

Nanoscience at the Atomic and Molecular Scales

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Abstract:

The unique capabilities of the scanning tunneling microscope (STM) for spatially resolved imaging, manipulation, spectroscopy, and chemistry enable new opportunities for control and investigation of chemistry and condensed matter at the atomic and molecular scales. Reactants are manipulated into pre-designed configurations to capture the formation of reaction intermediates and subsequent stimulation of reactions. Detailed motions, conformational changes, and energy exchange in single molecules are induced and monitored, revealing their fundamental properties. Manipulation of individual atoms leads to the formation of chains of metal atoms, which allows the realization of optical emission and magnetic systems from the bottom up, starting from single atoms. These atomic chains enable the observation of particle-in-a-box states as well as the effects of single impurities, systematic variation of the structure, composition, and atomic arrangement in alloys, and chemical sensing of single molecules. The interactions of a pair of chains in a break-junction configuration with a single molecule make it possible to visualize and understand the nature of the contacts between a molecule and the metallic leads, which are pertinent to molecular electronics. This approach reveals a way to synthesize chemical systems with novel bonding and structure. The use of spin polarized electrons from the STM tip enables the investigation of magnetic properties at the atomic scales. In this talk, an overview will be given, highlighting a variety of interesting facets of atomically controlled structures, down to those of single atoms and molecules, and the scientific excitement of nanoscience.