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speaks

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about

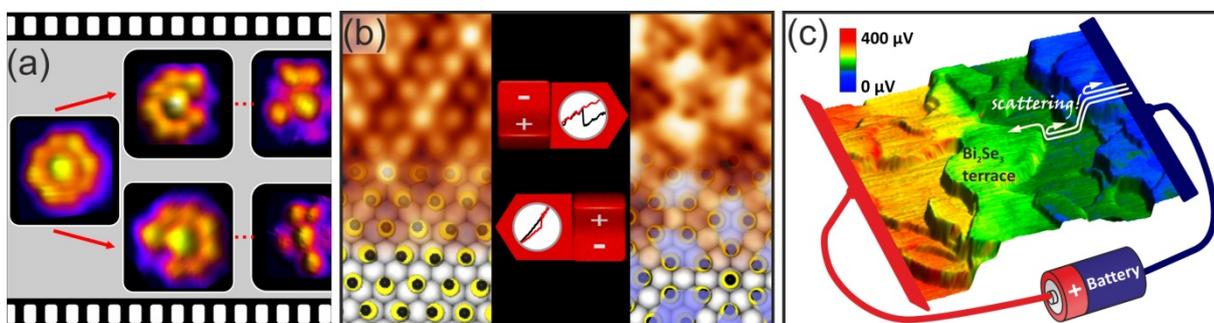
**Visualization and analysis of molecular reactions, phase transitions  
and electron transport with atomic scale precision**

In this talk I will show that with the help of extended scanning tunneling microscopy (STM) techniques one can gain insight into nanoscale phenomena at surfaces such as chemical reactions, phase transitions and electron transport.

In particular, we followed a molecular reaction of adsorbed molecules by combining the STM analysis of a large ensemble of molecules with a statistical analysis. The internal structure of each molecule is resolved so that the analysis of the intermediate species enables us to follow the different steps of dehydrogenation and dechlorination reactions of porphyrin molecules on Cu(111) [1]. By comparing the experimental data-set to a numerical simulation, our model for the reactions can be verified [2].

In the second part, STM is applied to observe and control a reversible structural phase transition of a two dimensional system which can be locally induced by an external electric field. Two coexisting structural configurations of a CO monolayer on Cu(111) are observed. The balance between both phases can be shifted by the electric field of the STM tip, giving insight into the physics of structural phase transitions [3].

In my last part I will address a three terminal STM technique (scanning tunneling potentiometry, STP [4]) which permits us to directly analyze the electrochemical surface potential  $\mu_{ec}$  under realistic conditions, i.e. under a current flux through the surface. In the vicinity of step edges at the surface of the topological insulator  $\text{Bi}_2\text{Se}_3$  we find a step-like variation of  $\mu_{ec}$  which is a fingerprint of electron scattering at the step edges [5].



**Fig. 1 a) Topographic STM snapshots of intermediate states of the on-surface reaction of porphyrin molecules on Cu(111). b) Two metastable structural phases of a CO monolayer adsorbed on Cu(111) can be manipulated and analyzed with the tip of the STM. c) STM data of the topography and the local surface potential (color coded) upon lateral current flow through a  $\text{Bi}_2\text{Se}_3$  surface.**

- [1] D. van Vörden, et al., J. Chem. Phys. **138**, 211102 (2013).
- [2] D. van Vörden, et al., Chem. Comm. **55**, 7711 (2016).
- [3] B. Wortmann et al., Nano Letters **16**, 528 (2016).
- [4] A. Bannani, C.A. Bobisch, and R. Möller, Rev. Sci. Instrum. **79**, 083704 (2008).
- [5] S. Bauer and C.A. Bobisch, Nature Comm. **7**, 11381 (2016).

All interested persons are cordially invited.

Sgd. Prof. Niklas Nilius