

9.46 Compute the mass fractions of α ferrite and cementite in pearlite.

Solution

This problem asks that we compute the mass fractions of α ferrite and cementite in pearlite. The lever-rule expression for ferrite is

$$W_{\alpha} = \frac{C_{\text{Fe}_3\text{C}} - C_0}{C_{\text{Fe}_3\text{C}} - C_{\alpha}}$$

and, since $C_{\text{Fe}_3\text{C}} = 6.70$ wt% C, $C_0 = 0.76$ wt% C, and $C_{\alpha} = 0.022$ wt% C

$$W_{\alpha} = \frac{6.70 - 0.76}{6.70 - 0.022} = 0.89$$

Similarly, for cementite

$$W_{\text{Fe}_3\text{C}} = \frac{C_0 - C_{\alpha}}{C_{\text{Fe}_3\text{C}} - C_{\alpha}} = \frac{0.76 - 0.022}{6.70 - 0.022} = 0.11$$

9.47 (a) What is the distinction between hypoeutectoid and hypereutectoid steels?

(b) In a hypoeutectoid steel, both eutectoid and proeutectoid ferrite exist. Explain the difference between them. What will be the carbon concentration in each?

Solution

(a) A “hypoeutectoid” steel has a carbon concentration less than the eutectoid; on the other hand, a “hypereutectoid” steel has a carbon content greater than the eutectoid.

(b) For a hypoeutectoid steel, the proeutectoid ferrite is a microconstituent that formed above the eutectoid temperature. The eutectoid ferrite is one of the constituents of pearlite that formed at a temperature below the eutectoid. The carbon concentration for both ferrites is 0.022 wt% C.

9.51 Consider 2.5 kg of austenite containing 0.65 wt% C, cooled to below 727 °C (1341°F).

(a) What is the proeutectoid phase?

(b) How many kilograms each of total ferrite and cementite form?

(c) How many kilograms each of pearlite and the proeutectoid phase form?

(d) Schematically sketch and label the resulting microstructure.

Solution

(a) Ferrite is the proeutectoid phase since 0.65 wt% C is less than 0.76 wt% C.

(b) For this portion of the problem, we are asked to determine how much total ferrite and cementite form.

For ferrite, application of the appropriate lever rule expression yields

$$W_{\alpha} = \frac{C_{\text{Fe}_3\text{C}} - C_0}{C_{\text{Fe}_3\text{C}} - C_{\alpha}} = \frac{6.70 - 0.65}{6.70 - 0.022} = 0.91$$

which corresponds to $(0.91)(2.5 \text{ kg}) = 2.27 \text{ kg}$ of total ferrite.

Similarly, for total cementite,

$$W_{\text{Fe}_3\text{C}} = \frac{C_0 - C_{\alpha}}{C_{\text{Fe}_3\text{C}} - C_{\alpha}} = \frac{0.65 - 0.022}{6.70 - 0.022} = 0.09$$

Or $(0.09)(2.5 \text{ kg}) = 0.23 \text{ kg}$ of total cementite form.

(c) Now consider the amounts of pearlite and proeutectoid ferrite. Using Equation 9.20

$$W_p = \frac{C_0' - 0.022}{0.74} = \frac{0.65 - 0.022}{0.74} = 0.85$$

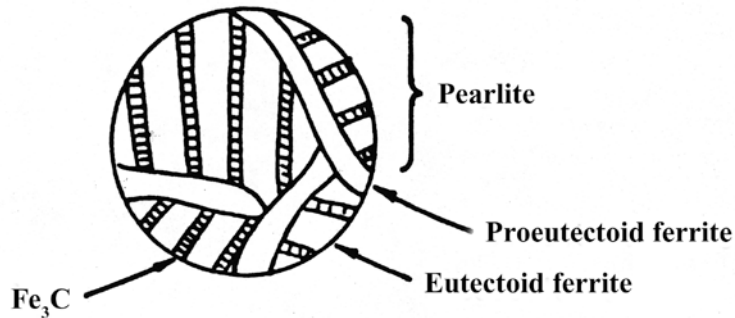
This corresponds to $(0.85)(2.5 \text{ kg}) = 2.12 \text{ kg}$ of pearlite.

Also, from Equation 9.21,

$$W_{\alpha'} = \frac{0.76 - 0.65}{0.74} = 0.15$$

Or, there are $(0.15)(2.5 \text{ kg}) = 0.38 \text{ kg}$ of proeutectoid ferrite.

(d) Schematically, the microstructure would appear as:



Chapter 10:

10.14 (a) Briefly describe the phenomena of superheating and supercooling.

(b) Why do these phenomena occur?

Solution

(a) Superheating and supercooling correspond, respectively, to heating or cooling above or below a phase transition temperature without the occurrence of the transformation.

(b) These phenomena occur because right at the phase transition temperature, the driving force is not sufficient to cause the transformation to occur. The driving force is enhanced during superheating or supercooling.