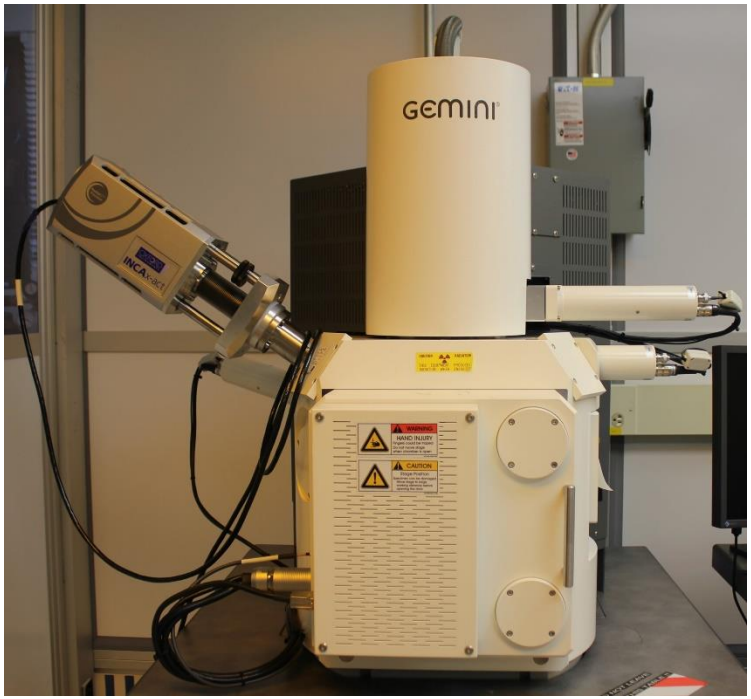
PennState College of Engineering

CENTER FOR NANOTECHNOLOGY EDUCATION AND UTILIZATION

Field Emission Scanning Electron Microscope (FESEM)



How It Works:

A stream of electrons is emitted from a tungsten filament in the top of the scanning electron microscope. This stream of electrons is accelerated due to a potential difference of 10's of eV up to 50keV. These electrons are focused through condenser lenses and then an objective lens to focus the beam to a spot size between 1 and 5 nm. The beam rasters (like how a TV draws a picture) over the area to be imaged, using the scan coils to direct the beam, and a variety of different imaging techniques can be used based on the results of this pattern.

Tool Operation:

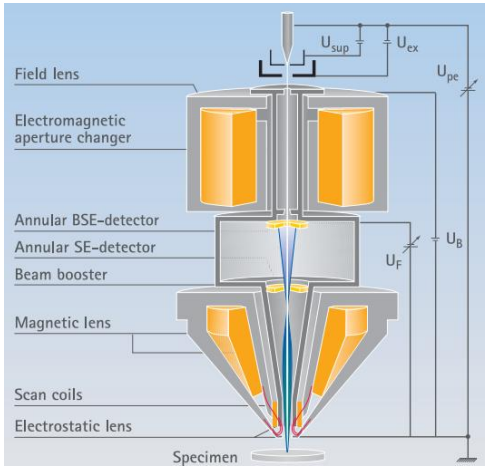
Secondary Electron (SE) Mode: This mode shows the surface topography of the sample based on the emission of electrons from the first few nanometers of material. Using this technique resolutions down to 1nm can be achieved.

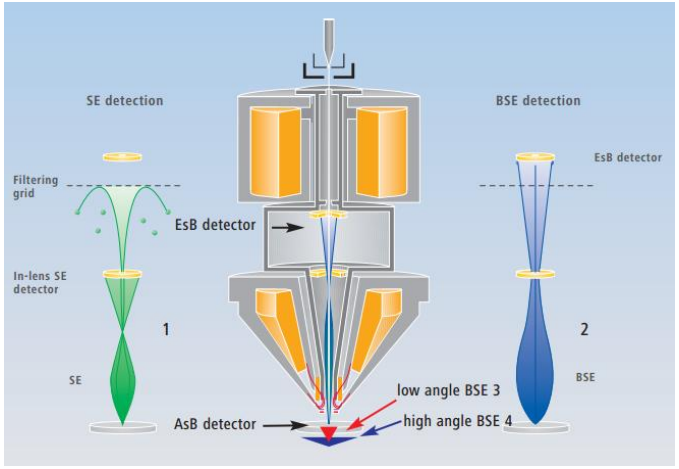
Backscattered Electron (BSE) Mode: Detects differences in relative chemical composition of material with heavier elements appearing darker than lighter elements.

X-Ray Spectroscopy: X-Rays generated by electrons changing energy states are detected. This tells the exact elemental composition of any given part of the sample.

Material / Applications:

Capable of imaging samples with resolutions in the 1-20nm range. One of the limitations is that the sample must be conductive or be coated with a layer of conductive material in order to avoid charging effects.





Resolution	1.0 nm at 15 kV 1.7 nm at 1 kV 4.0 nm at 0.1 kV
Magnification	12 – 900,000x in SE mode 100 – 900,000x in BSE mode
Emitter	Thermal field emission type
Acceleration Voltage	0.1 – 30 kV
Probe current	4 pA – 20 nA
Detectors	BSE detector with filtering grid (voltage between 0-1500 V) High efficiency In-lens SE detector Everhart-Thornley Secondary Electro detector