UNIT V MATERIALS TESTNG

5.1 SCANNING TUNNELING MICROSCOPE (STM)

Definition

An electron microscope that works by using an electrical probe tip which scans over the surface of a sample at a constant spacing is known as scanning tunneling microscope.

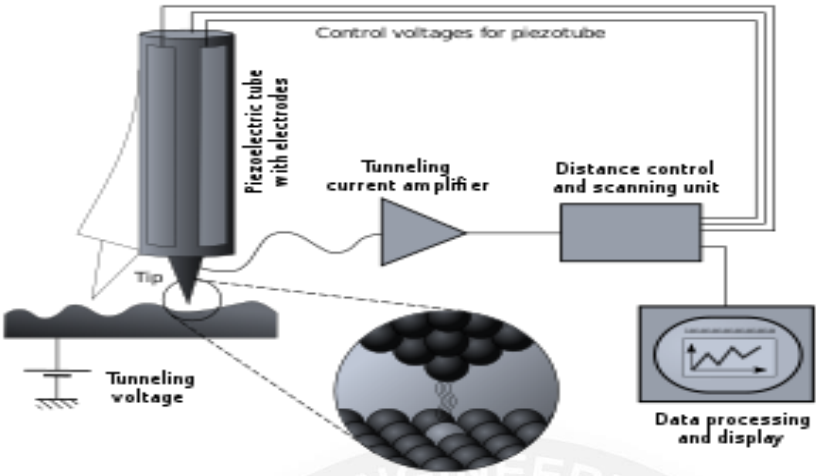
Principle

- Tunneling effect is the principle behind scanning tunneling microscope.
- When a voltage difference is applied between a conducting tip and a surface close to it, electrons can tunnel through the vacuum between the tip and the surface, causing a tunneling current.
- The current that results depends upon the distance between probe tip and sample surface

Construction.

The basic components of STM are

- Piezoelectric tube with the tip and electrodes capable of moving in X,Y,Z direction.
- Fine needle tip made of tungsten for scanning the sample surface.
- Tunneling current amplifier
- Distance Control Unit and Scanning Unit
- Data Processing and Display Unit



5.1.1 STM

Working

- Circuit is switched ON and necessary biasing voltage is given to the probe tip.
- Due to biasing, the electrons will tunnel across the gap, and therefore produces a small electric current called tunnelling current.
- The current produced is amplified and measured in the computer.
- It is found that the current increases (or) decreases based on the distance (d) between the tip and the sample.
- The current in the circuit should be monitored in such a way that it should be maintained constant.
- Therefore, for maintaining the constant current distance (d) between the tip and the sample should be continuously adjusted whenever the tip move over the surface of the sample.
- • The height fluctuations (d) between the tip and the sample are recorded and as a resultant map of 'bumps' is obtained in the computer.
- • Similarly the tip will scan the sample atom by atom and line by line and the topography of the sample is recorded in the display unit.

Advantages

- Examine surfaces at an atomic level.
- Give 3D profile of a surface.
- Latest technique used in Research laboratories for scanning the materials.
- Operate in temperatures from zero kelvin to few hundred degree Celsius.
- Magnification is upto nano-scale

Disadvantages

- Even a very small sound (or) vibrations will disturb the measurement setup.
- It should be kept in vacuum, as even a single dust particle may damage the tip of the probe.
- Cost is high.
- More Complexity

Applications

- It is used to produce integrated circuits
- It is used in biomedical devices
- Used in Research labs
- Used in material science studies for both bump and flat surfaces