canning Probe Microscopy Method :- (SPM)

Scanning -probe microscopes are able to create detailed ree dimensional image of specimen surface with tomic resolution.

Two basic types of scanning probe microscopes are used in SPM.

1. Scanning tunneling Microscope (STM)
2. Atomic force Microscope (AFM).

The magnitude of the tunneling current b/w the probe tipe and the atoms of a substrate surface is monitored. STM sample must be electrically Conductin

In AFM, the size of the force b/w a probe tip and the atoms of the ~~probe tip~~ substrate surface is monitored. the sample of AFM Must be Insulating:

the AFM is able to measure the force of the order of 1 ...

: the Probe is usually made of silicon or Si_3N_4 for AFM and tungsten for STM.

* The resolving power of AFM and STM depends on the sharpness of the tip of the probe.

· Piezoelectricity :- It is the induction of electrical polarization in certain types of crystal due to mechanical stress. piezoelectric devices are made of dielectric components that are able to convert mechanical

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stress (e.g. sound, waves) into electrical signals & vice-versa.

* Depending upon the manufacturer, two types of scan motions are possible. In one, the sample is moved relative to the probe probe tip. In the other, the sample is kept stationary while the probe is rastered across the surface.

Atomic force Microscopy :-

* The AFM Technique relies on a balance b/w attractive vander waal and repulsive electrostatic forces b/w the probe tip and the surface. The net force is a function of the distance b/w the two. The force is also a function of the dielectric constant ε of the medium.
* There are three major modes of operation :. contact, tapping and non contact.
* Noncontact AFM Mode cantilevers are made of highly doped single crystal silicon.

The force by AFM.

A sensor measures the force that is ~~measured~~ generated b/w the probe tip and the electron clouds of the sample. Hooke law describes the relationship b/w the cantilever and the applied force.

$$F = -kz$$

Resolution :- The Image resolution in AFM is acquired in three dimensions : the x-y plane and in the z- or perpendicular direction. The resolving power of AFM is depends on the radius of curvature and size of the tip.

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Tunneling is the penetration of an electron into a classical forbidden region.
The inversion of the conformation of ammonia is an example of tunneling by a particle, in the case the nitrogen atom.
Small changes in the distance b/w the probe tip and the substrate surface translate in to large changes in the tunneling current.
The density of states (DOS) of solid-state materials can be mapped by the technique called scanning tunneling spectroscopy.
The difference b/w SEM and STM are that the magnitude current is quite diminutive in STM and the current originates from electron tunneling. Electron tunneling occurs b/w the conducting sample and the tip of the STM.
The tip is very close to the substrate but not in actual physical contact.
Electron tunneling current b/w two flat plates seperated by a vacuum is given by

$$I \propto V e^{-2KW}$$

or

$$I = C \rho_{tip} \rho_{sample} e^{-W\sqrt{K}}$$

* The tip potential is biased with respect to the substrate. The direction of electron flow is determined by the direction of the bias. if the tip is Negatively biased with respect to the substrate, then electron will flow from the substrate to the probe. if the reverse

~~configuration~~
configuration is applied, the electron will flow from the probe to the surface.

Atomic Force Microscopy :-

* AFM relies on the mechanical deflection of a cantilever to relay information about the contour of a sample surface. An atomically sharpened probe tip descends perpendicularly from the distal end of cantilever.

* the tip to sample distance is fixed by means of a feedback mechanism that maintains constant force b/w them.

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* the force b/w the tip and the surface are much weaker if the probe is submerged in a liquid.

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