Imaging Electron Transfer at the Molecular Scale by Atomic Force Microscopy

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Electron transfer is at the heart of many fundamental processes, from photosynthesis to combustion and molecular self-assembly. Yet, its influence on the electronic structure of organic and organometallic molecules remains incompletely understood. In this talk, I will present recent advances in atomic force microscopy (AFM) that allow us to directly visualize and manipulate electron transfer at the single-molecule level.

In the first part of this talk, I will present an AFM-based imaging approach, namely single-electron alternate charging scanning tunneling microscopy (AC-STM), that enables mapping the orbital structure of single molecules upon electron transfer [1]. This method has revealed the effects of electron transfer and polaron formation on the scale of individual molecular orbitals [2,3].

In the second part, I will turn to metal-molecule charge transfer and its role in molecular self-assembly on surfaces. Using a combination of Kelvin Probe Force Microscopy and Scanning Tunneling Spectroscopy, we investigated charge transfer in self-assembled phases of fullerene C_{60} and a porphyrin derivative. Through detailed analysis of force and tunneling spectra, we reveal that the driving force behind the formation of the row-like structure is the alleviation of repulsive inter-fullerene Coulomb interactions, which in turn promotes a larger degree of charge transfer to the C_{60} molecules [4]. These findings demonstrate how the delicate balance between substrate-mediated electron transfer and intermolecular interactions can be harnessed to control molecular organization at surfaces.

References

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