MATE 313

Fall 2019

Homework # 2

Due: October 17th, 2019

Group submission (up to 3 students per group) is allowed.

Question 1

a) Compute the radius *r* of an atom that will just fit into one of the tetrahedral interstitial sites in FCC crystal structure in terms of the atomic radius *R* of the host atom.

b) Do the same computation for a octahedral site in BCC structure.

Question 2:

The preexponential (D_0) and activation energy (Q) for the self-diffusion of aluminum are 2.3×10^{-4} m^2/s and 144 kJ/mole, respectively. Determine the mean time of stay of an aluminum atom at a lattice site a) at 300°C and b) at 600°C.

Question 3

Consider an atom diffusing by a random walk mechanism in a simple cubic lattice with a lattice parameter of 0.2 nm. It is known that the atom jumps 10^{-5} times per second at 300K and 10^4 times per second at 600K.

1) How many times the atom will jump per second at 900K?
2) How far the atom will move away from its original position at 900K in one minute?

Question 4

Carbon is allowed to diffuse through a 12 mm thick steel plate of austenitic microstructure. The concentrations of carbon at the two faces are 0.80 and 0.45 kg/m^3, which are maintained constant. Find the temperature at which the diffusion flux is 6.3×10^{-11} kg/m^2-s.

Question 5:

A diffusion couple composed of two platinum-gold alloys is formed; these alloys have compositions of 99.0 wt% Pt-1.0 wt% Au and 95.5 wt% Pt-4.5 wt% Au.

Determine the time this diffusion couple must be kept at 800°C in order for the composition to be 3.5 wt% Au at the 15 μm position into the 4.5 wt% Au side of the diffusion couple.

Preexponential and activation energy values for Au diffusion in Pt are $1.3 \times 10^{-5} m^2/s$ and 252,000 J/mol, respectively.