Assignment #21

10.3 *If copper (which has a melting point of 1085°C) homogeneously nucleates at 849°C, calculate the critical radius given values of* -1.77×10^9 *J/m*^{3} *and 0.200 J/m*^{2}*, respectively, for the latent heat of fusion and the surface free energy.*

10.4 *(a) For the solidification of iron, calculate the critical radius* r^* *and the activation free energy* ΔG^* *if nucleation is homogeneous. Values for the latent heat of fusion and surface free energy are* -1.85×10^9 *J/m*^{3} *and 0.204 J/m*^{2}*, respectively. Use the supercooling value found in Table 10.1.*

(b) Now calculate the number of atoms found in a nucleus of critical size. Assume a lattice parameter of 0.292 nm for solid iron at its melting temperature.

10.5 *(a) Assume for the solidification of iron (Problem 10.4) that nucleation is homogeneous and that the number of stable nuclei is* 10^6 *nuclei per cubic meter. Calculate the critical radius and the number of stable nuclei that exist at the following degrees of supercooling: 200 and 300 K.*

(b) What is significant about the magnitudes of these critical radii and the numbers of stable nuclei?

10.10 *The kinetics of the austenite-to-pearlite transformation obeys the Avrami relationship. Using the fraction transformed–time data given here, determine the total time required for 95% of the austenite to transform to pearlite:*

Fraction Transformed	***Time (s)***
0.2	12.6
0.8	28.2

10.19 (acfh) *Using the isothermal transformation diagram for an iron–carbon alloy of eutectoid composition (Figure 10.23), specify the nature of the final microstructure (in terms of microconstituents present and approximate percentages of each) of a small specimen that has been subjected to the following time–temperature treatments. In each case assume that the specimen begins at 760°C (1400°F) and that it has been held at this temperature long enough to have achieved a complete and homogeneous austenitic structure.*

(a) Rapidly cool to 700°C (1290°F), hold for 10^4 *s, then quench to room temperature.*

(c) Rapidly cool to 600°C (1110°F), hold for 4 s, rapidly cool to 450°C (840°F), hold for 10 s, then quench to room temperature.

(f) Cool rapidly to 400°C (750°F), hold for 200 s, then quench to room temperature.

(h) Rapidly cool to 250°C (480°F), hold for 100 s, then quench to room temperature in water. Reheat to 315°C (600°F) for 1 h and slowly cool to room temperature.

10.28 *Name the microstructural products of 4340 alloy steel specimens that are first completely transformed to austenite, then cooled to room temperature at the following rates:*

(a) 10°C/s

(b) 1°C/s

(c) 0.1°C/s

(d) 0.01°C/s

10.D7 *(a) For a 1080 steel that has been water quenched, estimate the tempering time at 425°C (800°F) to achieve a hardness of 50 HRC.*

(b) What will be the tempering time at 315°C (600°F) necessary to attain the same hardness?