Molecular telegraphy: Sending and receiving individual molecules precisely

RThe concept of throwing and catching a ball is familiar to everyone and works well in the macroscopic world. But could this be done in the nanoworld using individual molecules instead? And if one could transfer molecules precisely back and forth between two distant places, how fast would they be? An international team involving Stefan Hecht, who is a member of IRIS Adlershof, found some spectacular answers to these questions and the results of their study have been published as the cover story a recent issue of Science magazine.

"Through the targeted movement of individual molecules, we can gain insight into fundamental physical and chemical processes that are important for molecular dynamics - for example during chemical reactions or in catalysis," explains Leonhard Grill from the University of Graz, who led the team. For the study, the scientists brought organic molecules about two nanometers long on a silver surface with the fine metal tip of a scanning tunneling microscope in a special orientation, in which they are still extremely mobile, even at -266 °C. “We were able to show that, despite the very flat surface, the molecules move along a single row of atoms, i.e. only in one direction,” the researcher describes.

If an electric field is switched on, individual molecules can be moved perfectly along a straight line by electrostatic forces, as if the molecule would be on rails. As a result, the molecules can – depending on the direction of the field – be sent and received in a targeted manner by the forces of repulsion and attraction, respectively. The uncovered phenomenon operates over relatively long distances of 150 nanometers and at the same time with extremely high precision of 0.01 nanometers. The researchers were able to measure the time it took an individual molecule to be transferred and thus could determine the speed of an individual molecule directly. At these low temperatures, the molecule moved at 0.1 mm per second over the silver surface. These studies provide completely new possibilities for the investigation of molecular energies during movement and more importantly during chemical reactions.

At Oak Ridge National Laboratory, the researchers were able to carry out a unique transmitter-receiver experiment. Specifically, two separate scanning tunnel microscope tips were first appropriately positioned. Upon switching the “transmitter tip” from attractive to repulsive mode, the molecule moved precisely to the location of the “receiver tip”. This allowed to characterize the molecular motion and deduce the speed. But moreover this experiments illustrates the great potential for information transfer since all information stored in the molecule can be transfered with exquisite spatial precision. "

Control of long-distance motion of single molecules on a surface - Emitting Diodes
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