**動機系材導第三次習題(Chap. 5, 6)**

**106年4月27日繳交**

5.34 The concentration of carbon on the surface of a 1018 steel gear is 0.8 wt% at 1000 °C. Determine the flux of carbon atoms from the surface to a plane 25 μm below the surface where carbon concentration is unaffected by the surface concentration. Hint: convert wt% to atoms/m3 using information in Table 3.2.

5.36 A bar of pure nickel is coupled with a bar of pure iron (interfaced). The diffusion couple is then heated to a temperature of 1000 °C. (*a*) How long will it take for the concentration of nickel to reach 0.1 wt%, 1.0 μm below the interface? (*b*) How long will it take for the concentration of nickel to reach 0.1 wt%, 1.0 mm below the interface? (*c*) What does the comparison of the two answers show?

5.39 The activation energy of nickel atoms in FCC iron is 280 kJ/mol and carbon atoms in FCC iron is 142 kJ/mol. (*a*) What does this tell you about the comparative diffusion of nickel and carbon in iron? (*b*) Can you explain why the activation energies are so drastically different? (*c*) Find a way to qualitatively explain how much energy is 142 kJ to a non-engineer or a non-scientist.

5.40 The melt temperatures of copper and aluminum are 1083°C and 657°C respectively. Compare the diffusivities of copper in copper and copper in aluminum at 500°C (use Table 5.2). Can you explain why a drastic difference exists?

5.47 If hydrogen diffuses in ferrous alloys, it will make the material significantly more brittle and susceptible to fracture. The activation energy of hydrogen in steel is 3.6 kcal/mol. Should we worry about hydrogen embrittlement of steels (is it very likely to occur)? Explain.

6.76 (*a*) Derive the relationship between true strain and engineering strain. (Hint: Start with expression for engineering strain.) (*b*) Derive a relationship between true stress and engineering strain. (Hint: Start with *σt* = *F/Ai* = (*F/A0*)(*A0/Ai*).)

6.79 The material for a rod of cross-sectional area 2.70 in2 and length 75.0 inches must be selected such that under an axial load of 120,000 lb, it will not yield and the elongation in the bar will remain below 0.105 inches. (*a*) Provide a list of at least three different metals that would satisfy these conditions. (*b*) Narrow the list down if cost is an issue. (*c*) Narrow the list down if corrosion is an issue. Use Appendix I for properties and cost of common alloys only.

6.81 A cylindrical component is loaded in tension until the cross-sectional area is reduced by 25% (the specimen does not neck or fracture). (*a*) Determine the true strain for the specimen at this loading level. (*b*) If you were to calculate the uniaxial stress in the specimen under the given conditions, would you use the true stress or the engineering stress? Support your answer by showing the difference?

6.84 A one-inch cube of tempered stainless steel (alloy 316) is loaded along its z direction under a tensile stress of 413 MPa. (*a*) Draw a schematic of the cube before and after loading showing the changes in dimension. (*b*) Repeat the problem assuming the cube is made of tempered aluminum (alloy 2024). Use Fig. 6.15*b* and Appendix I for relevant data.

6.91 Determine the tensile stress that must be applied to the axis of a high-purity copper single crystal to cause slip on the system. The resolved shear stress for the crystal is 0.85 MPa.