Session #24: Homework Problems

Problem #1

To increase its corrosion resistance, chromium (Cr) is diffused into steel at 980°C. If during diffusion the surface concentration of chromium remains constant at 100%, how long will it take (in days) to achieve a Cr concentration of 1.8% at a depth of 0.002 cm below the steel surface? (D_o = 0.54 cm^2/s; E_A = 286 kJ/mol)

Problem #2

By planar diffusion of antimony (Sb) into p-type germanium (Ge), a p-n junction is obtained at a depth of 3×10^{-3} cm below the surface. What is the donor concentration in the bulk germanium if diffusion is carried out for three hours at 790°C? The surface concentration of antimony is held constant at a value of 8×10^{18} cm^{-3}; $D_{790°C}$ = 4.8×10^{-11} cm^2/s.

Problem #3

You wish to dope a single crystal of silicon (Si) with boron (B). The specification reads 5×10^{16} boron atoms/cm^3 at a depth of 25 μm from the surface of the silicon. What must be the effective concentration of boron in units of atoms/cm^3 if you are to meet this specification within a time of 90 minutes? Assume that initially the concentration of boron in the silicon crystal is zero. The diffusion coefficient of boron in silicon has a value of 7.23×10^{-9} cm^2 s^{-1} at the processing temperature.

Problem #4

A slab of plate glass containing dissolved helium (He) is placed in a vacuum furnace at a temperature of 400°C to remove the helium from the glass. Before vacuum treatment, the concentration of helium is constant throughout the glass. After 10 minutes in vacuum at 400°C, at what depth from the surface of the glass has the concentration of helium decreased to 1/3 of its initial value? The diffusion coefficient of helium in the plate glass at the processing temperature has a value of 3.091×10^{-6} cm^2/s.

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