

9th Nano Congress for Next Generation

August 01-02, 2016 Manchester, UK



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Investigation of Ultrathin Periodically Ordered Adsorbate Films with Controlled Polymorphism and Induced Surface Reactions

The investigation of self-assembled periodic adsorbate structures on crystalline substrate surfaces is a classical topic of surface physics which has been dominated for a long time by diffraction techniques. The appearance of scanning probe microscopies – especially scanning tunneling microscopy (STM) – has opened the fascinating opportunity of direct real-space imaging with atomic or submolecular resolution. At the interface between a solution and a crystalline solid, solute (and sometimes also solvent) molecules may deposit in an ordered manner at the solid substrate surface. In-situ studies of the adsorption pattern created this way are possible by ambient STM with the tip immersed in a deposited solution droplet. As an example, trimesic acid (TMA) molecules solved in alkanolic acids may arrange in open adsorption patterns (chicken wire and flower structures) due to H bonding via carboxylic functional groups. At the liquid-solid interface, such type of polymorphism may be controlled by the nature of the solvent (especially its polarity) as well as the concentration of the solutions which opens access to further novel structures. By a controlled increase of molecular packing density of solutions of TMA in alcohols, even a surface-reaction of TMA with coadsorbed solvent molecules (monoester formation with undecanol) has been observed. Recent investigations concerning substrate temperature during deposition and replacement of trimesic acid by the non-planar benzene-triphosphonic acid will be discussed also. Another approach is based on the self-assembly of molecules at the crystalline surface in ultra-high vacuum (UHV). Under such “ideal conditions” the local electronic structure at the adsorbate-substrate interface can be studied in detail by scanning tunneling spectroscopy (STS) offering insight e.g. into highly localized donation-backdonation charge transfer processes. We demonstrate some examples for the adsorption of phthalocyanines and porphyrines on metal surface. As an example, shows a temperature-induced polymerization in a monolayer of brominated Cu-Tetraphenylporphyrin on a Au(111) substrate. Such kind of investigations may open a way to better understanding the conditions of structure formation and control which is permanently encountered in the biotic world and which might become extremely fruitful for future engineering of molecular architectures and devices.

Biography

Prof. Dr. Michael Hietschold studied physics and completed Ph.D. 1976 in theoretical solid state physics at Technical University Dresden, Germany. He was a postdoc at Quantum Theory Group of Moscow State Lomonosov University, Soviet Union. Since 1993, he is a professor for Solid Surfaces Analysis and head of the Electron Microscopy Laboratory at the Institute of Physics, Technische Universität Chemnitz, Germany. His research interests are surface physics, nanophysics and ultramicroscopy. He was a guest professor at the National University Ho Chi Minh City, Vietnam, and also lecturing at Portland State University, Oregon, USA. Since 2008 he is advisor for the National Metals and Materials Technology Center (MTEC), Pathumthani, Thailand. Michael Hietschold is a referee for many international scientific journals and research funding organizations and has published about 250 scientific papers. h-index: 27.

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