ФИЗИКО-ХИМИЧЕСКИЕ ОСНОВЫ НАНОТЕХНОЛОГИИ

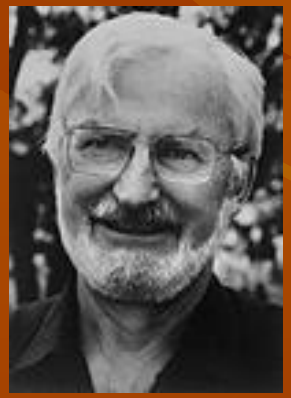
Профессор Н.Г. Рамбиди

5. Атомный дизайн

What is Scanning Tunneling Microscopy?

- Allows for the imaging of the surfaces of metals and semiconductors at the atomic level.
- Developed by Gerd Binnig and Heinrich Rohrer at the IBM Zurich Research Laboratory in 1982.

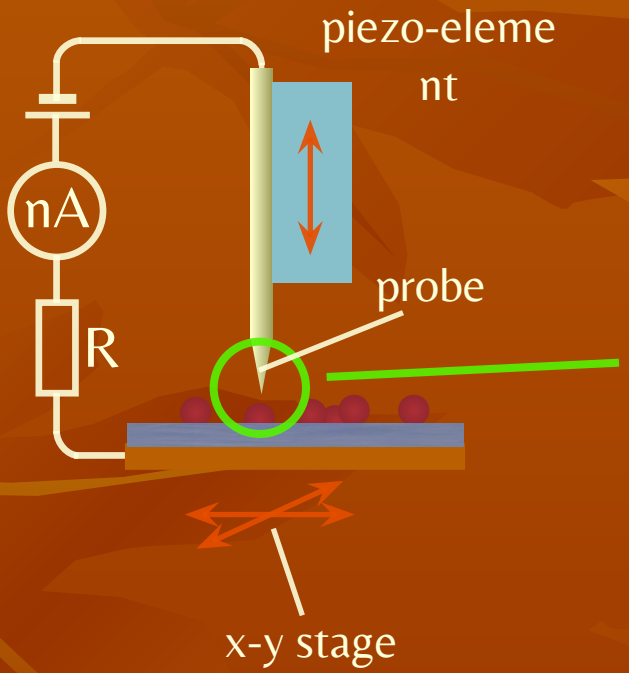
Binnig



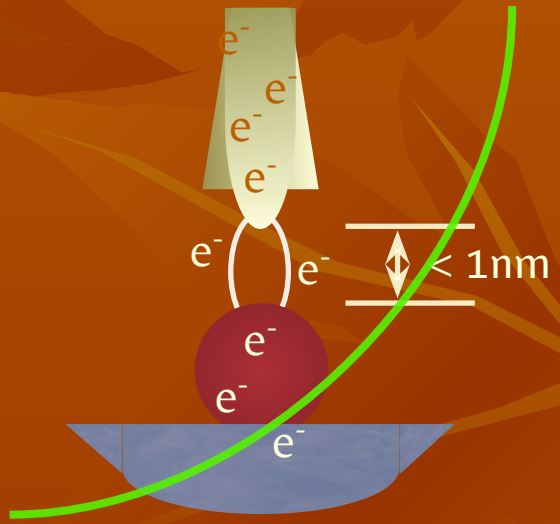
Rohrer

- The two shared half of the 1986 Nobel Prize in physics for developing STM.
- STM has fathered a host of new atomic probe techniques: Atomic Force Microscopy, Scanning Tunneling Spectroscopy, Magnetic Force Microscopy, Scanning Acoustic Microscopy, etc.

STM: scanning tunneling microscope



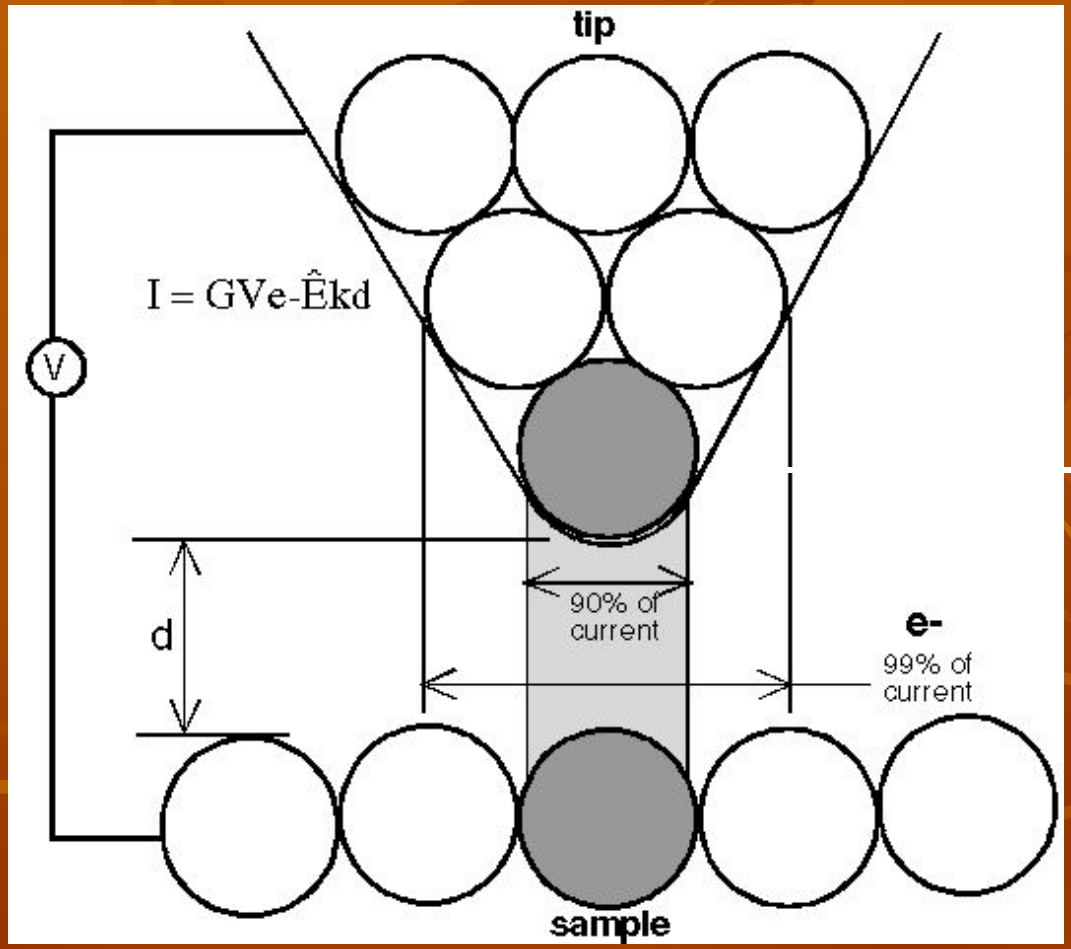
tunneling of electrons through air between probe and surface



only conducting material

Basic Principles of STM

d ~ 6 Å

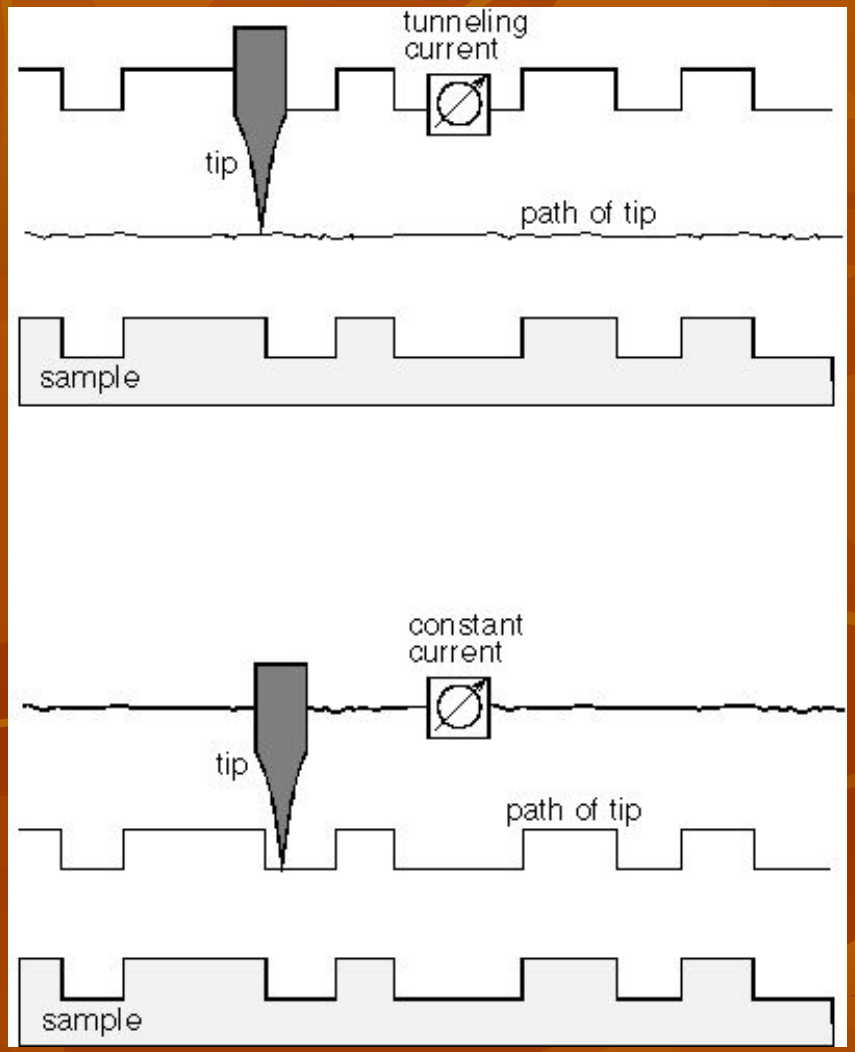


Bias voltage: mV – V range

- Electrons tunnel between the tip and sample, a small current I is generated (10 pA to 1 nA).
- I proportional to $e^{-2\kappa d}$, I decreases by a factor of 10 when d is increased by 1 Å.

Two Modes of Scanning

Constant Height Mode

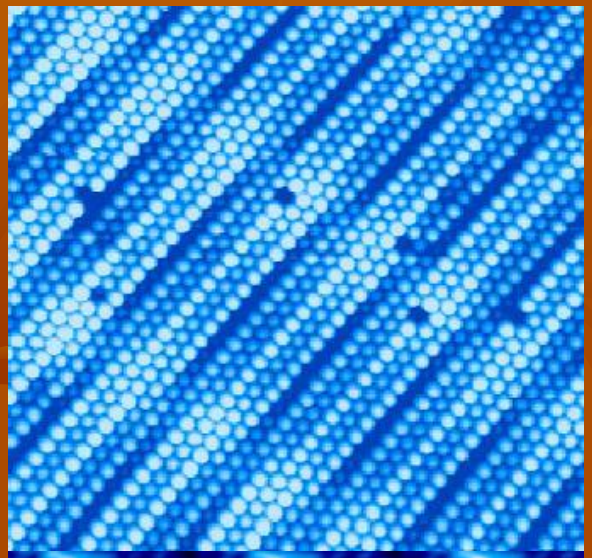


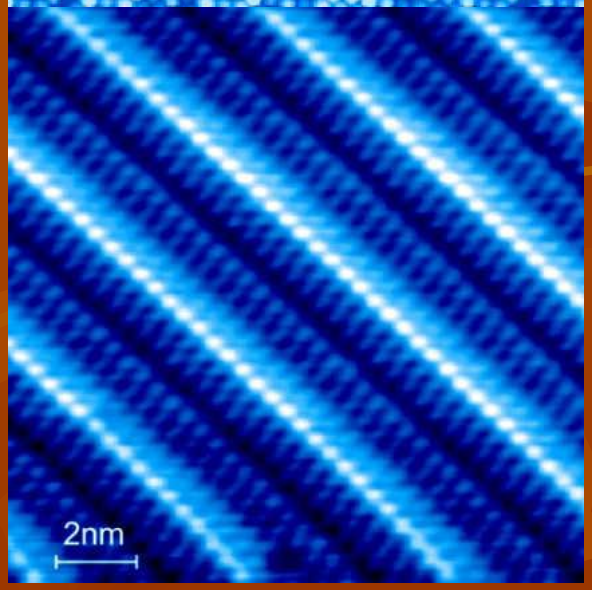
Constant Current Mode

- Usually, constant current mode is superior.

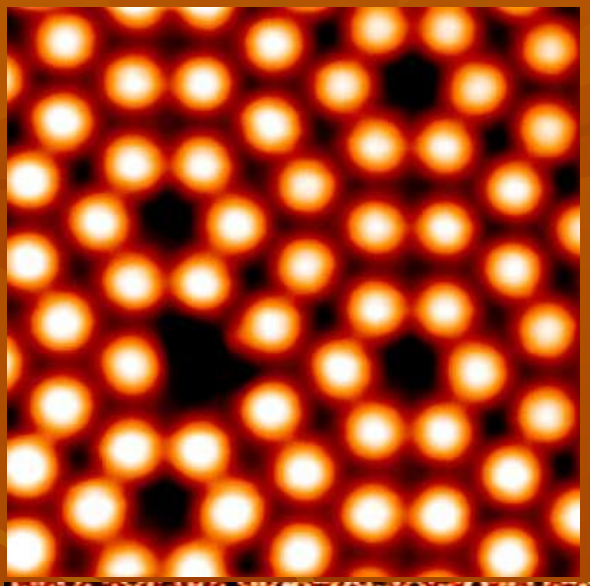
STM изображения

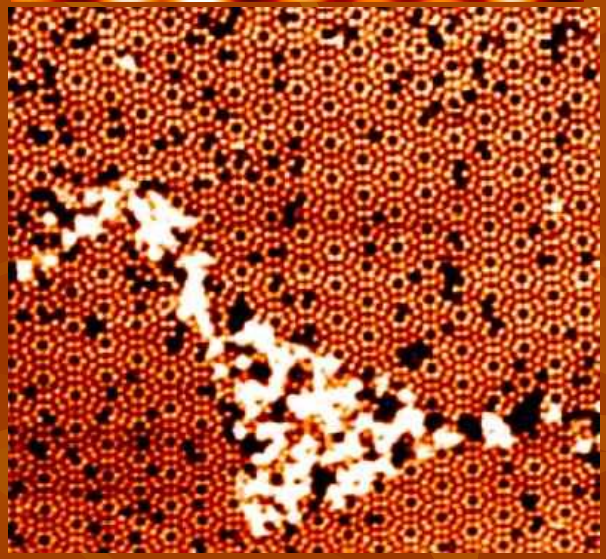
Examples of STM images…



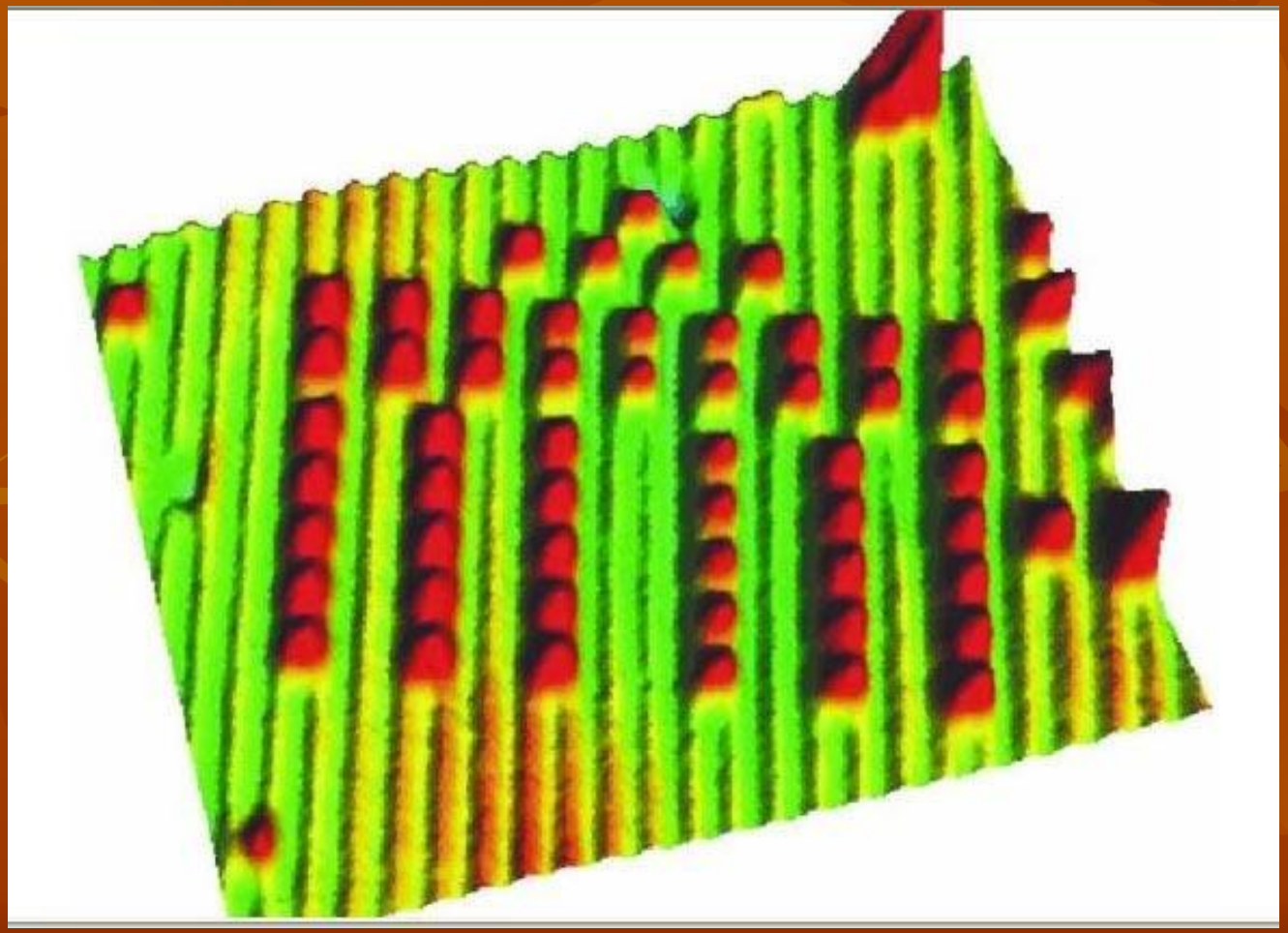


- Pt (100) with vaccancies
- Si (111) 7x7 reconstructio n
- Annealed decanethiol film on Au(111)
- Si (111) with terraces and

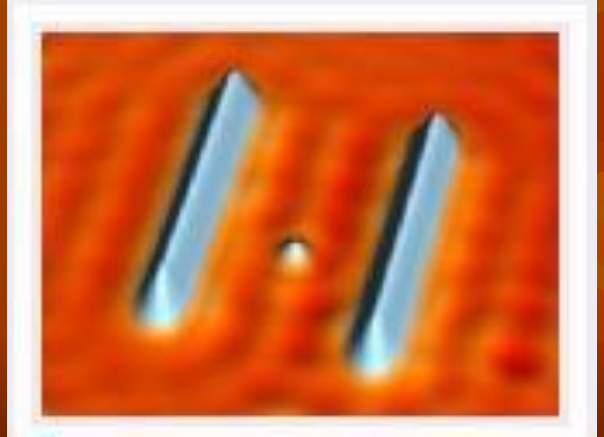




Бранденбургские ворота

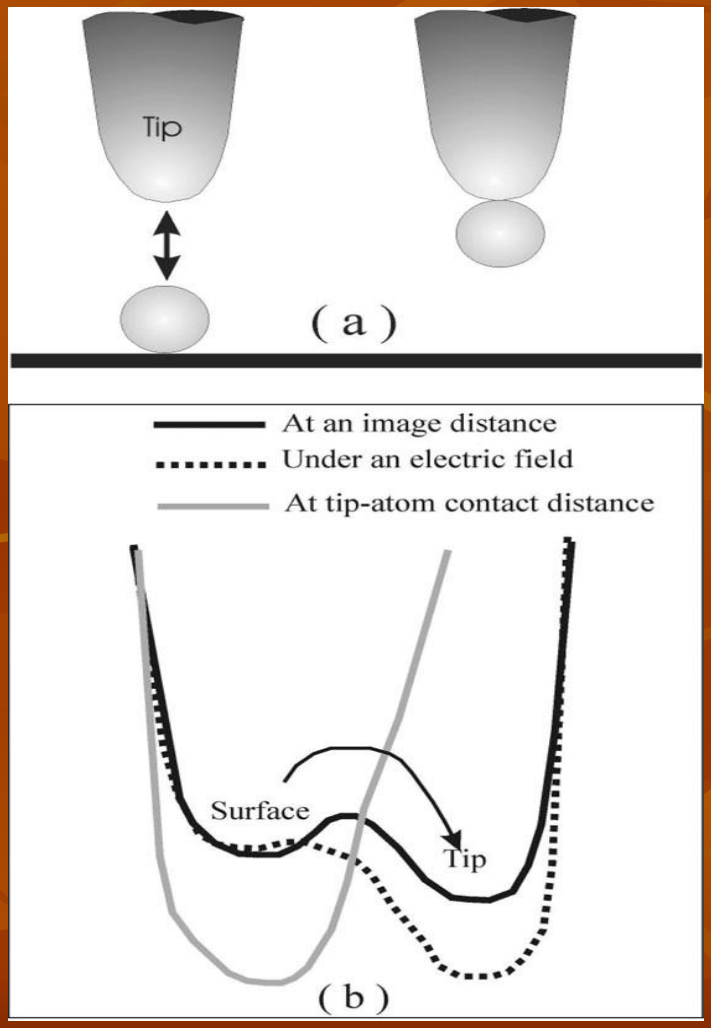


Диффузия атомов на поверхности

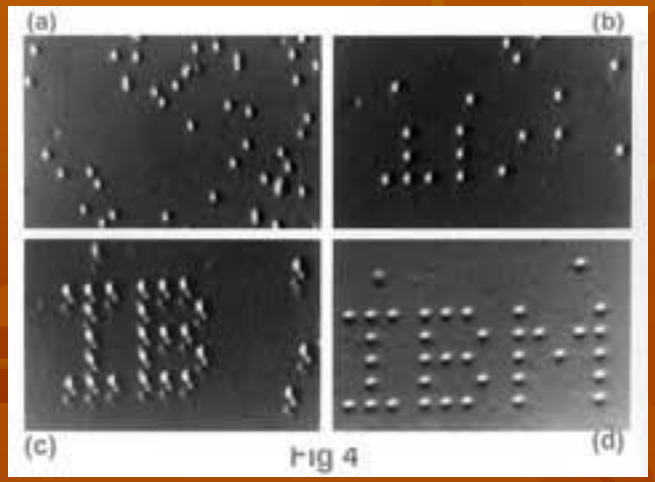


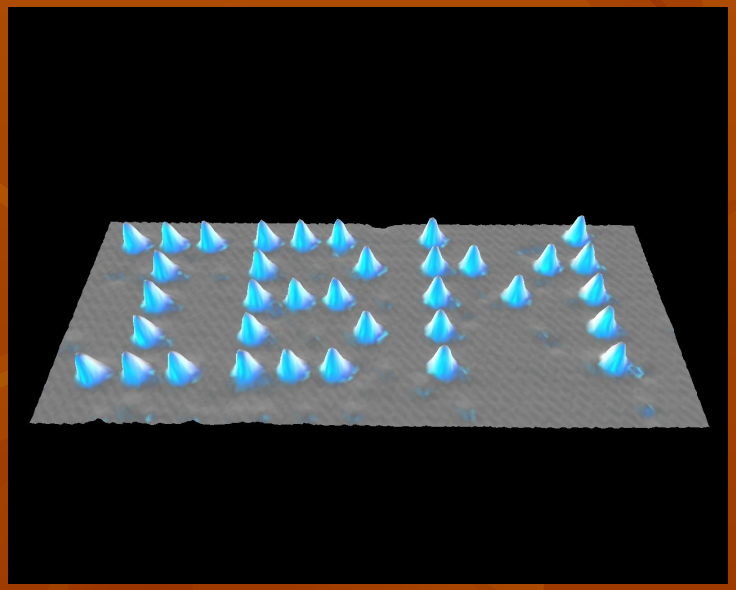
Атомно-молекулярный дизайн

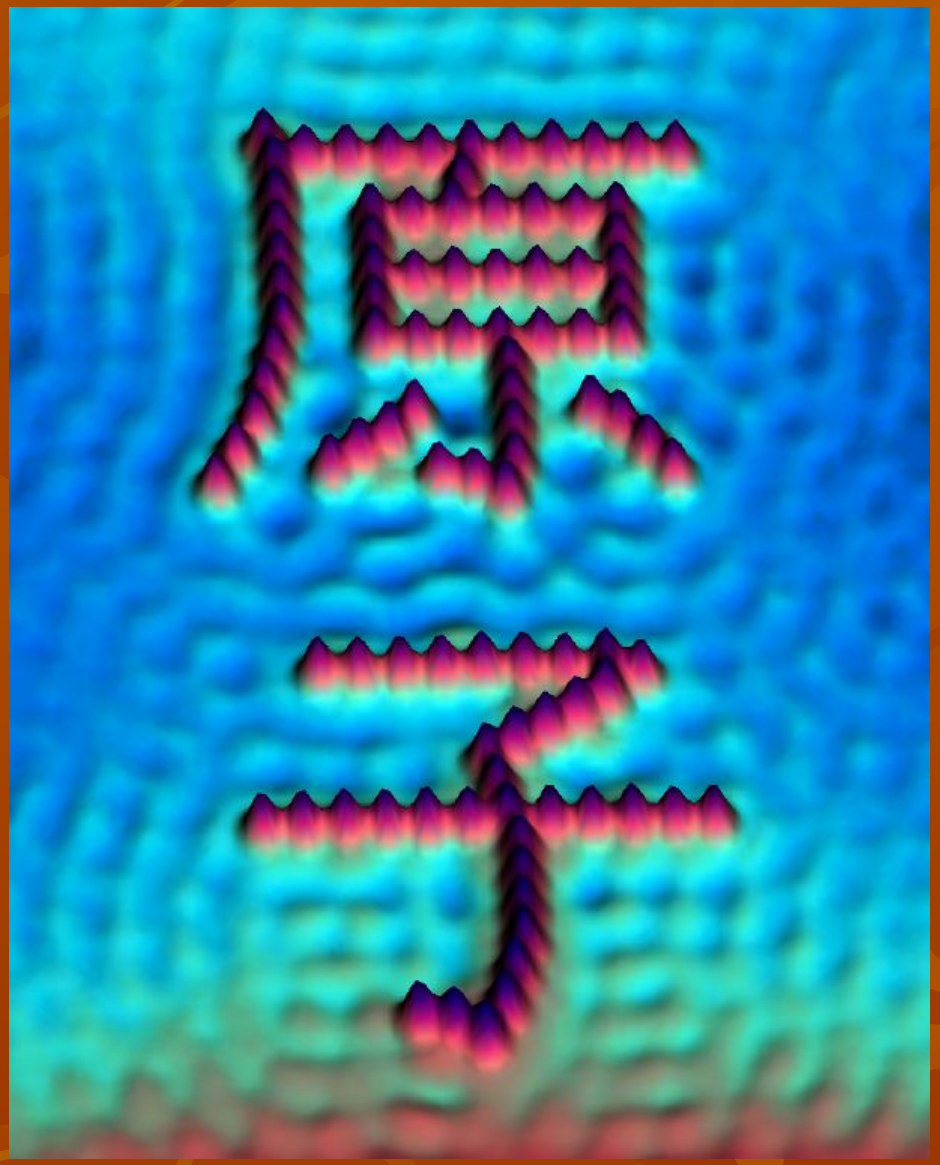
Смещение атомов по поверхности



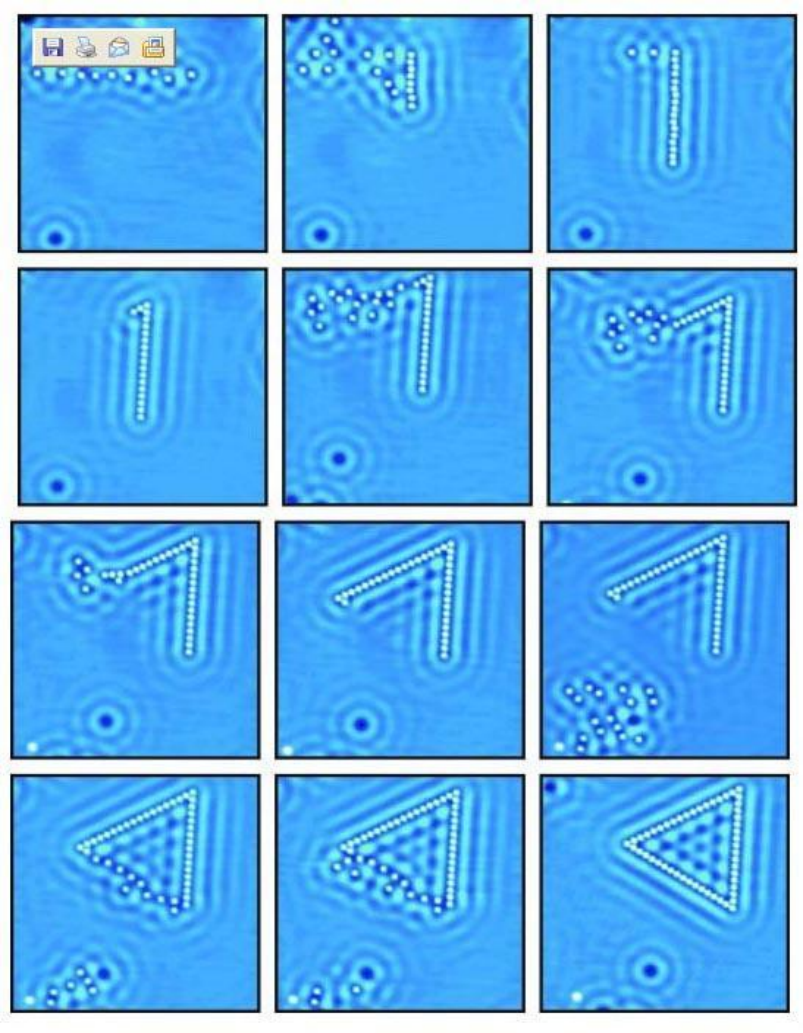
Moving atoms one at a time…



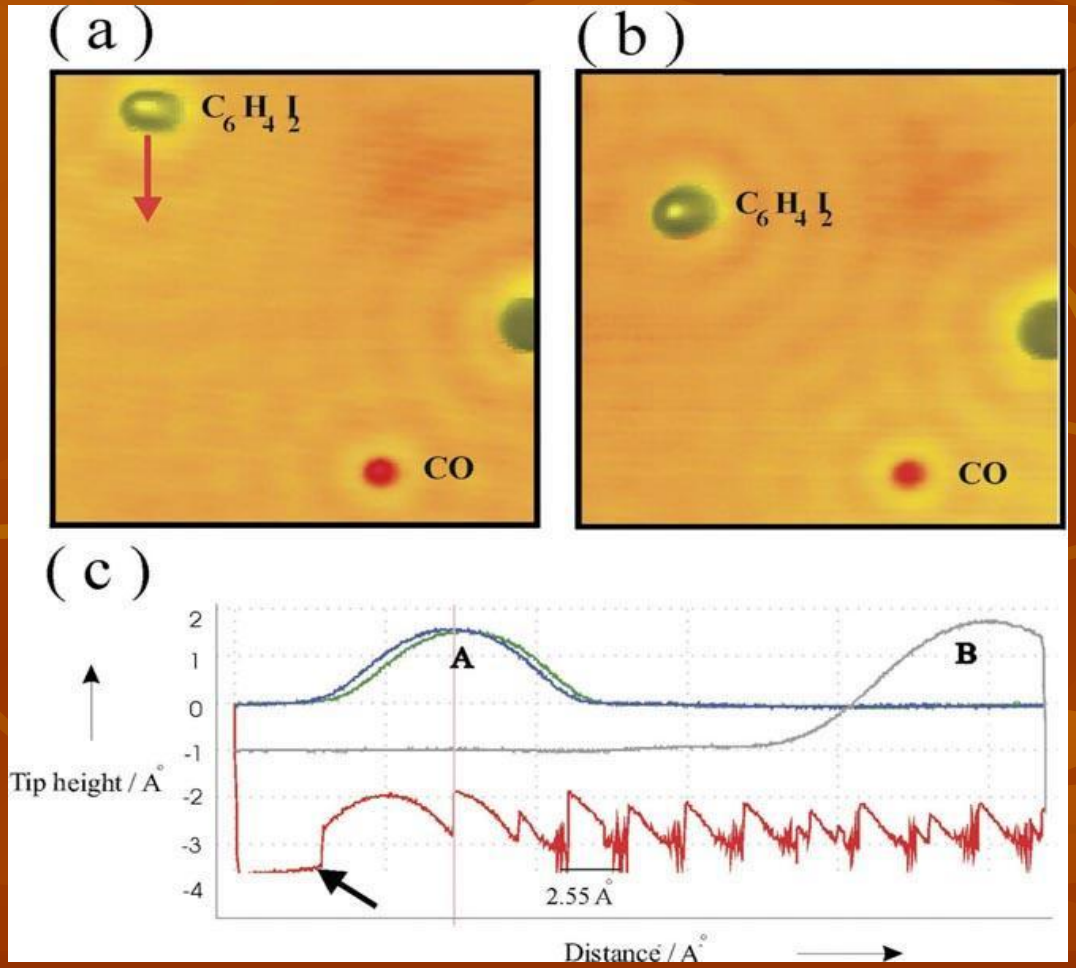




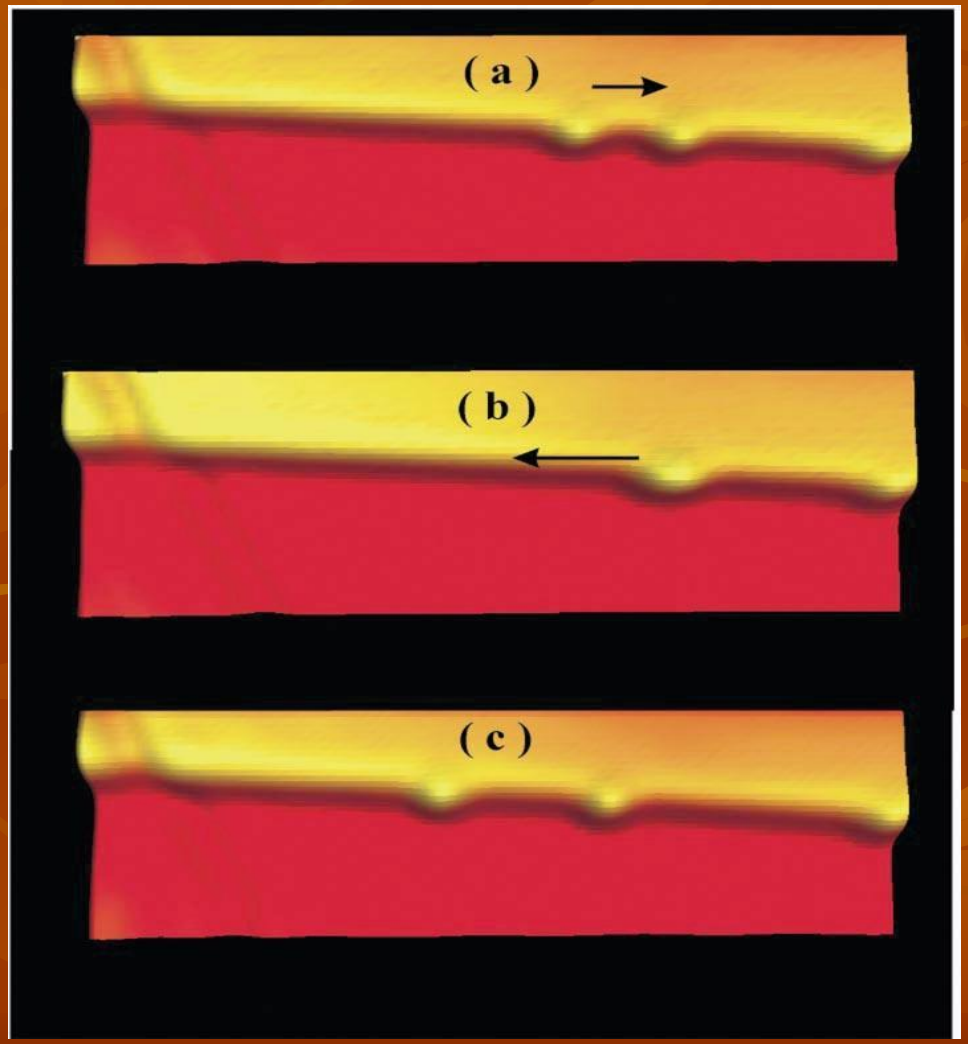
Создание треугольной системы атомов



Смещение молекулы иодбензола

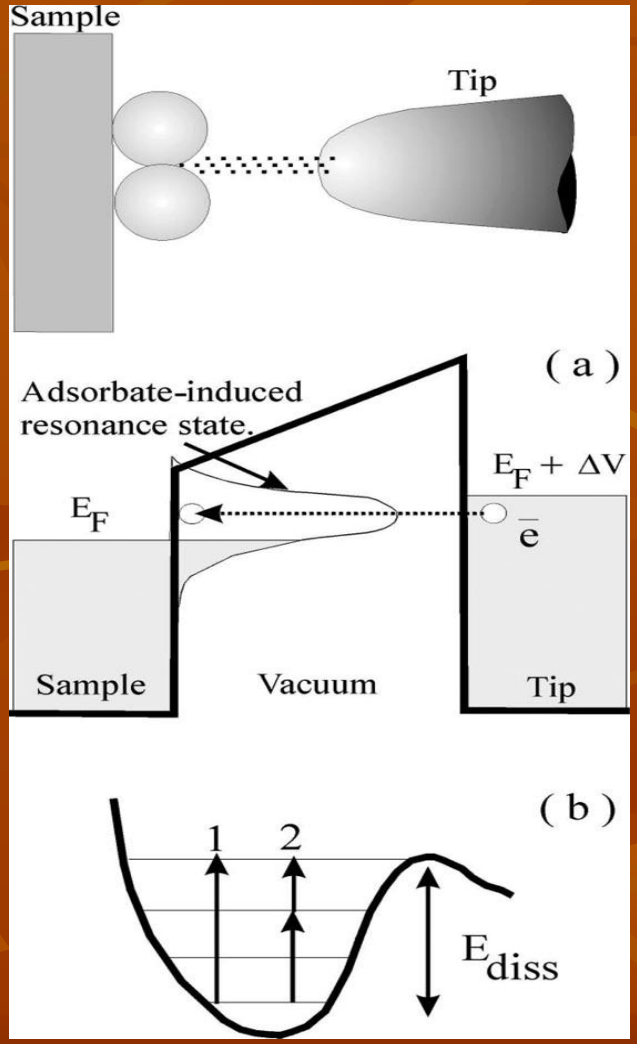


Смещение молекул на поверхности

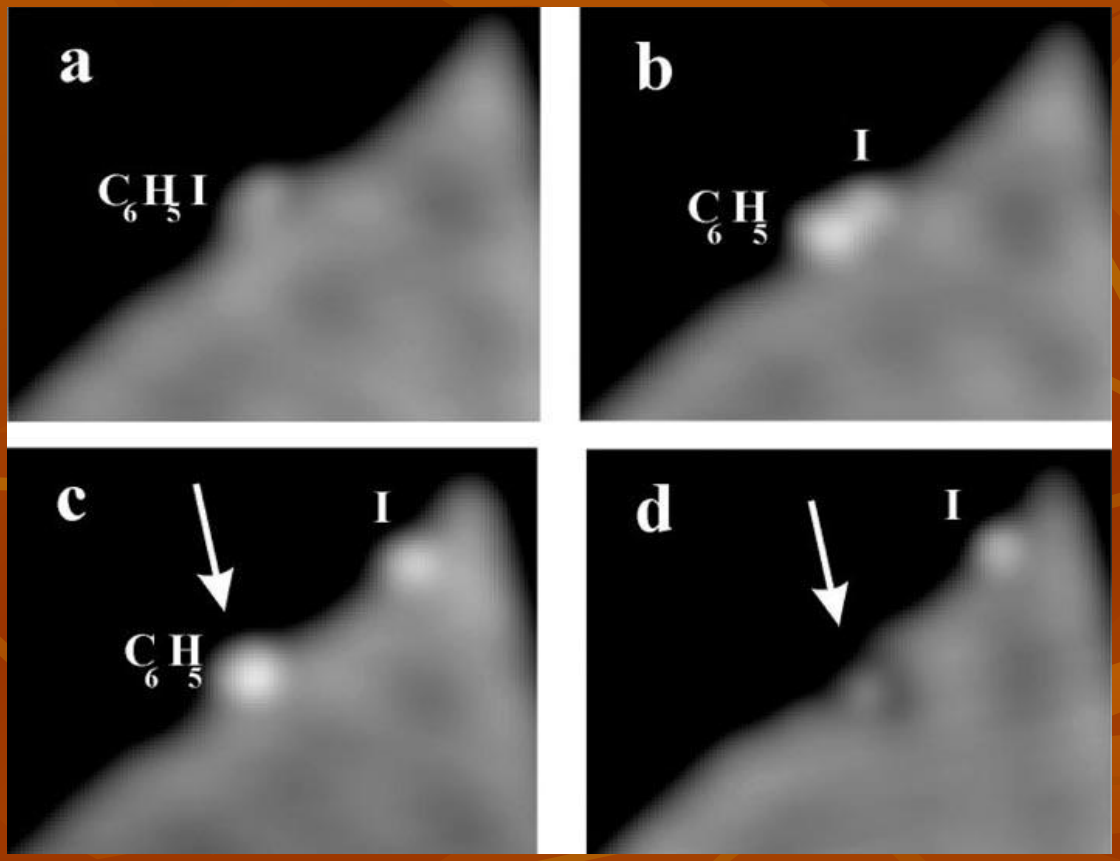


Разложение молекул

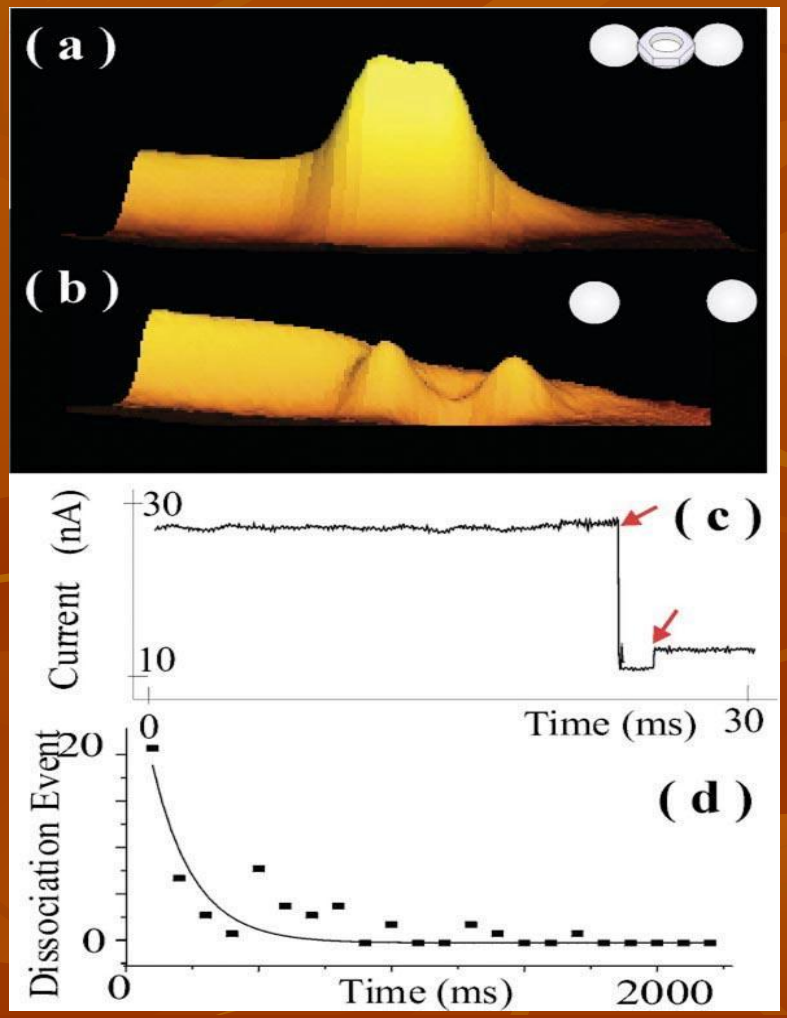
Диссоциация



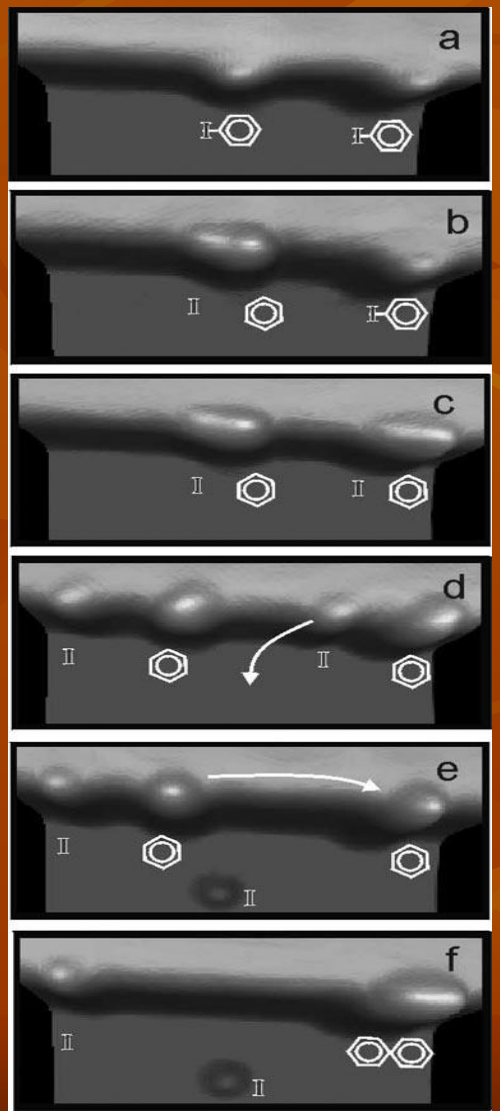
Иодбензол



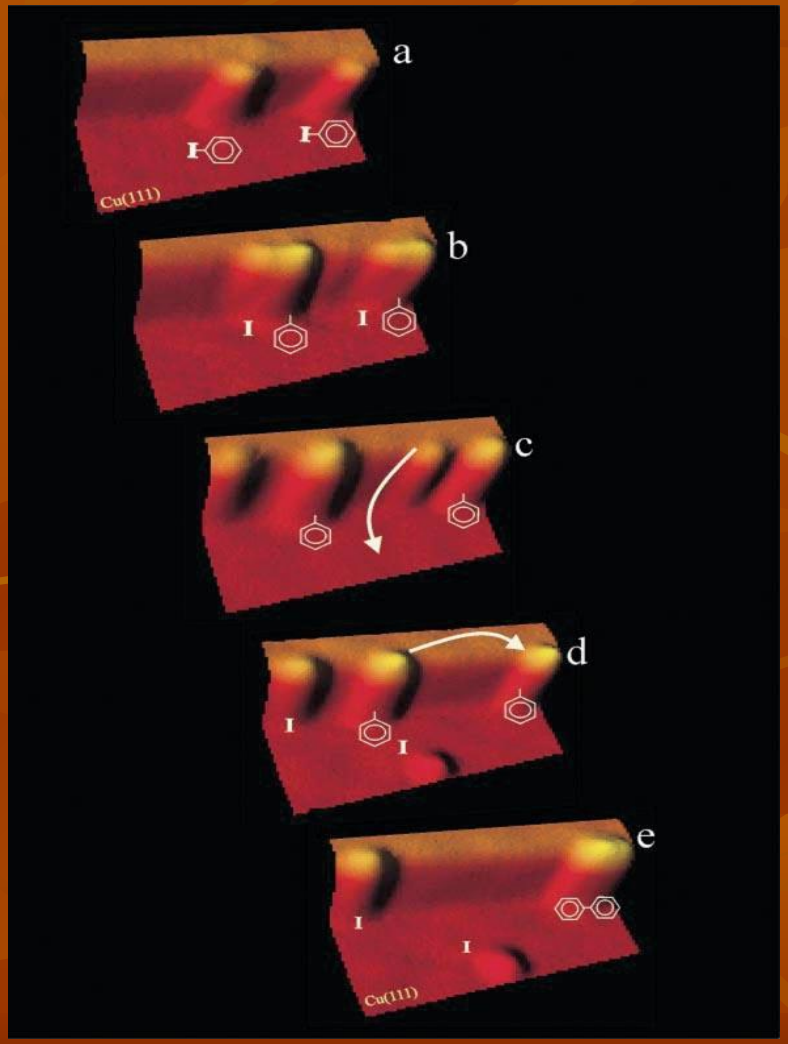
P-дииодбензол



Реакция Ульмана



Реакция Ульмана



Молекулярное конструирование