Properties of Materials Final Exam
December 6, 2010

1) a) List two polymers that fall into each of the following categories: thermoplastic, semi-crystalline, thermoset, elastomer.

b) Define the variance, σ^2, and the standard deviation, σ for a distribution of molecular weights.

c) Define the weight average, number average and z-average molecular weight and the polydispersity index (PDI).

d) How is M_w related to the moments M_2 and M_1?

e) Describe an atactic polymer in terms of diad and triad tacticity.

2) a) In what way are HCP and FCC crystal structures similar?

b) In a cubic unit cell what direction is normal to the (111) plane? Is this true for a triclinic unit cell?

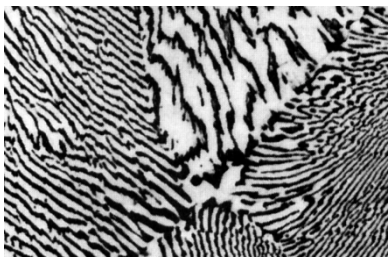
c) Explain the following expressions giving all possible values for each expression where appropriate: {001},[002],<003>,(200).

d) Calculate the packing factor (packing efficiency) for a closest packed unit cell.

e) The (111) diffraction peak for a FCC crystal is found to occur at $2\theta = 22.5^o$ using x-rays of wavelength 1.54 Å. What is the lattice spacing "a"?

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

b) The following micrograph shows the structure of a metal alloy.



Sketch a simple phase diagram that could explain this grain structure.

c) The Einstein-Stokes equation includes the shear viscosity which is defined by, $\tau_{x,y} = \eta\dot{\gamma}_{x,y}$. Explain what the subscripts x and y refer to in $\tau_{x,y}$ and in $\dot{\gamma}_{x,y}$ using a sketch of shear flow with Cartesian coordinates (define the directions of force and velocity).

d) Obtain an expression for the sedimentation velocity using a force balance between viscous drag and gravity.

e) What is the zeta potential? How can the zeta potential be measured?