Homework 8: Various topics; *Solutions*
A.D. Rollett, 27-750, Texture, Microstructure and Anisotropy
30+30+20+20 = 100
Due date: 13th April, 2016

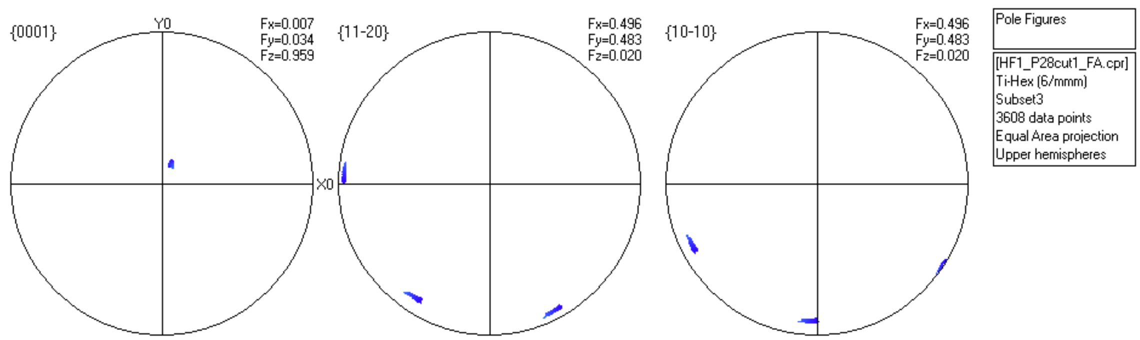
Q1. [30 points]
a) Certain 5-sided grains are observed to be just able to grow in a 2-dimensional microstructure. What are the dihedral angles likely to be found at the triple points?
b) What estimate can you make of the ratio of the energy of their perimeters (the GBs around their edges) to the energy of the GBs in the matrix around them?
c) Assume that these special grains are able to grow to a large size and preserve the difference in energy. If such a sample is annealed to develop surface grooves where the GBs intersect the surface, what do you expect to observe about the dihedral angles at the surface that associated with the special grains, versus the angles at GBs in the matrix? Assume that the surface energy is everywhere the same.

Q2. [30 points]
a) Make diagrams or sketches to explain the point made on slide 45 in the Stereology notes about nearest neighbor distances being smaller than mean free paths (for a given particle volume fraction and size). Here we consider only particles as point objects (not, e.g., grains as defined by a network of boundaries).

b) Read Chapter 4 in the Underwood book. Derive the expression given in the notes on abnormal grain growth (see slide 16 about drag pressure) for the number of particles per unit area of boundary, $N_A = 3f/2\pi r^2$. Hint: the derivation is simple once you identify the correct expression.

c) Based on the standard Smith-Zener analysis of particle pinning of grain growth, does variation in (anisotropy of) the grain boundary energy make any difference to the pinned grain size?

Q3. [20 points]
Reference Frames
The figure below is taken from slide 27 in the EBSD Analysis lecture. From this set of discrete pole figures (ignore the spread in orientation that the streaks suggest), deduce the euler angles of the crystal assuming the reference frame is the default for HKL/Oxford (as indicated by the labels “X0” and “Y0” on the lefthand pole figure). Then repeat but with the assumption of the TSL/OIM system (as described in the lecture notes). You are strongly encouraged to make diagrams of the successive rotations starting from the reference position in order to verify that result is correct.



Q4. [20 points] Learning how to make probability plots
This exercise is included mainly to convince you that making probability plots is not difficult and can produce interesting results.
Firstly, download the "R" project from www.r-project.org and install it on your computer.
Secondly, figure out how to install the package e1071 that allows you to draw probability plots.
Thirdly, read in the data from the list given below, e.g., by storing the numbers in a text file and using the *read.table* command.

Submit a screenshot (or copy of the transcript) that shows that you have read in the data, taken the log of each datapoint, and made a probability plot, along with a copy of the plot. Indicate on the plot which parts of the distribution conform to a normal distribution (bell curve) and which parts do not. If you observe divergence from log-normal, does the result indicate more large grains/particles than you would predict from the log-normal part of the data, or fewer?

Hints:
- Once you have read in the data, you should type "summary" to see what R thinks it has.
- Try using the probability plot directly on the data.
- Then make a probability plot of the log of the data.

There are many guides and introductions to R on the web. Google is your friend!
[As an extra exercise, see if you can figure out how to normalize each column of points by their mean; look at the "summary" command above which provides a mean value and create a new dataset from the existing column of data.]

Data for probability plot question.

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