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Energy Portrait: Capturing a Molecule's Moment of Excitement

Researchers at the University of Regensburg in collaboration with IBM Research Europe - Zurich have found a way to access excited states of single molecules and determine their energies.

A very fundamental property of atoms and molecules are the energies, at which electrons can be added to or removed from the compound. This is decisive for many chemical reactions, in which electrons are exchanged. However, it is not only of fundamental interest: Organic compounds are promising candidates for advanced solar cells and light emitting devices, being cheap, abundant, and non-toxic. For the functionality of such devices, the energies of electron exchange with the surrounding are also of utmost importance.
The functionality of solar cells and light emitting devices is strongly influenced by excited states, in which the molecule has acquired additional energy. Knowing the value of this energy is key in many applications.

Researchers at the University of Regensburg in collaboration with IBM Research Europe - Zurich have found a way to access energies of charge exchange for ground and excited states of a single molecule. To this end, they utilized an atomic force microscope, a microscope, in which tiny forces between a tip and a surface are being sensed. Such a microscope allows even the internal structure of single molecules to be imaged (see also Science 325, 1110; 2009), such that the researchers can identify the molecule under the microscope's tip. In addition, the tip can also be used to locally add and remove electrons to and from the molecule (see also Nature 566, 245; 2019). The researchers in Regensburg used this ability to access differently charged and excited states of individual molecules. Specifically, by slowly changing the energy of the electrons available in the tip and observing when the molecule undergoes charge-state transitions, the different excited states could be accessed, identified and their energies measured. The researchers envision that this technique could be applied to a wide range of molecules, including those interesting from the perspective of fundamental research and those for applications in energy conversion and organic electronics.

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Controlled single-electron transfer enables time-resolved excited-state spectroscopy of individual molecules; Nature Nanotechnology
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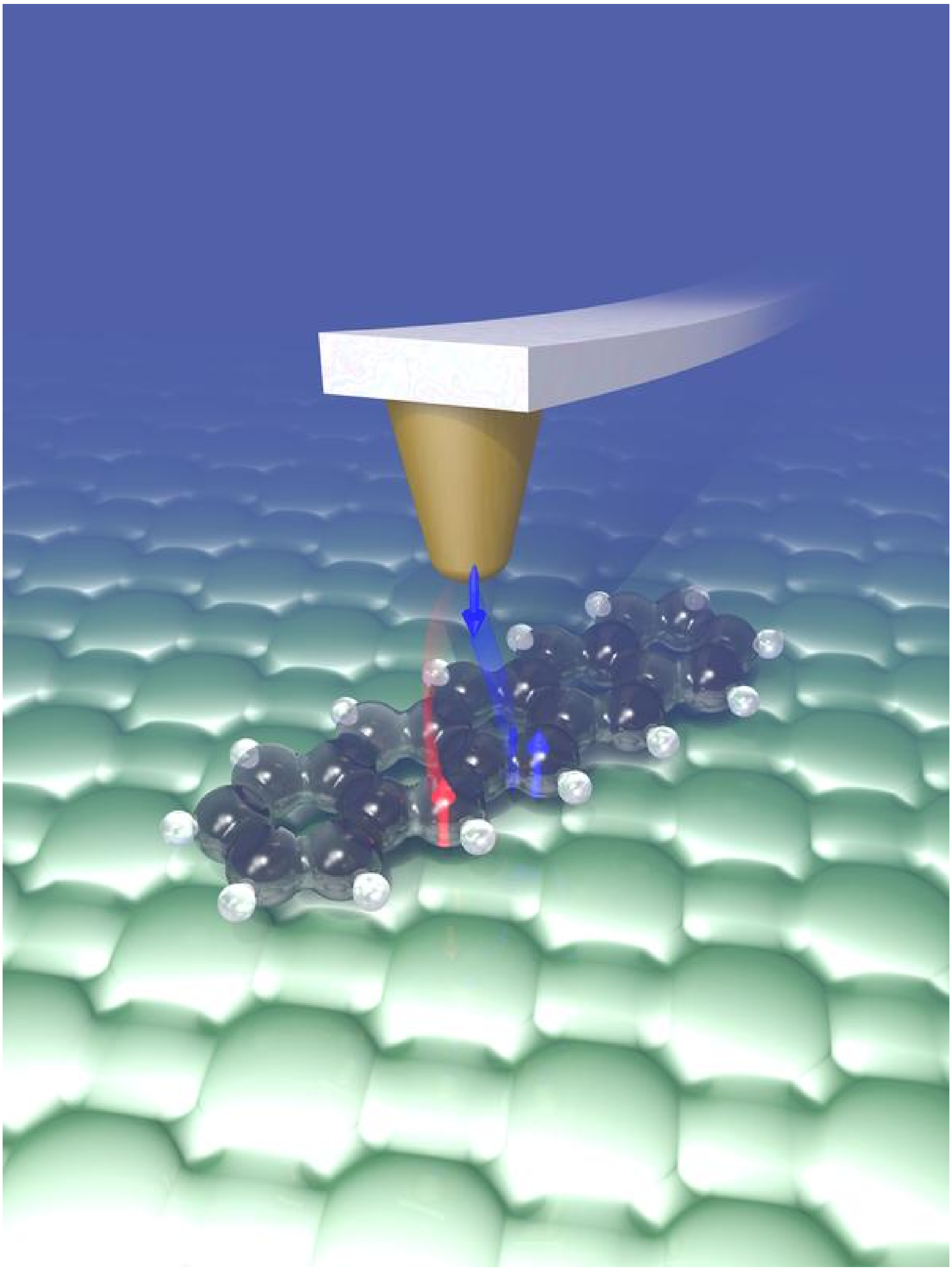

Artistic illustration of the steered exchange of single electrons (red and blue) between the tip of an atomic force microscope (golden) and a single pentacene molecule (black/white spheres) adsorbed on NaCl (green).
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