

EEE6009 – Advanced Instrumentation – Electron Microscopy Assessment

Due Date: 19th May 2014

1. State two advantages and one disadvantage for the use of the scanning electron microscope compared to conventional optical (visible light) microscopy.
2. Calculate the wavelength in (nm) (allowing for relativistic effects) and hence the diffraction limited resolution (r) of an electron microscope operating at an accelerating voltage (V) of:
(i) 15kV and (ii) 300kV (assume α has a value of 0.02radians in each case).
3. State which electron microscopy imaging technique and instrumentation you would select to observe (i) a series of <5nm layers in a semiconductor device and (ii) the surface topography of a metallic specimen containing 2 μ m size features.
4. A thin film of single crystal germanium has been tilted in the transmission electron microscope to produce an **electron diffraction spot** pattern showing a series of spots, three of which having a distance (r) from the central spot of 6.3mm, 10.4mm and 12.2mm respectively. Assuming a camera length (L) of 100cm and that the diffraction pattern was obtained using 300kV electrons calculate the corresponding real space atomic spacing (d) in nm for each of the spots.
5. Name two analytical techniques (for composition analysis) that can be applied in a transmission electron microscope. Which of these techniques would be most suitable to investigate the composition of <10nm size particles of a metal oxide?
6. You have been given a fragment of a semiconductor wafer to investigate containing several laser devices, each with dimensions, 5 μ m wide, 3 μ m high and 1mm in length. You have been asked to obtain images of all the devices on the wafer fragment and then select one device and prepare a thin cross-section of that device for further study in the transmission electron microscope (TEM). The remaining un-sectioned devices will need to be retained for further testing at a later date. State the instrumentation you could use to obtain (i) your images and (ii) the technique to subsequently prepare the cross-section for the TEM.
7. What is the dominant factor limiting the imaging resolution of an electron microscope? How could these limitations be partially resolved in a modern electron microscope?