NANO 703/703L
Lab: Scanning TEM (STEM) and Energy-Dispersive X-Ray Spectrometry (EDX)
Due: Following Lab Session

BACKGROUND

Analytical TEM uses various auxiliary methods, such as EDX, to determine and map materials compositions. EDX is tied particularly closely with STEM, because EDX mapping and profiling can be performed by acquiring X-ray spectra at each point within an area or along a line in the sample, which requires the beam deflection capabilities associated with STEM. The characteristic X-ray lines can be used to identify the distributions of elements within the scanned region (FIG.).

The microscope lens configuration in STEM mode is similar to that used to acquire CBED patterns. That is, the condenser system acts to form a finely focused probe that is directed onto the sample. The deflector lenses, which can provide both deflection and tilting functions, are used in this case to raster the probe across a rectangular sample region. Below the sample, a CBED pattern forms, which is projected down the column onto one of a variety of detectors, with different geometries and dimensions. The diffraction camera length and alignment of the direct beam with the detector have substantial influence over the resulting image contrast: The camera length directly affects the collection solid angle of the detector: With shorter camera length, the collection semi-angles are reduced and the total solid-angle is increased.

The probe size, controlled mainly by the C1 lens, affects both STEM resolution and beam current. A smaller probe gives higher imaging resolution, but weaker signal. This compromise is especially apparent in EDX mapping, where a large signal is desirable. As in CBED, the condenser aperture (CA) size affects the probe convergence angle. A small CA diameter is needed to perform STEM at large camera length with reasonable control of the collection angle, but further reduces the beam current available for EDX mapping.

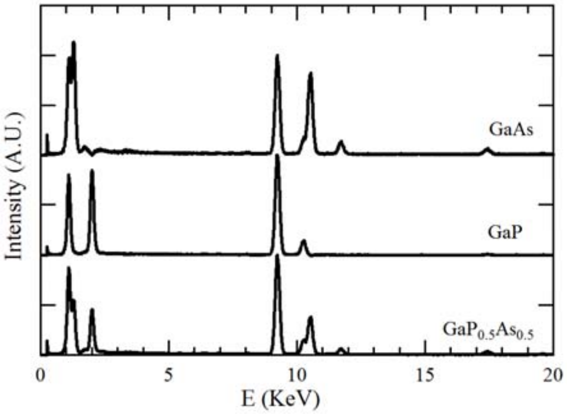

FIG: Standards-based EDX simulations.

PROCEDURE

Please strive to obtain the data listed below. Please describe the method used and results obtained. If you are unable to complete any of the tasks, please document the difficulties met:

1) Obtain STEM BF and DF images. Observe any influence of camera length.
2) Acquire an EDX spectrum and map a 2-D region. Observe any influence of integration time constant;
3) Measure the beam current density as a function of CL1 current (spot size). Tabulate and plot the data;
4) Explore other acquisition modes of the STEM.

REPORT

Provide an overview of the STEM and EDX systems operation. Include examples of data.