**ME213 Homework set2**

Name: email: -

**Problem 1**

(a) Diamond is an electrical insulator and is one of the hardest substances known. Interpret these properties in terms of its bonding.

(b) Graphite is an anisotropic conductor. It has high conductivity in the plane of the sheet, and very low conductivity perpendicular to the sheet plane. Explain this behavior in terms of a simple chemical bonding model.

(c) In its usual microstructure, small three-dimensional particles made of stacked planar sheets, graphite deforms easily, and is used in pencil lead and lubricants. Given that the carbon sheets themselves are very rigid, explain why graphite is so easily deformed.

(d) Graphite fiber is made by modifying the microstructure into long, thin ribbons, in which the carbon sheets parallel the plane of the ribbon. The ribbons are then rolled, somewhat as one would roll a newspaper, to form the graphite fiber. While normal graphite is weak, graphite fiber is extremely strong when pulled along the fiber axis. Explain in terms of the microstructure and the bonding in graphite.

**Problem 2**

(a) The surface energy of a single crystal depends on crystallographic orientation. Does this surface energy increase or decrease with an increase in planar density? Why?

(b) For an FCC single crystal, would you expect the surface energy for a (100) plane to be greater or less than that for a (111) plane?

**Problem 3**

(a) Cite two reasons why interstitial diffusion is normally more rapid than vacancy diffusion.

(b) Cite the values of the diffusion coefficients for the interdiffusion of carbon in both alpha-iron (bcc) and gamma-iron (FCC) at 900oC. Which is larger? Explain why this is the case.

**Problem 4**

(a) Compute the radius r of an impurity atom that will just fit into an FCC octahedral site in terms of the atomic radius R of the host atom (without introducing lattice strains).

(b) Repeat part (a) for the FCC tetrahedral site.

(c) Compute the radius r of an impurity atom that will just fit into a BCC tetrahedral site in terms of the atomic radius R of the host atom (without introducing lattice strains).

(d) Explain why a higher concentration of carbon will dissolve in FCC iron than in iron that has a BCC crystal structure.

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