CME 300 Properties of Materials

Homework 2 September 28, 2011

Problems from Callister p. 78

3.57 Using the data for aluminum in Table 3.1, compute the interplanar spacing for the (110) set of planes.

3.58 Determine the expected diffraction angle for the first-order reflection from the (310) set of planes for BCC chromium when monochromatic radiation of wavelength 0.0711 nm is used.

3.59 Using the data for α-iron in Table 3.1, compute the interplanar spacings for the (111) and (211) sets of planes.

3.60 The metal rhodium has an FCC crystal structure. If the angle of diffraction for the (311) set of planes occurs at 36.12° (first-order reflection) when monochromatic x-radiation having a wavelength of 0.0711 nm is used, compute **(a)** the interplanar spacing for this set of planes, and **(b)** the atomic radius for a rhodium atom.

3.61 The metal niobium has a BCC crystal structure. If the angle of diffraction for the (211) set of planes occurs at 75.99° (first-order reflection) when monochromatic x-radiation having a wavelength of 0.1659 nm is used, compute **(a)** the interplanar spacing for this set of planes, and **(b)** the atomic radius for the niobium atom.

3.62 For which set of crystallographic planes will a first-order diffraction peak occur at a diffraction angle of 44.53° for FCC nickel when monochromatic radiation having a wavelength of 0.1542 nm is used?

3.63 Figure 3.21 shows an x-ray diffraction pattern for lead taken using a diffractometer and monochromatic x-radiation having a wavelength of 0.1542 nm; each diffraction peak on the pattern has been indexed. Compute the interplanar spacing for each set of planes indexed; also determine the lattice parameter of Pb for each of the peaks.

3.64 The diffraction peaks shown in Figure 3.21 are indexed according to the reflection rules for FCC (i.e., h, k, and l must all be either odd or even). Cite the h, k, and l indices of the first four diffraction peaks for BCC crystals consistent with $h + k + l$ being even.

3.65 Figure 3.24 shows the first five peaks of the x-ray diffraction pattern for tungsten, which has a BCC crystal structure; monochromatic x-radiation having a wavelength of 0.1542 nm was used.

(a) Index (i.e., give h, k, and l indices) for each of these peaks.

(b) Determine the interplanar spacing for each of the peaks.

(c) For each peak, determine the atomic radius for W and compare these with the value presented in Table 3.1.

3.66 Would you expect a material in which the atomic bonding is predominantly ionic in nature to be more or less likely to form a noncrystalline solid upon solidification than a covalent material? Why? (See Section 2.6.)

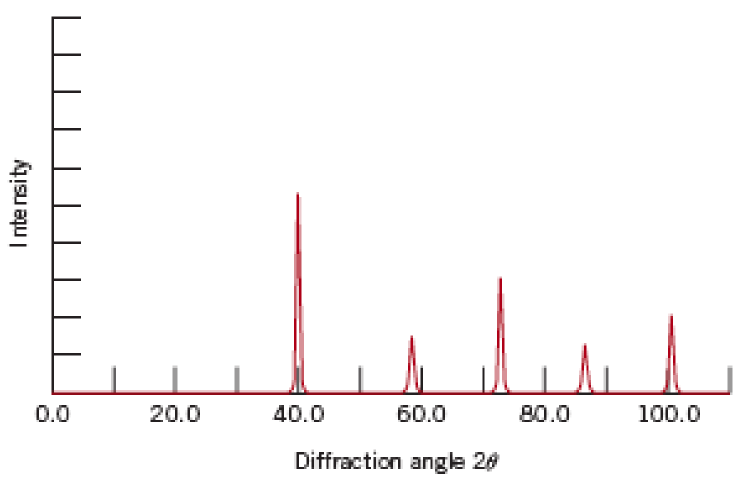


Figure 3.24 Diffraction pattern for powdered tungsten. (Courtesy of Wesley L. Holman.)

Table 3.1 Atomic Radii and Crystal Structures for 16 Metals

Metal	*Crystal Structure*[a]	*Atomic Radius*[b] *(nm)*	*Metal*	*Crystal Structure*	*Atomic Radius (nm)*
Aluminum	FCC	0.1431	Molybdenum	BCC	0.1363
Cadmium	HCP	0.1490	Nickel	FCC	0.1246
Chromium	BCC	0.1249	Platinum	FCC	0.1387
Cobalt	HCP	0.1253	Silver	FCC	0.1445
Copper	FCC	0.1278	Tantalum	BCC	0.1430
Gold	FCC	0.1442	Titanium (α)	HCP	0.1445
Iron (α)	BCC	0.1241	Tungsten	BCC	0.1371
Lead	FCC	0.1750	Zinc	HCP	0.1332

[a] FCC = face-centered cubic; HCP = hexagonal close-packed; BCC = body-centered cubic.
[b] A nanometer (nm) equals 10^{-9} m; to convert from nanometers to angstrom units (Å), multiply the nanometer value by 10.

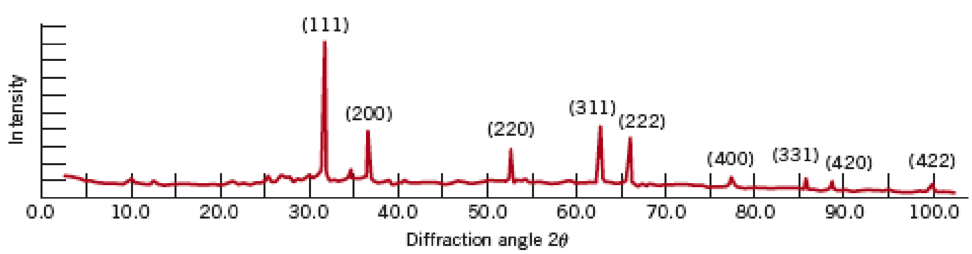


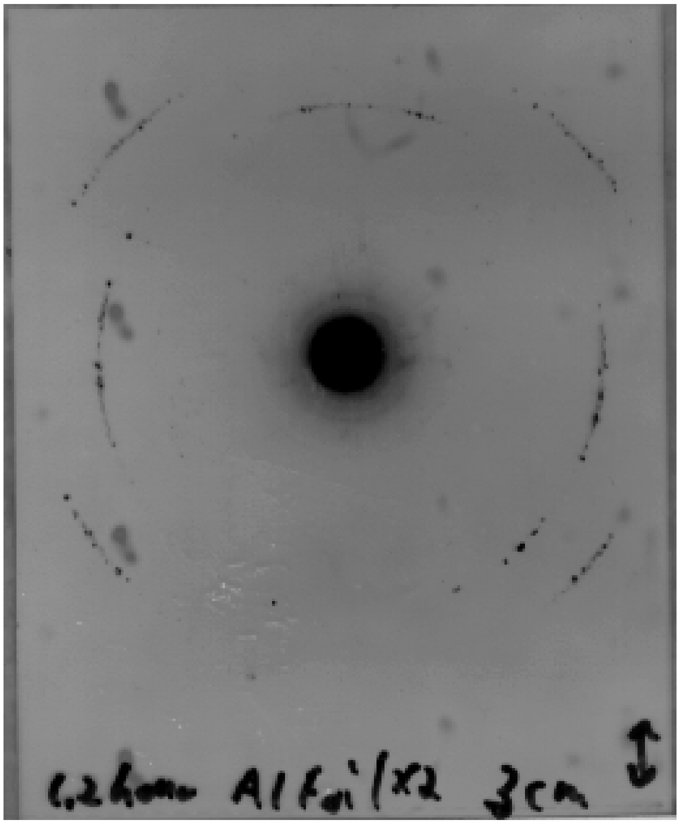
Figure 3.21 Diffraction pattern for powdered lead. (Courtesy of Wesley L. Holman.)

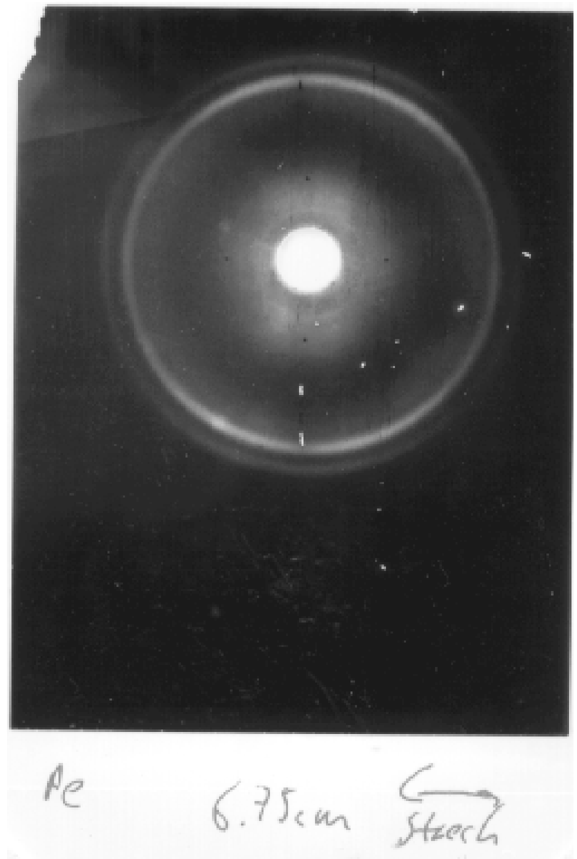
11) Sketch the diffraction pattern from an FCC, BCC and HCP metals as well as the diffraction pattern from an amorphous solid. What does the peak position of the amorphous halo indicate?

12) Derive Bragg's Law using the specular reflection analogy.

13) What can the breadth of a diffraction peak indicate? That is, for two copper samples if one displays a broad diffraction peak while the other displays a sharp peak what is the difference between the two samples? What about for two aluminum samples.

14) The following images are photographic diffraction patterns from aluminum foil and a polyethylene bag. Explain why the aluminum shows dots in the Debye-Scherrer rings and the polymer does not. Explain why the polymer peaks are broader than those of aluminum. Explain why the aluminum pattern shows arcs rather than complete rings.


Al foil
3cm


Pe
6.75cm