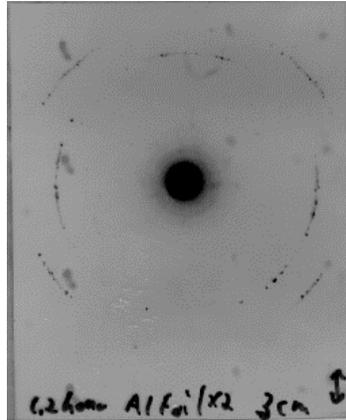


Quiz 1 November 1, 2010 Properties of Materials

a) Explain the following diffraction pattern as best you can.



b) Explain how yield stress scales with grain size and indicate why this relationship might motivate the study of nanomaterials.

c) FCC and HCP crystal structures have some similarities and some differences. Explain these.

d) Explain what happens when a FCC metal approaches the failure stress and it is heard to creak.

e) Sketch the engineering stress versus engineering strain for an FCC metal that displays strain hardening. Show the yield stress yield strain and failure stress and failure strain. At what point does strain hardening occur in this plot?

ANSWERS: Quiz 1 November 1, 2010 Properties of Materials

a) Explain the following diffraction pattern as best you can.

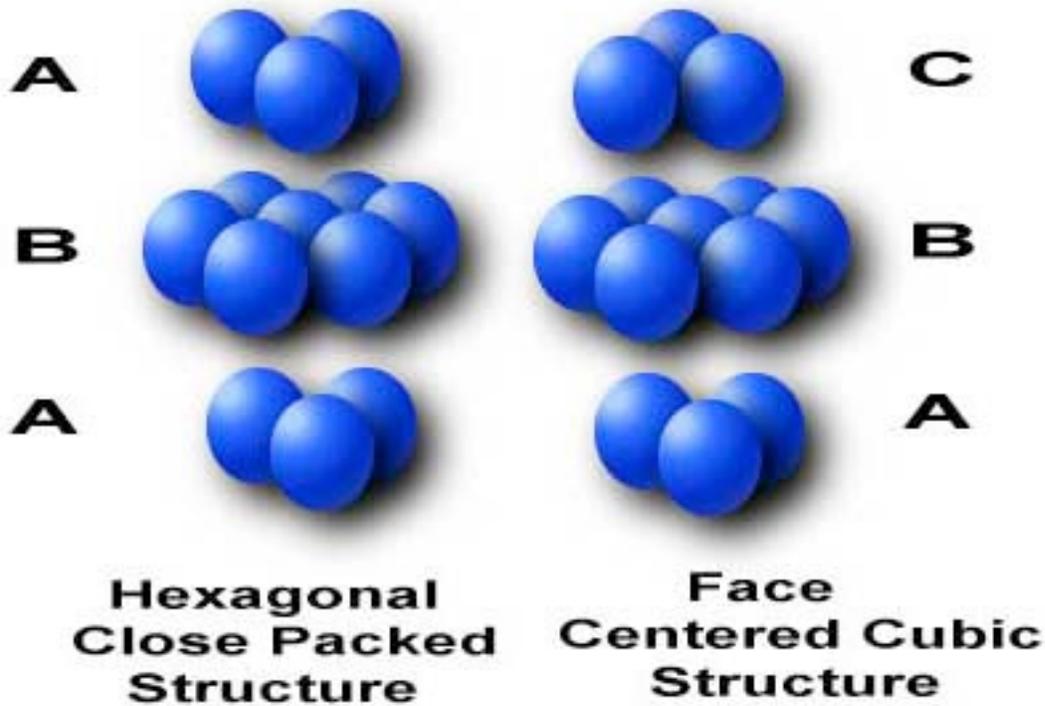
The x-ray beam passes through a sheet of aluminum foil and then to a photographic film. The beam is very bright compared to the diffraction pattern and shows up in the center as a dark spot. The lighter rings on the outside show orientation of the crystals since only arcs are seen. Also, we can see that the grains are fairly large since we see spots from individual grains. These spots result from individual crystals with the proper orientation (specular arrangement of the planes) to give rise to a diffraction peak. The inner ring is from the (111) plane and the outer ring is from the (200) plane for the FCC crystals. There are about 20 grains in the beam of about 20 micron diameter so the grains are on the order of one micron in size.

b)

$$\sigma_{yield} = \sigma_i + \frac{k}{D^{1/2}}$$

The yield stress should increase with decreasing grain size so we expect a great enhancement of yield strength for nano-scale grains.

c) The hexagonal closest packed (111) plane is the same in FCC and HCP. Both pack at 74% filled space which is the highest packing efficiency for spheres. FCC follows an ABCABC packing in the [111] direction while HCP follows an ABABABAB packing in the [111] direction.



d) Twinning is occurring. In an FCC crystal structure we see a twin plain formed where the ABCABCABC repeat in the [111] direction becomes ABCABABCABC where the bold A is the twinning plane.

e)

