Current-Induced Conductance Switching of Individual Molecules

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Ultrathin insulating films on metal substrates facilitate the use of the scanning tunneling microscope to study the electronic properties of single atoms and molecules, which are electronically decoupled from the metallic substrate.
Individual gold atoms on an ultrathin insulating sodium chloride film supported by a copper surface exhibit two different charge states, which are stabilized by the large ionic polarizability of the film. The charge state and associated physical and chemical properties such as diffusion can be controlled by adding or removing a single electron to or from the adatom with a scanning tunneling microscope tip.
The bistability in the position of the two hydrogen atoms in the inner cavity of single free-base naphthalocyanine molecules constitutes a two-level system that was manipulated and probed by scanning tunneling microscopy. The molecules can be switched in a controlled fashion between the two states by excitation induced by the inelastic tunneling current. The tautomerization reaction can be probed by resonant tunneling through the molecule and is expressed as considerable changes in the conductivity of the molecule. We also demonstrated a coupling of the switching process so that the charge injection in one molecule induced tautomerization in an adjacent molecule.