Ph.D. Qualifying Examination

Materials Science

Spring 2015

Logistics Notes:

- Time allowed: 2 hours.
- Problems count 25 points each (total=100 points).
- Exam is closed-book and closed-notes
- State your assumptions, methods, and procedures. Show your work on these exam sheets. (Add additional sheets, if needed.)
- Calculators are allowed.
- Laptops, tablets and cell phones are not allowed.
1) Rank the below samples made from a hypothetical metal ‘X’ in terms of strength and ductility. Explain your reasoning.

   i) Single crystal X
   ii) Defect-free single crystal X
   iii) Poly-crystalline X
   iv) Cold-worked Poly-crystalline X
2) Drive expressions for elastic modulus of a continuous fiber reinforced composite in longitudinal and transverse directions. Elastic moduli of fiber and matrix are $E_f$ and $E_m$ and fiber volume fraction is $V_f$. 
3) A hypothetical AX type of ceramic crystal is known to have a density of 2.65 g/cm³. The edge length of the cubic unit cell is 0.43 nm. The atomic weights of the A and X elements are 86.6 and 40.3 g/mol, respectively. On the basis of this information, which of the following three crystal structures is (are) possible for this material. Justify your choice(s).
4) Compute the volume fraction of pearlite in a 99.6 wt% Fe–0.4 wt% C steel in the condition that the steel is cooled slowly from a temperature in the austenite region to just below the eutectoid temperature.