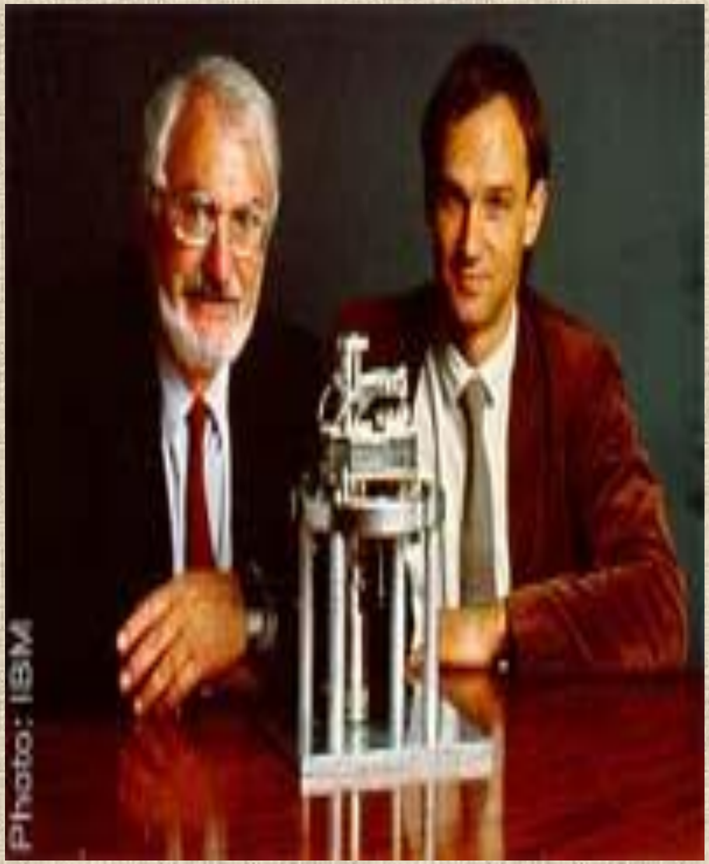
MATERIAL SCIENCE AND TECHONOLOGY-1

Scanning Tunneling Microscope, STM

Tunneling Electron Microscope, TEM

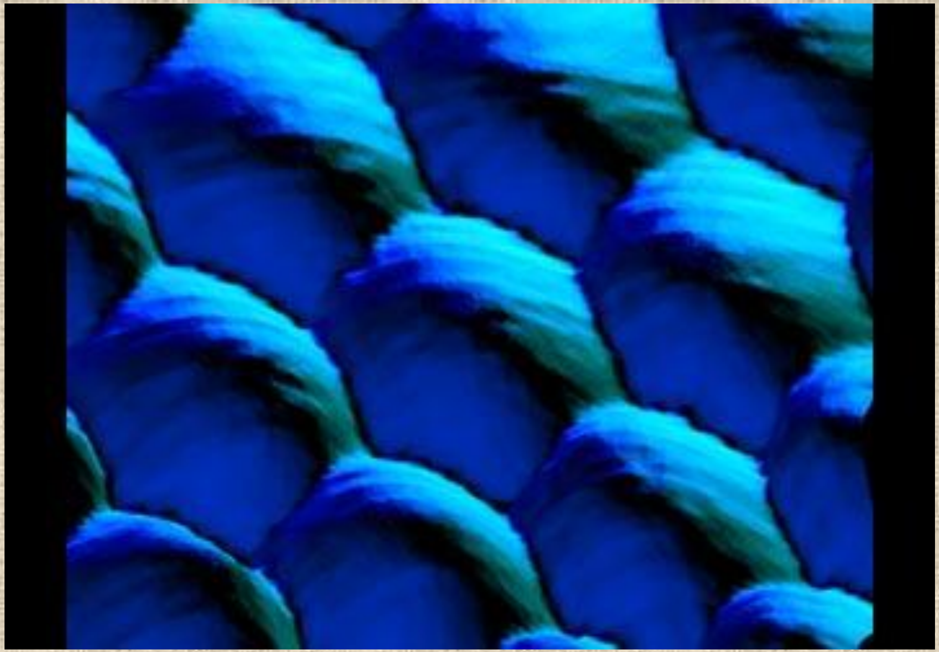
HATİCE DOĞRUOĞLU

Scanning Tunelling Microscope (STM)

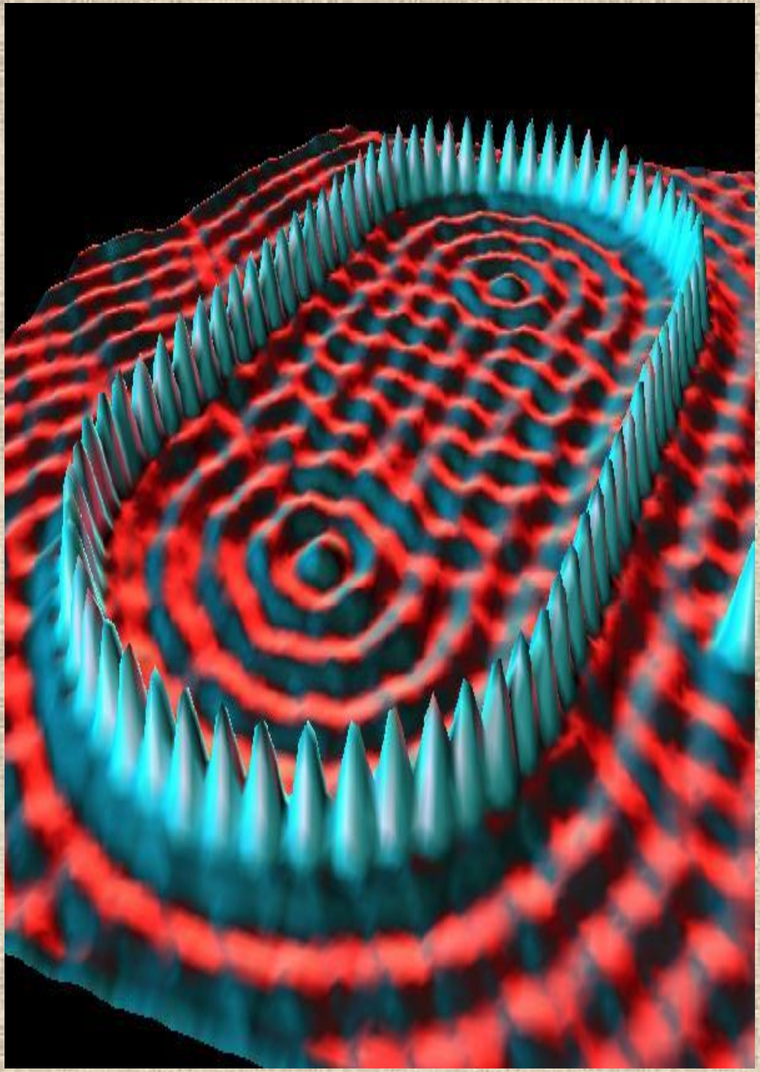


In 1981,Gerd Binnig and Heinrich Rohrer and their colleagues at the Zürich Research Laboratuary of the International Business Machines(IBM) developed STM and they were awarded the 1986 Nobel Prize in Physics for discovering the STM.

The scanning tunneling microscope (STM) is a type of electron microscope also is used in both industrial and fundamental research to obtain atomic-scale images of metal surfaces and that shows three-dimensional images of a sample.



Blue Platinum
The surface of Platinum.



STM provides of a three-dimensional profile of the surface which is very useful for characterizing surface roughness, observing surface defects, and determining the size and conformation of molecules and aggregates on the surface.

STM Instrumentation

1.The vibrational isolation system

The frame of the instrument is always subjected to vibrations transmitted from the ground or the air.It is very important for a well-functioning STM,and the changes of the gap distance caused by vibrations must be kept less than 0.001nm.

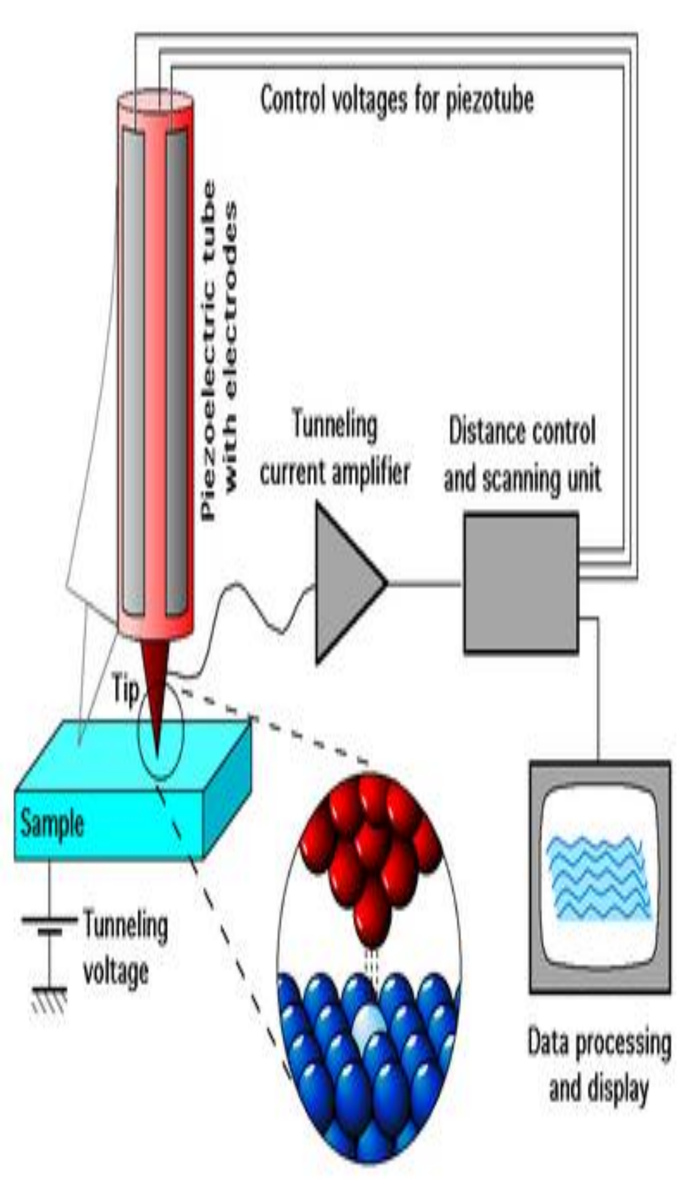
2.Mechanical designs

Piezoelectric ceramics,three-dimensional scanners,coarse sample positioning **.**

3.Tip preparation

The size,shape and chemical identity is important for tips.Tungsten tips,Pt-Ir tips are the most commanly used tips in STM.

!!!The main differences between the STM and all other microscopes is that there is no need for lenses and special light or electron sources.



Preparation of specimen

An STM specimen needs a substrate that is extremely flat, down to the atomic level. If the specimen is uneven, the STM probe will have difficulties in scanning very steep pits or ridges. Other defects, such as single atoms sitting on an otherwise flat substrate, will also be a problem since the atoms themselves may function as unwanted STM probes, destroying the desired image.

Graphite

One of the most commonly used STM substrates is a special form of graphite (highly oriented pyrolytic graphite or HOPG). It is a naturally layered material that is easy to prepare and relatively inert. A fresh surface can be obtained as easily as pressing a piece of adhesive tape to the surface and peeling away the top layer. The resulting surface will have large flat areas useful for scanning.

Other Substrates

Other popular materials that provide large, atomically flat surfaces include mica, quartz, and silicon. These materials are insulators, so to be used for STM a thin layer of noble metal (mainly gold or platinum) is deposited on the surface. Annealing (heating and then slowly cooling) the metal layer helps to smooth the surface and produce large flat areas.

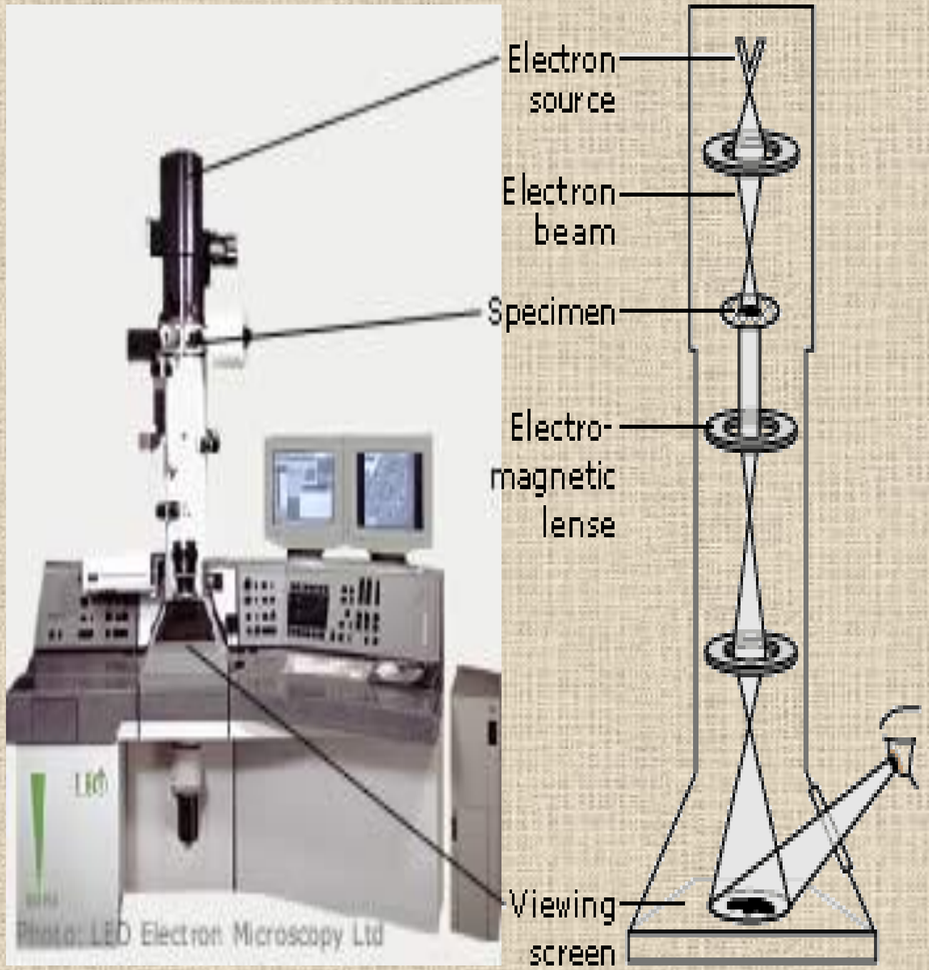
Avoiding Contamination

Once a flat surface has been achieved, it is important to keep it free of contamination. A typical dust particle consists of millions of atoms, and could easily destroy the STM probe. Other hazards include chemical reactions between the specimen and the surrounding air that result in impurities on the substrate. These impurities could eventually make the STM probe crash. To prevent these problems, many STMs operate in high vacuum. Other techniques include periodic heating of the sample in a neutral atmosphere to remove impurities from the surface.

Tunneling Electron microscope(TEM)

In 1931, while conducting research for his masters at the Technical College of Berlin, Ernst Ruska and Max Knoll design the first Transmission Electron Microscope (TEM).

The transmission electron microscope (TEM) operates on the same basic principles as the light microscope but uses electrons instead of light. What you can see with a light microscope is limited by the wavelength of light. TEMs use electrons as "light source" and their much lower wavelength makes it possible to get a resolution a thousand times better than with a light microscope.



Function and Design of TEM

A Transmission Electron Microscope is similar in design to an ordinary light microscope with one key difference: instead of using light, it uses *electrons. Using a cathode ray tube or filament (a source to generate highly excited electrons) in a vacuum, electrons are accelerated toward a given specimen by creating a potential difference. A series of magnets and metal apertures are used to focus this steam of electrons into a monochromatic beam, which then collide with the specimen and interact depending on the density and charge of the material. These interactions are greatly affected by how your specimen is prepared.*

Preparation of Specimen

Electrons, in general, are scattered by particles in the air, which necessitates that the excited (and accelerated) electrons be kept in a vacuum to prevent unwanted interactions. As such, it is impossible to view live specimens under a TEM. Also, electrons cannot penetrate specimens very deeply and at most can penetrate 50-100nm

Referances

- **Scanning electron microscopy and its applications** was written by **CHUNLI BAI**
- **http://nobelprize.org/educational/physics/microscopes/scanning**
- http://www.ncbi.nlm.nih.gov/books/bv.fcgi?rid=mboc4.table.1751
- http://www.hei.org/research/depts/aemi/emi.htm