SEM (Astigmatism)

Aftab Ahmed
Lens Systems

- Glass lenses can be used to converge or diverge light.
- Electrons can be deflected by electric and magnetic fields.
Lens Systems

- Each lens forms an image I from object O, but the electrons rotate in a spiral trajectory about the lens axis as they pass through the magnetic field between the pole pieces.
Aberrations of lenses

The most important aberrations are:

1. Spherical aberration
2. Chromatic aberration
3. Astigmatism
Astigmatism

- Arises when the lens is more powerful in one plane than in the plane normal to it
- Causes points to be imaged as short lines
Astigmatism
Most common causes

- Inhomogeneities of lens
- Heavy contamination & dirt particles
- Magnetic fields:
  - external: motors & transformers etc.
  - internal: magnetic specimens
Most common causes

- Scratches on final lens
- Misalignment of beam in SEM column/gun hardware
- Charging of specimen
Time dependant phenomenon

- Hence astigmatism is time-dependent
- Cannot be ‘designed out’
- Inevitably requires continuous correction
Correction

- With glass optics astigmatism is corrected using an additional lens of strength & asymmetry opposed to the asymmetry of the basic lens.

- Electron optics, same principle employed:

  Stigmator lens apposed to main lens, strength & direction of its asymmetry user-variable
Astigmatism can be corrected using additional elements called stigmators contained inside the objective lens.

Magnetostatic quadrupole lens is basis of a stigmator.
Astigmatism correction method

Before correction:
- Electron Source
- Objective Lens
- Electron Beam
- Beam Diameter

After correction:
- Electron Source
- Objective Lens
- Stigmator
- Electron Beam
- Beam Diameter

Astigmatism correction method
Thank You.