The Scanning Transmission Electron Microscope

Scanning transmission electron microscopy (STEM) combines the principles of transmission electron microscopy and scanning electron microscopy and can be performed on either type of instrument. Like TEM, STEM requires very thin samples and looks primarily at beam electrons transmitted by the sample. One of its principal advantages over TEM is in enabling the use of other of signals that cannot be spatially correlated in TEM, including secondary electrons, scattered beam electrons, characteristic X-rays, and electron energy loss.

Like SEM, the STEM technique scans a very finely focused beam of electrons across the sample in a raster pattern. Interactions between the beam electrons and sample atoms generate a serial signal stream, which is correlated with beam position to build a virtual image in which the signal level at any location in the sample is represented by the gray level at the corresponding location in the image. Its primary advantage over conventional SEM imaging is the improvement in spatial resolution.

STEM is similar to TEM. While in TEM para electron beams are focused perpendicular to the sample plane, in STEM the beam is focused at a large angle and is converged into a focal point. The transmitted signal is collected as a function of the beam location as it is rastered across the sample.

There are multiple detectors for STEM imaging:

1. BF (bright-field) detector: small angles (<0-10 mrad). These images are similar to the bright-field images obtained using TEM.
2. ADF (annular dark-field) detector: larger angles (10-50 mrad)
3. HAADF (high-angle annular dark-field) detector: Angles > 50mrad

None of the elastically scattered electrons rea
the detector, so it only images from inelastically
scattered electrons. This is also known as
contrast imaging because there is a direct
correlation between the local contrast and local
mass-thickness, which depends on the atomic
number Z. HAADF imaging allows for enhanced
contrast, especially at lower atomic numbers,
compared to TEM.