Demonstration of SEM

Aim

Observation of surface morphology of solid samples.

Principle

The scanning electron microscope (SEM) images a sample surface by raster scanning over it with a high-energy beam of electrons. The electrons interact with the atoms comprising the sample to produce signals that contain information about surface topography, composition and other properties, such as electrical conductivity. A Field Emission Source (FES), also called a cold cathode field emitter, does not heat the filament. The emission is reached by placing the filament in a huge electrical potential gradient. The FES is usually a wire of Tungsten fashioned into a sharp point. Electrons are liberated from a field emission source and accelerated in a high electrical field gradient. Within the high vacuum column these so-called primary electrons are focussed and deflected by electronic lenses to produce a narrow scan beam that bombards the object. As a result, secondary electrons are emitted from each spot on the object. The angle and velocity of these secondary electrons relates to the surface structure of the object. A detector catches the secondary electrons and produces an electronic signal. This signal is amplified and transformed to a video scan-image that can be seen on a monitor or to a digital image that can be saved and processed further. The acceleration voltage between cathode and anode is commonly in the order of magnitude of 0.5 to 30 kV, and the apparatus requires an extreme vacuum (10^{-6}- 10^{-8} Pa) in the column of the microscope.

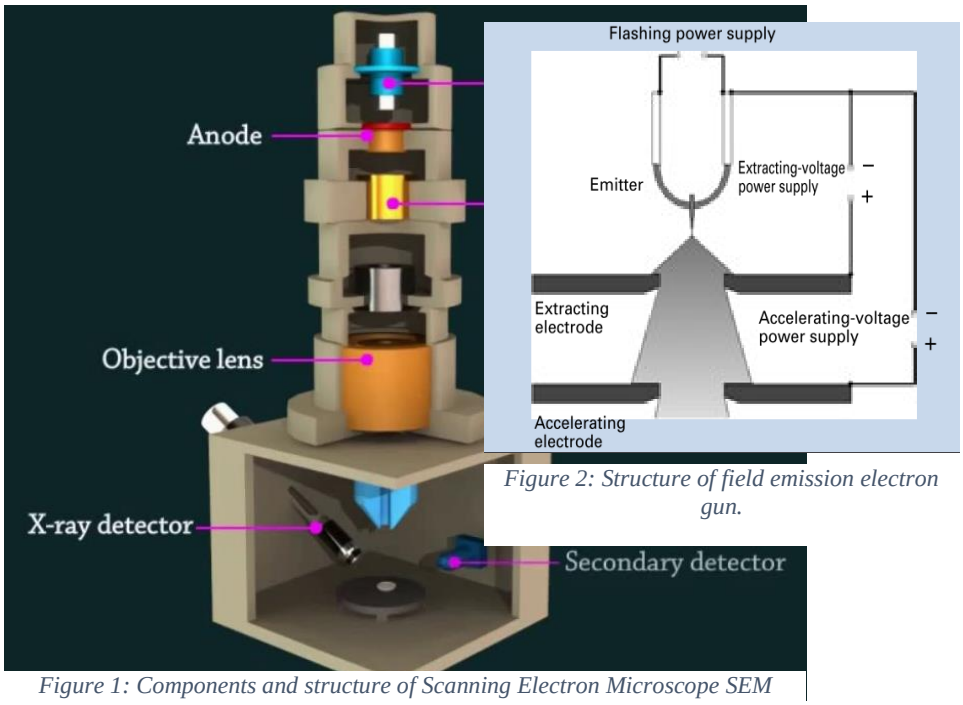

Figure 1: Components and structure of Scanning Electron Microscope SEM

Figure 2: Structure of field emission electron gun.

Components of SEM

- Electron Source: Field Emission Gun

- Electromagnetic and/or Electrostatic Lenses
- Vacuum chamber
- Sample chamber and stage
- Computer
- Detectors: Secondary Electron Detector (SE); Backscatter Detector; Diffracted Backscatter Detector (EBSD); X-ray Detector (EDS)

Sample Requirements for FESEM

- Sample should be dry & non-magnetic.
- Powder/metal/thin-film samples are accepted for analysis.
- Biological & liquid samples should be fixed and coated/drop-casted on a conducting substrate and dried well before the observation.
- Quantity of sample required (powder samples only): minimum 10 mg.

Sample Preparation

Biological specimen is chemically fixed, dehydrated through an acetone or ethanol series and then air-dried or dried at the critical point (a method used to minimize specimen distortion due to drying tensions). For dry samples, this process is not necessary. The samples are mounted on a stub of metal with adhesive, coated with 40 - 60 nm of metal such as gold/silver/palladium and then observed in the SEM for analysis.

Observation

SEM can only be used to see the samples of size up to 10 nm. Same parameters and magnification need to use to compare different the images.

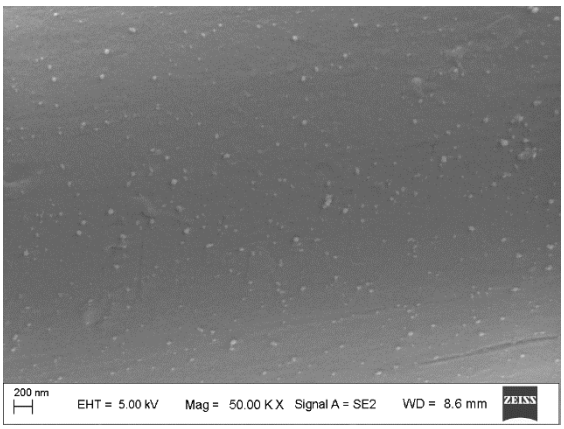

Figure 3: SEM image of silver nanoparticles.