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Lecture Title:
Seeing, Making and Measuring at the Nanoscale

Abstract:

This year marks the 25th and 20th anniversaries of the scanning tunneling microscope (STM) and the atomic force microscope (AFM), respectively. These microscopes made it possible to “see” atoms and molecules directly and consequently triggered the development of nanoscience and technology.

Due to their use of proximitive probes, the STM and AFM (referred to as scanning probe microscopes (SPMs) in general) can also manipulate single atoms and molecules and induce local chemical reactions. The author and co-workers have developed these capabilities extensively and have applied them to “make” various nanostructures of interest, e.g., single polymerized molecular wires formed at designated positions by inducing chain polymerization (see Fig. 1), the reversible creation and annihilation of several atoms that electrically connect two electrodes separated by a nanoscale gap (atomic switch), and the reversible control of local polymerization and depolymerization of C₆₀ molecules.

The author and co-workers also have developed multiprobe SPMs in which two, three or four probes are operated independently. Every probe can yield high-resolution STM or AFM images, but the main role of the multiple probes is their use as contact electrodes to “measure” electrical properties at the nanoscale. By using the multiprobe SPMs, we have succeeded in measuring electrical conductivity of various nanostructures, such as single-walled carbon nanotubes, ErSi₂ nanowires, and various conductive polymer thin films.

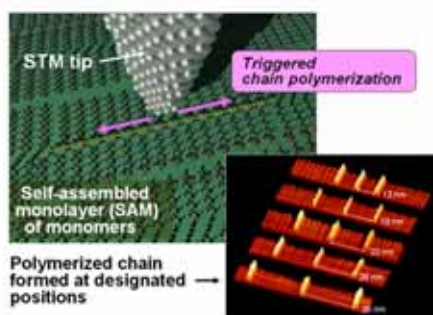


Fig.1 Example of *making at the nanoscale*: single polydiacetylene molecular wires were created at designated positions by inducing chain polymerization.

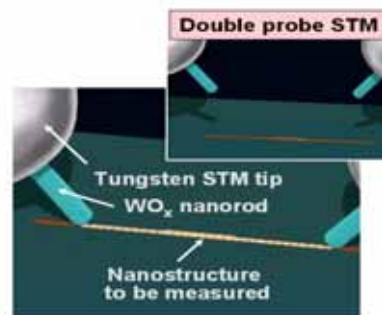


Fig.2 Example of *measuring at the nanoscale*: electrical conductivity measurement of an ErSi₂ nanowire using a double-probe STM.