

27-750 Advanced Characterization and Microstructural Analysis, Spring 2016

A.D. Rollett: last revised on Jan. 14th, 2016.

Homework 1; different representations of orientations (as rotations).

Due: Jan. 19th

[100 points]

Q1. [10] Assume that we dealing with a cubic material. What are the direction cosines

associated with (a) the direction [110]? (b) The direction [321]?

a) Form the unit vector of the direction [110] by first calculating the norm of [110].

$$|1\ 1\ 0| = \sqrt{(1^2 + 1^2 + 0^2)} = \sqrt{2}$$

$$[u\ v\ w] = [1\ 1\ 0] / \sqrt{2} = [1/\sqrt{2}\ 1/\sqrt{2}\ 0] = [0.707\ 0.707\ 0]$$

This forms the direction cosines for the direction [110].

b) Form the unit vector of the direction [321] by first calculating the norm of [321].

$$|3\ 2\ 1| = \sqrt{(3^2 + 2^2 + 1^2)} = \sqrt{14}$$

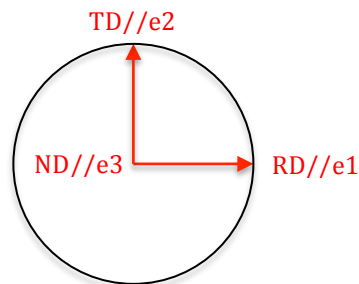
$$[u\ v\ w] = [3\ 2\ 1] / \sqrt{14} = [3/\sqrt{14}\ 2/\sqrt{14}\ 1/\sqrt{14}] = [0.802\ 0.535$$

0.267]

This forms the direction cosines for the direction [321].

Q2 [30] The position of sample reference frame is shown in the below circle (ND is out of the plane). For each set of Euler angles (ϕ_1 , ϕ , ϕ_2), show the positions of [100], [010] and [001] in the three successive rotations as each Euler angle is applied.

- a) (45, 45, 0)
- b) (0, 30, 60)
- c) (30, 45, 60)



Q3. [20] Read the 1965 paper by Dillamore & Roberts (look on Blackboard under "Course Content" and "Useful Files") and answer these questions.

a. [5] What effect does varying the strain rate and temperature have on texture development, to first order?

Answer: none, to first order.

b. [5] Which two fiber texture components develop when uniaxial tension (wire drawing) is applied to fcc metals?

Answer: $\langle 100 \rangle$ and $\langle 111 \rangle$.

c. [10] Figure 11 shows $\{10\cdot10\}$ pole figures for various rolled hexagonal metals, which are fairly similar to one another. Based on these and the descriptions in the text, sketch a (0001) pole figure that is consistent with these textures. Be sure to explain how you arrived at your answer. Hint: remember that (0001) and $\{10\cdot10\}$ are mutually perpendicular.

Answer: the basal PF should show two peaks, each one displaced an equal amount (of order 30°) from the center towards the TD and $-TD$. If two extra peaks are indicated with displacements towards RD and $-RD$, that is also acceptable.

Q4. [15] Read the 2004 paper by Wenk & van Houtte (look on Blackboard under "Course Content" and "Useful Files") and answer these questions.

a. [5] What effect does a platy particle shape (flat discs) have on texture development, e.g. when powder compacts are compressed? Give an example from the paper.

Answer: one example is the high temperature superconductor-123 which forms a $\langle 001 \rangle$ texture on compression because the plate normals align with the compression axis.

b. [5] Which texture component in a TiN coating is more resistant to erosion?

Answer: $\langle 111 \rangle$ is much more resistant than $\langle 100 \rangle$

c. [5] Which crystal direction (or plane normal) in aragonite in nacre is normal to the surface of mollusc shells?

Answer: $\langle 001 \rangle$

Q5. [25] Use the R package to analyze the data set in ReducedDiameter_StagDerrJih_Cu_A-O.csv. Make the following plots:

a. A frequency histogram of the data

b. A probability density plot of the data

c. A probability plot of the data; note that the package e1071 can be used to do this.

d. A frequency histogram of the $\log(\text{data})$

e. A probability density plot of the $\log(\text{data})$

f. A probability plot of the $\log(\text{data})$.

g. Comment on whether you think the data follows a normal or a log-normal distribution. You should be able to easily find information about probability plots.

Answer: most of these plots are already in the lecture notes, except for the probability plots. The answers should identify that a straight line in a probability plot indicates that the data is normally distributed.