Scanning Electron Microscopy.

* Electron gun emitted electron beam. The beam is focused to a diameter of ~50 Å.
* The various 2° effects emitted from the surface of the specimen (e.g, secondary electrons, backscattered electrons, x rays).
* Generally two types of materials are used to produce electrons: filaments made of either Tungsten (W) or lanthanum hexaboride (LaB_6).
* Electrons exist exit the filament with average energy.

$$E_e \sim KT$$

* The temperature of field emission electron guns is much lower than that required for thermionic filaments.
* The Richardson's law (Richardson–Dushman) relates the current density J_c obtain by thermionic emission of the filament.

$$J_c = A_c T^2 \exp\left[-\frac{\phi_B}{KT}\right]$$

* A positively charged anodic plate serves to accelerate electrons through the aperture.
* Stigmators are special lenses that are able to compensate for the distortions and are housed in the objective lens
* A short life time phosphor that is very efficient in converting electrons in to ~400nm ultraviolet photons.
* The number of electrons that reach the detector is a function of surface topography.
* Back scattered electrons (BSEs) are detected by a semi-conductor array located at the bottom of the column. A current is produced when BSEs strikes the semiconductor array
* All SEM samples are conducting

and BSE, Transmitted and Auger electrons have left

sample. this absorbed current is a function of

atomic number of the elements in the specimen.

mage generation occur by rastering the electron beam

oss the sample surface

uring the rastering process, there is a "Dwell time"

which point the beam is faused.

~~life time of secondary effects is shorter than that~~

the "dwell time".

gnification, brightness and contrast all affect the

nage quality.

ontrast is the variation of the signal from one

astered point to the next and is expressed by

$$C = \Delta S \cdot S_{average}^{-1}$$

where ΔS is the change in strength of signal b/w two points

d S_{av} is the average signal strength.

the chamber is evacuated with a roughing pump.

he column is evacuated to a pressure less than

$^{-6}$ torr in order to begin the filament warm-up

rocess.

Transmission Electron Microscopy.

* The TEM functions by the same principles as the SEM except that the detector is a phosphor plate that is able to capture image formed by transmitted electrons.

* Another major difference b/w TEM and SEM is that the accelerating voltage in TEM usually far greater: 300kV compared to ~ 50kV.

* the wavelength of the electron beam is in the picometer range 6.13 – 2.24 pm.

* Another difference from SEM is that TEM have a projector lens system at base of the coloum.

* CCD → Charge coupled device Camera.

* The resolution of good TEM is ca. 0.2 nm on par with the distance b/w two atoms and the atomic radii of some heavy metals.

* Image generation :-
There are generally four types of image that are produced by TEM.
① Bright field image ② low-resolution dark field image
③ High resolution dark field image ④ high resolution lattice image.

* with HR-TEM, which is a combination of bright field and lattice imaging, real & reciprocal space can be observed simultaneously.

* Samples are restricted to thickness generally less than 100nm.

* chemical & electrochemical thining and reactive ion etching are also technique used to reduce the thickness of samples for TEM analysis.

* Any type of sample, whether electrically insulating, semiconducting, or conducting is able to be imaged by TEM.

nage resolution and energy resolution of 0.7 eV

spot size can be made as small as 0.4 nm.

magnification ranges from 100x to as high as 1.

llion X the size of the specimen structure.