STATE UNIVERSITY OF NEW YORK AT BUFFALO

Department of Mechanical and Aerospace Engineering

MEA 589 Diffraction, Microscopy and Spectroscopy Techniques

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February 12, 2004

Homework No. 5

1. Construct a Wulff net, 18 cm in diameter and graduated at 30° intervals, by the use of compass, dividers, and straightedge only. Show all construction lines.

In some of the following problems, the coordinates of a point on a stereographic projection are given in terms of its latitude and longitude, measured from the center of the projection. Thus, the N pole is 90°N, 0°E, the E pole is 0°N, 90°E, etc.

2. Plane *A* is represented on a stereographic projection by a great circle passing through the N and S poles and the point 0°N, 70°W. The pole of plane *B* is located at 30°N, 50°W.

a) Find the angle between the two planes by measuring the angle between the poles of *A* and *B*.

b) Draw the great circle of plane *B* and demonstrate that the stereographic projection is angle-true by measuring with a protractor the angle between the great circles of *A* and *B*.

3. On a standard (001) projection of a cubic crystal, in the orientation of Fig. 1, the pole of a certain plane has coordinates 53.3°S, 26.6°E. What are its Miller indices? Verify your answer by comparison of measured angles with those given in Table 1.

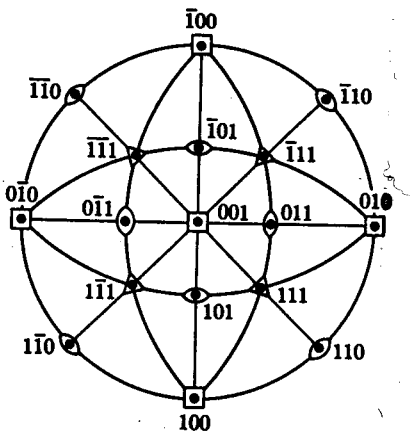

Fig. 1 Standard projections of cubic crystals on (001).

Table

Interplanar Angles (in degrees) in Cubic Crystals between Planes of the Form $\{h_1k_1l_1\}$ and $\{h_2k_2l_2\}$

$\{h_2k_2l_2\}$	$\{h_1k_1l_1\}$						
	100	110	111	210	211	221	310
100	0 90						
110	45 90	0 60 90					
111	54.7	35.3 90	0 70.5 109.5				
210	26.6 63.4 90	18.4 50.8 71.6	39.2 75.0	0 36.9 53.1			
211	35.3 65.9	30 54.7 73.2 90	19.5 61.9 90	24.1 43.1 56.8	0 33.6 48.2		
221	48.2 70.5	19.5 45 76.4 90	15.8 54.7 78.9	26.6 41.8 53.4	17.7 35.3 47.1	0 27.3 39.0	
310	18.4 71.6 90	26.6 47.9 63.4 77.1	43.1 68.6	8.1 58.1 45	25.4 49.8 58.9	32.5 42.5 58.2	0 25.9 36.9
311	25.2 72.5	31.5 64.8 90	29.5 58.5 80.0	19.3 47.6 66.1	10.0 42.4 60.5	25.2 45.3 59.8	17.6 40.3 55.1
320	33.7 56.3 90	11.3 54.0 66.9	36.9 80.8	7.1 29.8 41.9	25.2 37.6 55.6	22.4 42.3 49.7	15.3 37.9 52.1
321	36.7 57.7 74.5	19.1 40.9 55.5	22.2 51.9 72.0 90	17.0 33.2 53.3	10.9 29.2 40.2	11.5 27.0 36.7	21.6 32.3 40.5
331	46.5	13.1	22.0				
510	11.4						
511	15.6						
711	11.3						

Largely from R. M. Bozorth, *Phys. Rev.* **26**, 390 (1925); rounded off to the nearest 0.1°. A much longer list is given on p. 120–122 of Vol. 2 of [G.11].

4. A transmission Laue pattern is made of a cubic crystal having a lattice parameter of 4.00 Å. The x-ray beam is horizontal. The [0$\bar{1}$0] axis of the crystal points along the beam towards the x-ray tube, the [$\bar{1}$00] axis points vertically upward, and the [001] axis is horizontal and parallel to the photographic film. The film is 5.00 cm from the crystal.

a) What is the wavelength of the radiation diffracted from the (3$\bar{1}$0) planes?
b) Where will the 3$\bar{1}$0 reflection strike the film?

5. A transmission Laue pattern is made of an aluminum crystal with 40-kV tungsten radiation. The film is 5 cm from the crystal. How close to the center of the pattern can Laue spots be formed by reflecting planes of maximum spacing, namely (111), and those of next largest spacing, namely (200)?

6. A transmission Laue pattern is made of an aluminum crystal with a specimen-to-film distance of 5 cm. The (111) planes of the crystal make an angle of 3° with the incident beam. What minimum tube voltage is required to produce a 111 reflection?

7. (a) A back-reflection Laue pattern is made of an aluminum crystal at 50 kV. The (111) planes make an angle of 88° with the incident beam. What orders of reflection are present in the beam diffracted by these planes? (Assume that wavelengths larger than 2.0 Å are too weak and too easily absorbed by air to register on the film.)
b) What orders of the 111 reflection are present if the tube voltage is reduced to 40 kV?

8. A back-reflection Laue photograph is made of an aluminum crystal with a crystal-to-film distance of 3 cm. When viewed from the x-ray source, the Laue spots have the following x, y coordinates, measured (in inches) from the center of the film:

x	y	x	y
+0.26	+0.09	−0.44	+1.24
+0.45	+0.70	−1.10	+1.80
+1.25	+1.80	−1.21	+0.40
+1.32	+0.40	−1.70	+1.19
+0.13	−1.61	−0.76	−1.41
+0.28	−1.21	−0.79	−0.95
+0.51	−0.69	−0.92	−0.26
+0.74	−0.31		

Plot these spots on a sheet of graph paper graduated in inches. By means of a Greninger chart, determine the orientation of the crystal, plot all poles of the form {100}, {110}, and {111}, and give the coordinates of the {100} poles in terms of latitude and longitude measured from the center of the projection.