [6].

Molecular recognition between complementary nucleic acid (NA) bases is vital for the replication and transcription of genetic information, both in the modern cell as well as under prebiotic conditions, when a dedicated molecular machinery of evolved living organisms had not yet been developed. By means of STM we show that on a flat metal surface, the formation of complementary NA bases pairs is favoured. The C+G mixture resilience to heating is due to the formation of G-C Watson-Crick (WC) base pairs. The observation that not the oligonucleotide backbone, but a flat metal surface may be instrumental for specific WC base pairing has interesting implications for the proposed scenarios of the emergence of life [7].

Finally, I will show how the DNA origami method allows us to fold long, single-stranded DNA sequences into arbitrary two-dimensional structures by a set of designed oligonucleotides. The method has revealed an unexpected strength and efficiency for programmed self-assembly of molecular nanostructures, and makes it possible to produce fully addressable nanostructures with wide-reaching application potential within the emerging area of nanoscience [8]. Here I will show how we used DNA Origami Design to form Dolphin-Shaped Structures with Flexible Tails.

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[6] Roberto Otero et al., Science 319 (2008) 312-315
[7] Wei Xu, submitted (2008)
[7] E. Andersen et al., ACS-NANO (2008)