Single-Molecule Motion at Surfaces

Leonhard Grill

Department of Physical Chemistry, University of Graz, Austria (www.nanograz.com)

Detailed insight into molecular motion at surfaces is important for understanding various physical and chemical topics as for instance interatomic interactions, molecular growth and self-assembly processes, on-surface reactions and polymerization and the functionality of molecular machines. In this talk, several studies of molecular motion at well-defined single-crystal surfaces, using scanning tunnelling microscopy (STM), are presented.

By reversibly changing the isomeric state of azobenzene tetramers via light-induced switching, their diffusion properties on a surface during STM imaging can be modified [1]. Using the STM tip to manipulate dipolar molecules, these can be either precisely rotated [2] or displaced [3] a surface, also in a pseudo-blind (and therefore much faster) mode without the typical imaging after every manipulation step [4]. In the case of fluorene derivatives, single molecules can be moved with high precision over relatively long distances, even between two independent STM tips (see Fig. 1) [5]. This unique setup, realized in a 4-probe STM, allows determination of traveling distance and time for a single molecule.

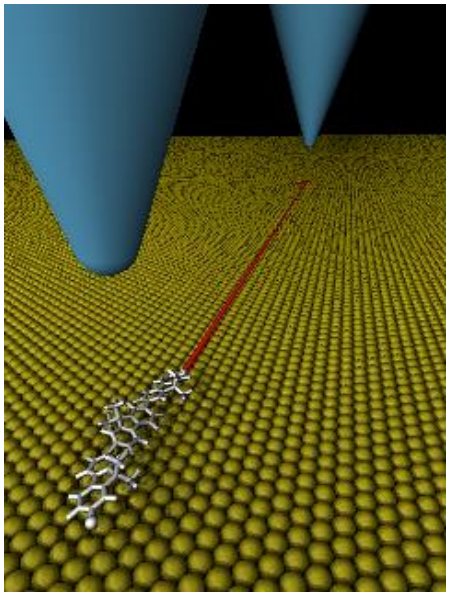

Figure 1: Single-molecule transfer between two STM tips [5].

Molecular motors are fascinating objects that can convert energy into controlled, directional motion [6]. Beside so-called Feringa-type motors, which can be activated on a surface [7], a novel type of ‘adsorbate motor’ will be presented, which is based on a simple molecule that does not contain any motor function [8]. It achieves this functionality only in combination with a surface, resulting in 100% uni-directional translation along an atomically defined straight line. These nano-machines can also do work by transporting single CO molecules as ‘cargo’ from one place to another.

[1] C. Nacci et al., *Angew. Chem. Int. Ed.* **57**, 15034 (2018); [2] G. J. Simpson et al., *Nature Comm.* **10**, 4631 (2019); [3] G. J. Simpson et al., *J. Phys. Chem. Lett.* **14**, 2487 (2023); [4] G. J. Simpson et al., *Nature Nanotech.* **12**, 604 (2017); [5] D. Civita et al., *Science* **370**, 957 (2020); [6] W. R. Browne et al., *Nature Nanotech.* **1**, 25 (2006); [7] A. Saywell et al., *ACS Nano* **10**, 10945 (2016); [8] G. J. Simpson et al., *Nature* **621**, 82 (2023)

Thursday 1st February 2024 at 16 :00 in Haworth 203, School of Chemistry