Introduction to Reciprocal Space
Assignment 1 Solution

1) From the perspective of diffraction, the primary difference between X-Ray Diffraction (XRD) and a Transmission Electron Microscope (TEM) is the wavelength of the radiation used. In XRD the wavelength used is of the order of 1 to 2 Angstroms. In TEM the wavelength used is of the order of 0.01 Angstrom. The inter-planar spacing in most crystalline materials is of the order of 1to 2 Angstroms. Therefore, the Ewald sphere obtained corresponding to XRD is of a much smaller radius compared to that obtained for TEM. Specifically, the Ewald sphere for XRD has magnitude similar to that of the reciprocal lattice of the material being investigated, while the Ewald sphere of the TEM is two orders of magnitude larger than that of the reciprocal lattice of the material being investigated. Therefore, in XRD, the reciprocal lattice points that satisfy the condition for diffraction, can occur in significantly different directions. Whereas, in the field of view in a TEM, only planes of a zone, where the beam direction is the zone axis, satisfy the condition for diffraction.

2) When filters are present only a single wavelength of X-Rays is used to probe the sample. Therefore there is a single Ewald sphere corresponding to this wavelength, that is used to determine whether or not diffraction occurs. Only Reciprocal lattice points that lie on the surface of this sphere will satisfy the condition for diffraction.

   When the filter is removed, a wide range of wavelengths impinge on the sample, starting from a minimum wavelength corresponding to the condition of operation of the X-Ray generator. Therefore, a wide range of Ewald spheres will be in operation. From a limiting outer sphere, corresponding to the lowest wavelength generated, to potentially the origin, the entire region will consist of Ewald Spheres that can result in diffraction spots. Therefore all reciprocal lattice points within the limiting sphere can result in diffraction spots.