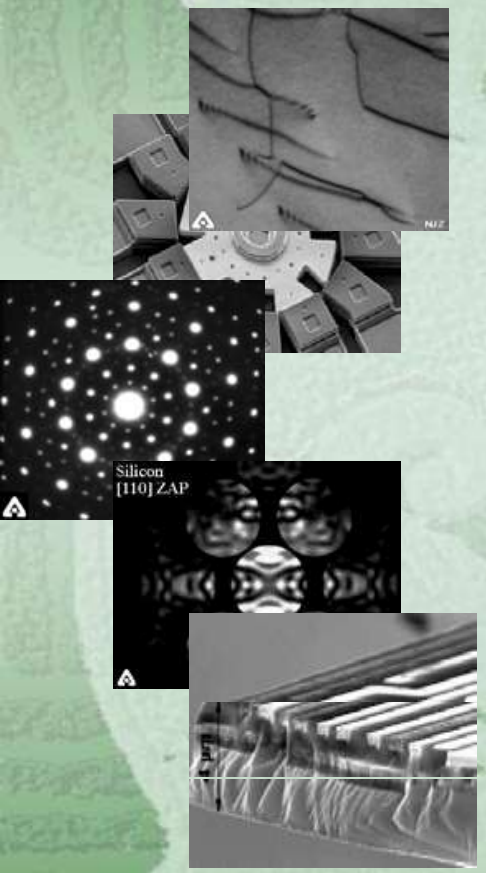
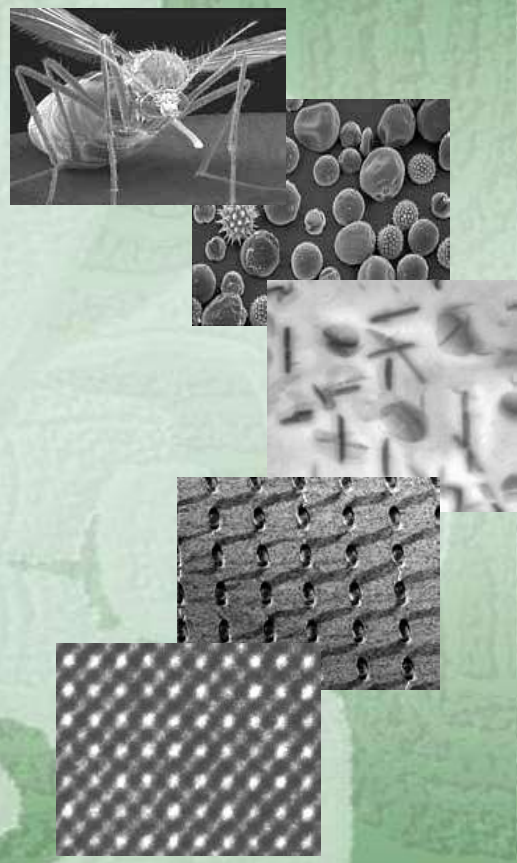
"Scanning Tunneling Microscopy Transmission Electron Microscopy"





Speakers *Burcu Başar*
Semih Gezgin
Yavuz Selim Telis

Place *Hacettepe University*
Department of Chemical Engineering

"It's a small world after all.. "

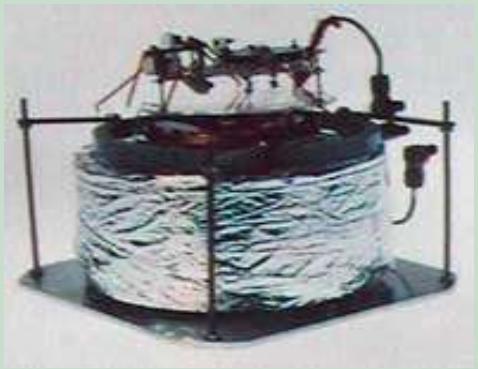
April 12/2012

IN THIS PRESENTATION...

- ✓Invention
- ✓General Overview
- ✓Basic Set-up
- ✓How They Work
- ✓Advantages&Limitations
- ✓Applications
- ✓Conclusion

INVENTION..

- *STM* -Invented by Binnig and Rohrer at IBM in 1981 (Nobel Prize in Physics in 1986)

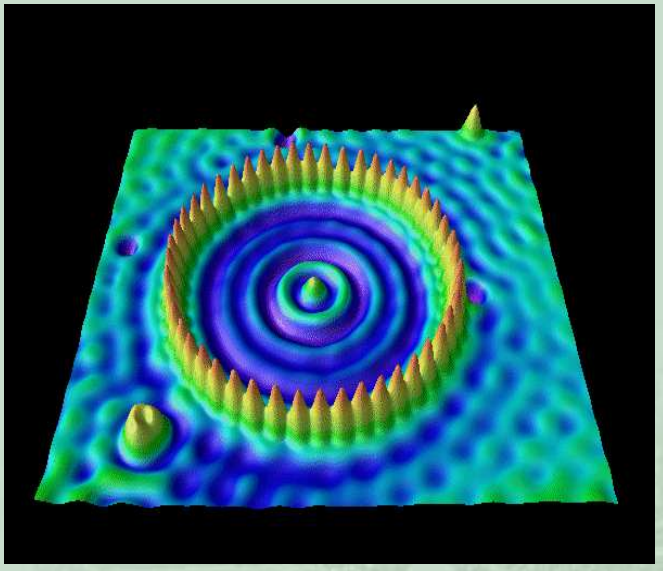


- *TEM*-Invented by Ernst Ruska and Max Knoll in 1931

GENERAL OVERVIEW..

STM

- An electron microscope that uses a single atom tip to attain atomic resolution.
- Topographic (real space) images
- Spectroscopic (electronic structure, density of states) images



Iron atoms on the surface of Cu(111)[2]

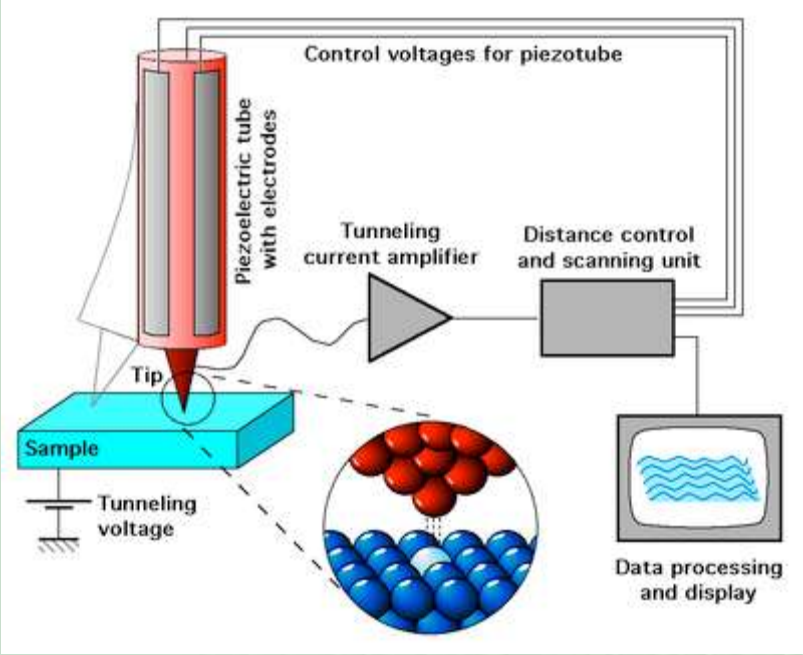
TEM

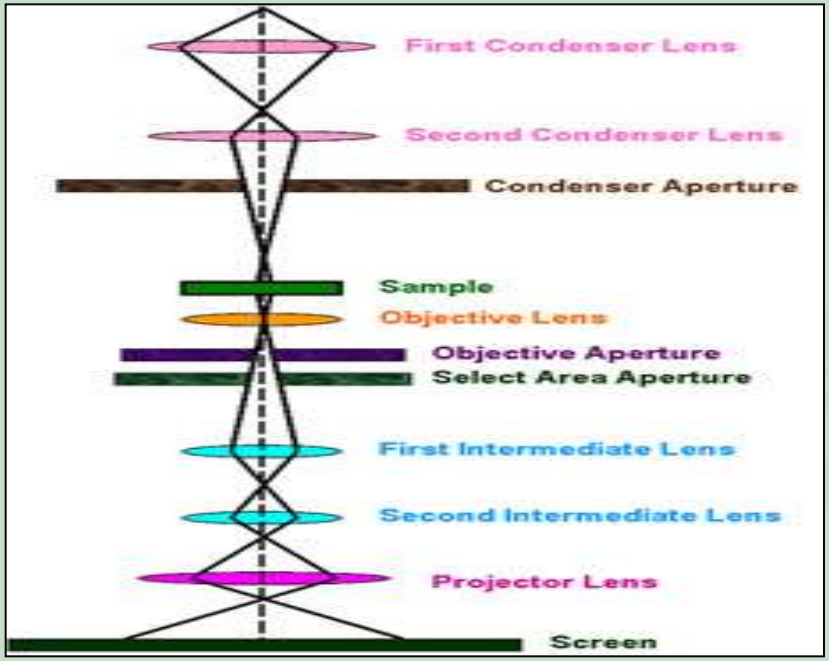
- Used to characterize the microstructure of materials with very high spatial resolution
- Examine internal morphology of polymers from segmental to atomic level(e.g.block copolymers,crystalline polymers..)

BASIC SET-UP..

STM includes;

- Scanning tip
- Piezoelectric controlled scanner
- Distance control and scanning unit
- Vibration isolation system
- Computer

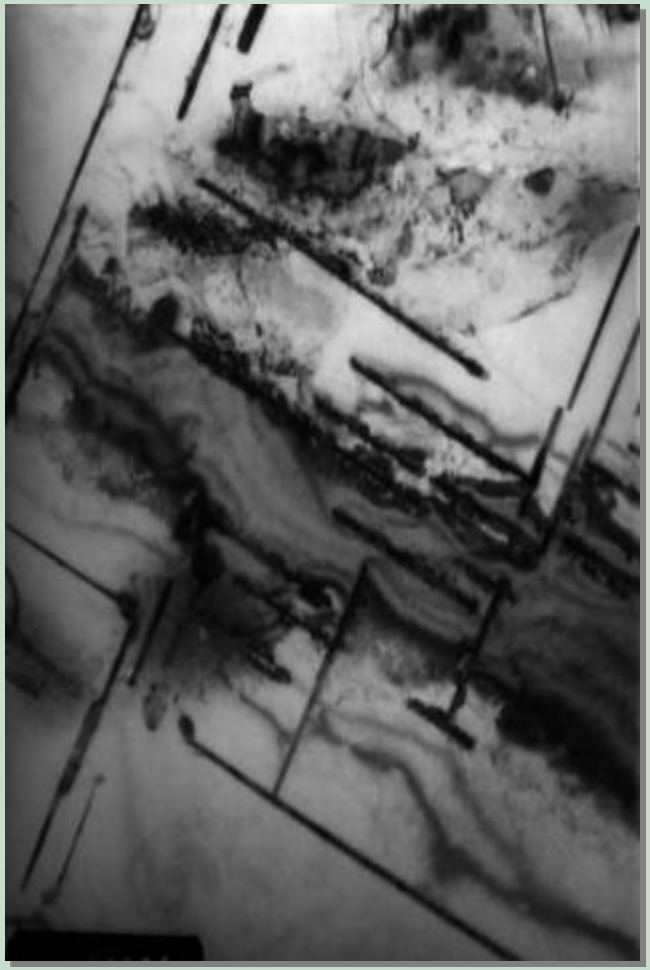




TEM includes;

- Electron gun
- Condenser system
- Specimen chamber
- Objective lens systems
- Projector lens systems

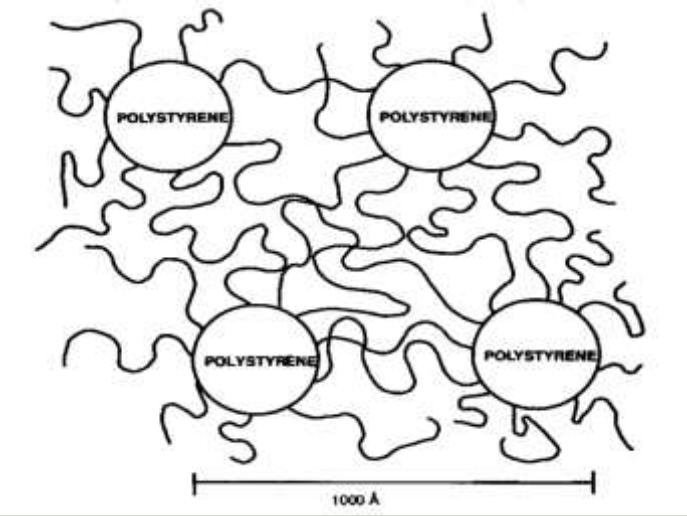
HOW TO OPERATE TEM?..



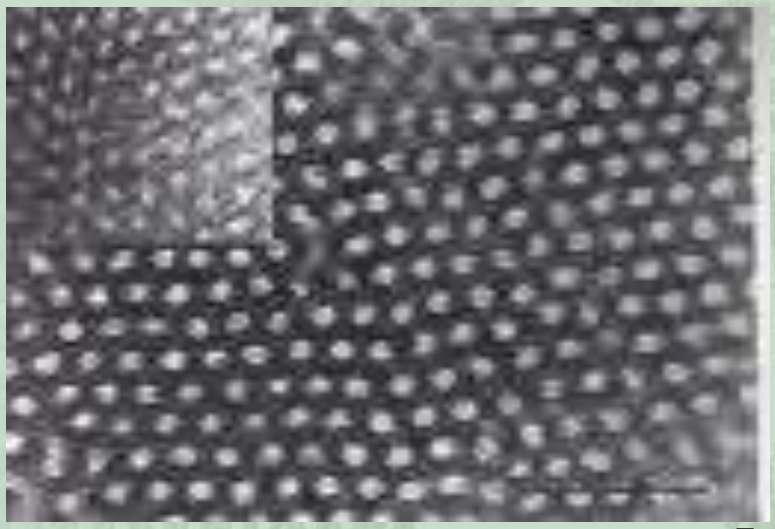
- Beam of **electrons** transmitted through an ultra thin specimen
- Image formed, magnified and detected through a sensor
- Image contrast produced through electron scattering by the atomic nuclei of the sample
- Contrast within the sample enhanced by the use of stains

LIMITATIONS ..

- ☹ More time for sample preparation
- ☹ Require experience than most other techniques
- ☹ Samples damaged by the electron beam irradiation;having to withstand high vaccum
- ☹ The entire specimen fit into a 3mm diameter cup&Be less than 100 microns in thickness

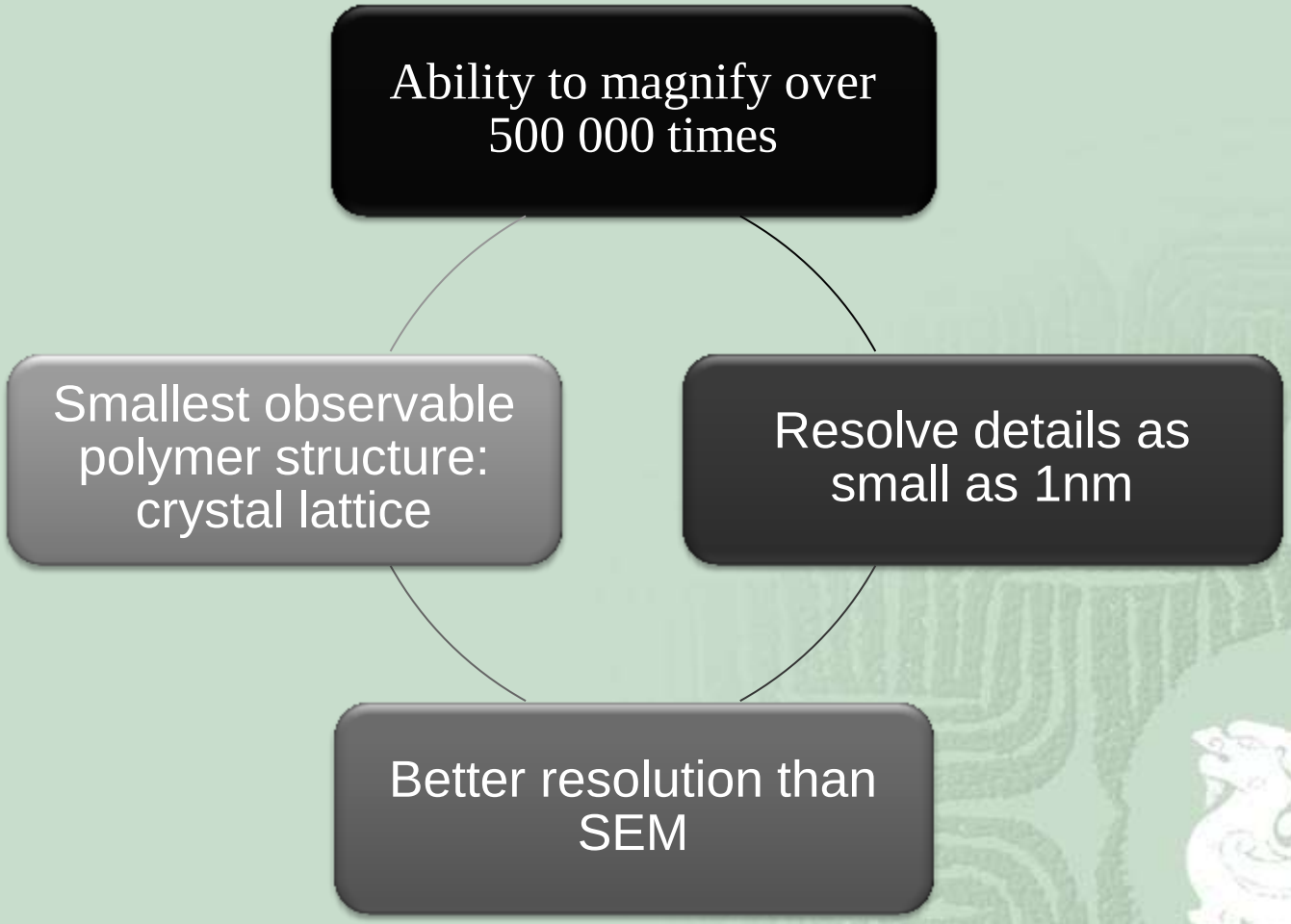


SBS block copolymer structure[3]

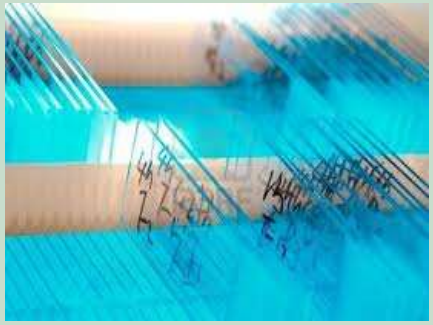


Typical TEM image of a SBS sample

ADVANTAGES..


Ability to magnify over 500 000 times
Resolve details as small as 1nm
Better resolution than SEM
Smallest observable polymer structure: crystal lattice

APPLICATIONS..



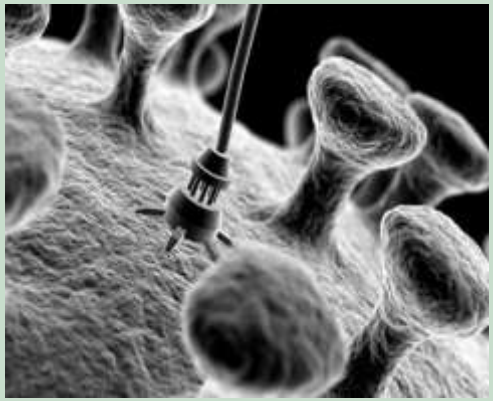
Materials Science&Metalurgy

Biological Science

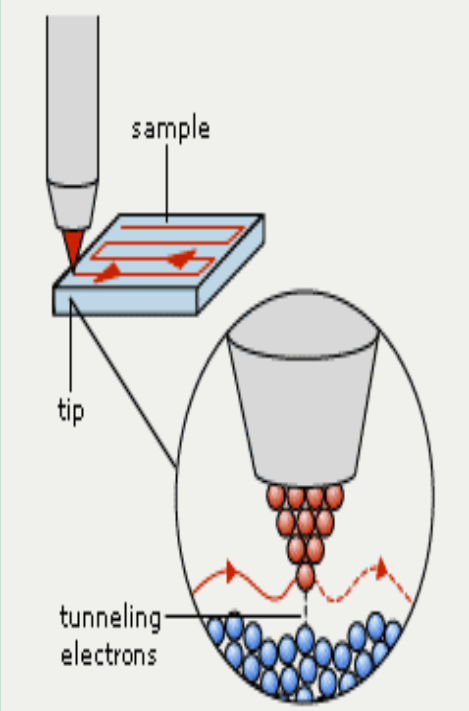
Ceramics

Nanotechnology

Pharmaceuticals



HOW TO OPERATE STM?..



Based on a phenomenon called Quantum Mechanical Tunneling

Applied voltage between the sharp tip and the surface

Small tunneling current produced

Small electric current under the circumstances without the need for the tip to touch the surface

"**I think I can safely say that nobody understands Quantum Mechanics."** Richard Feynman

How tunneling works ? → Simple answer

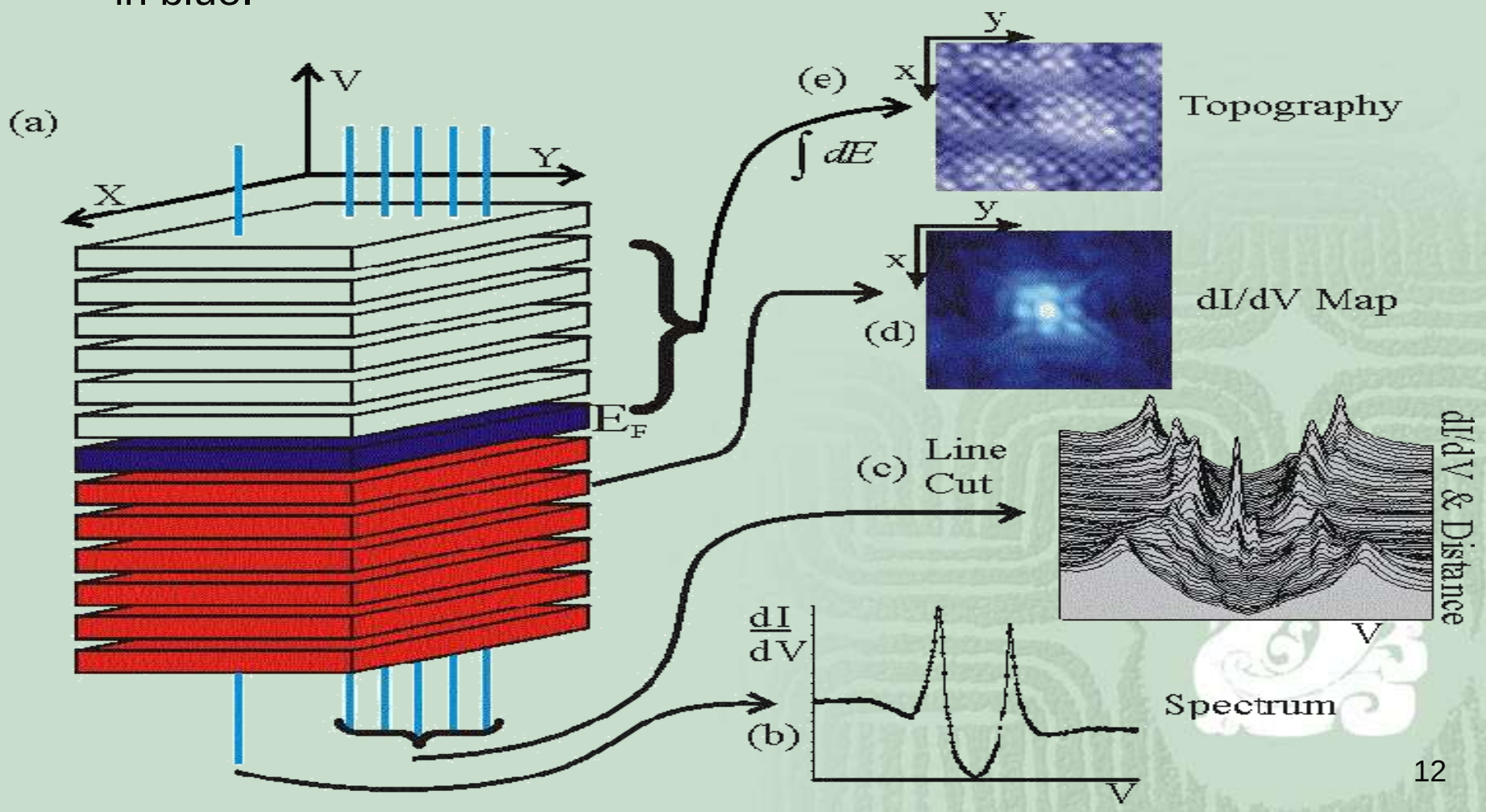
No possibility of e flows without a direct connection by a wire

A quantum mechanical particle behaves in its wave function

A finite probability that an electron “jump” from one surface to the other of lower potential

What an STM measures?------Local density of states

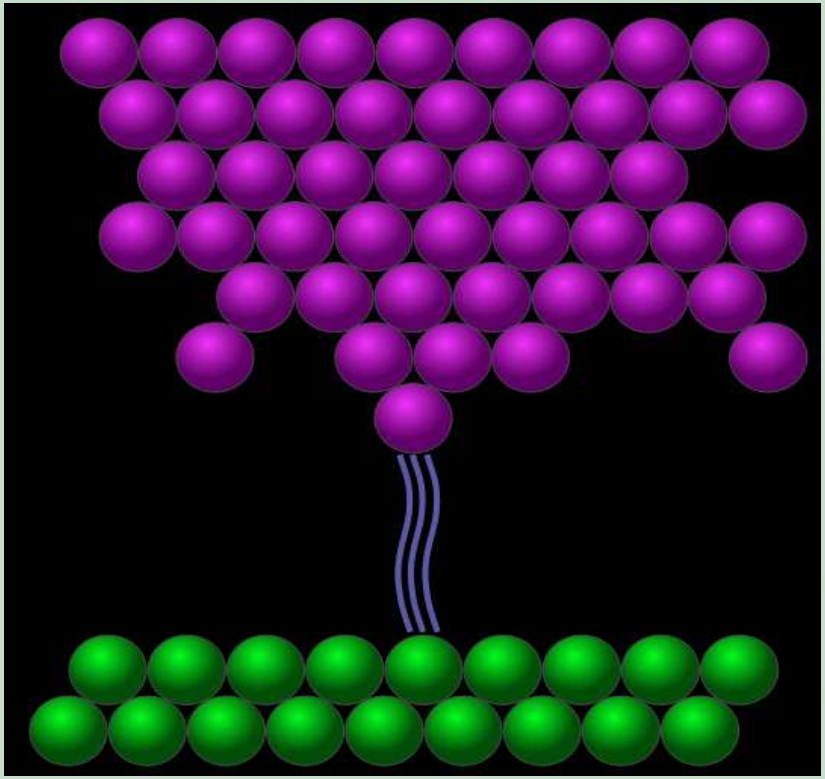
Each plane represents a different value of the tip-sample V, and the lateral position on the plane gives the x,y position of the tip. Filled states are given in red. The plane at the Fermi energy (V=0) is shown in blue.



ADVANTAGES..

- Conceptually simple but complexities in use
- Can even move atoms
- Can be used in variety of temperatures
- Perform in different environments(air, water etc.)

LIMITATIONS..

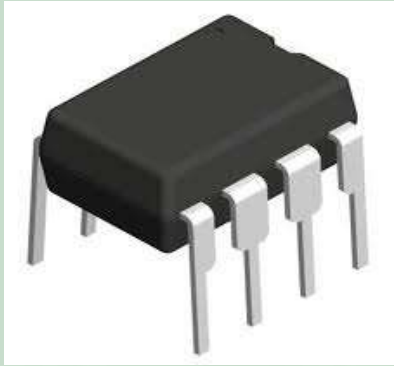


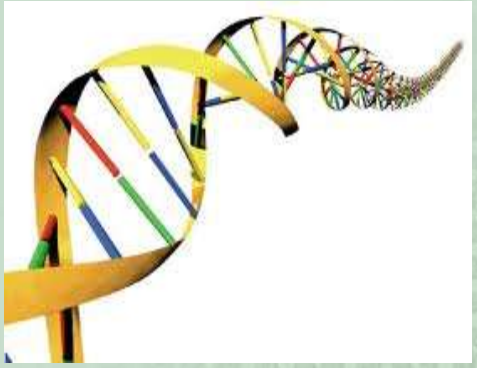
Damaged tip[6]

- ☹ Slower compared to other techniques
- ☹ Mainly used to analyze conducting materials
- ☹ The best results from STM can be obtained only in vacuum conditions,hence it may not be the best tool to inspect and analyse biological samples

WIDE USAGE AREA IN..

- ✓ Physics, semiconductor physics and microelectronics
- ✓ Chemistry, surface reaction catalysis
- ✓ Biology,in the study of DNA molecules
- ✓ Nanoscale chemistry labs, synthetic chemical compounds





CONCLUDING REMARKS..

STM vs TEM

- Maintains a constant tunnelling electrical current
- Very high resolution
- Better resolution but limited to conducting materials

- Offer the most powerful magnification, potentially over one million times or more
- Ability to utilize in a variety of different scientific, educational and industrial fields
- Provide information on element and compound structure
- Easy to operate with proper training

REFERENCES..

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- [3] The Tunneling Current - A Simple Theory http://wwwex.physik.uni-ulm.de/lehre/methmikr/buch/node5.html
- [4] Scanning Tunneling Microscopy http://www.physnet.uni-hamburg.de/home/vms/pascal/stm.htm
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- [8] Davis Baird,Ashley Shew,Department of Philosophy, University of South Carolina, Columbia, Probing the History of Scanning Tunneling Microscopy, October 2002,available online.
- [9] Lecture 4,Scanning Tunneling Microscopy, CHM8490/8190, Spring 2000, Dr. Gang-yu Liu

"The reason we are on an imaginative level is not because we have finer imagination,but because we have better instruments."

Alfred North Whitehead

THANK S FOR YOUR ATTENTION..