EUTECTIC DIAGRAM WITH LIMITED SOLID SOLUTION

For many binary systems, the two components are partially soluble in each other. The result is a phase diagram intermediate between the two cases we have treated so far. Figure 9.14 shows a eutectic diagram with limited solid solution. It generally looks like Figure 9.11 except for the solid-solution regions near each edge. These single-phase regions are comparable to the SS region in Figure 9.5 except for the fact that the components in Figure 9.14 do not exist in a single solid solution near the middle of the composition range. As a result, the two solid-solution phases, α and β, are distinguishable, and they frequently have different crystal structures. In any case, the crystal structure of α will be that of A, and the crystal structure of β will be that of B because each component serves as a solvent for the other, "impurity" component (e.g., α consists of B atoms in solid solution in the crystal lattice of A). The use of tie lines to determine the compositions of α and β in the two-phase regions is identical to the diagram shown in Figure 9.6, and examples are shown in Figure 9.15 together with representative microstructures.

The Pb–Sn system (Figure 9.16) is a good example of a binary eutectic with limited solid solution. Common solder alloys fall within this system. Their low melting ranges allow for joining of most metals by convenient heating methods, with low risk of damage to heat-sensitive parts. Solders with less than 5 wt % tin are used for sealing containers and coating and joining metals, and are also used for applications with service temperatures that exceed 120°C. Solders with between 10 and 20 wt % tin are used for sealing cellular automobile radiators

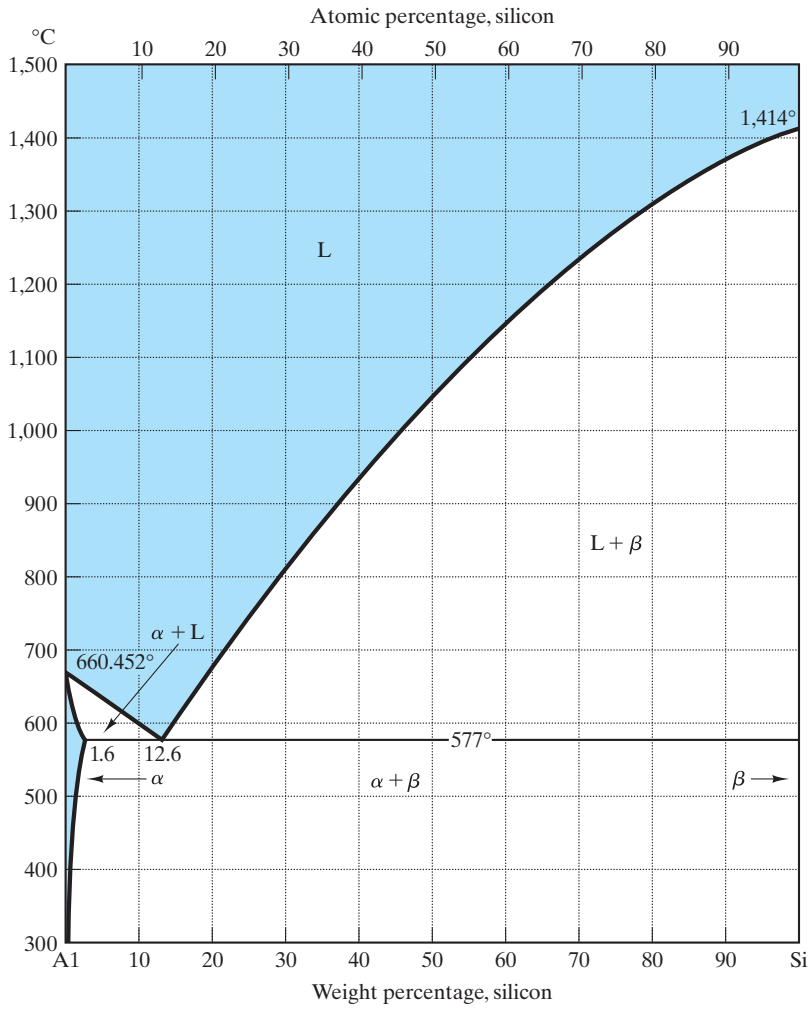

FIGURE 9.13 Al–Si *phase diagram. (After* Binary Alloy Phase Diagrams, *Vol. 1, T. B. Massalski, Ed., American Society for Metals, Metals Park, OH, 1986.)*

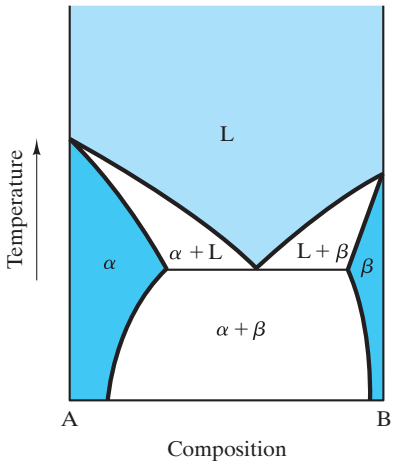

FIGURE 9.14 *Binary eutectic phase diagram with limited solid solution. The only difference between this diagram and the one shown in Figure 9.11 is the presence of solid-solution regions α and β.*

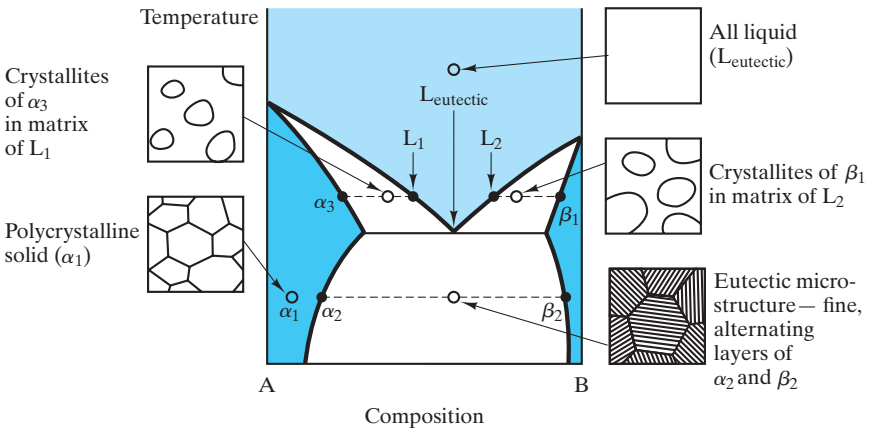

FIGURE 9.15 *Various microstructures characteristic of different regions in the binary eutectic phase diagram with limited solid solution. This illustration is essentially equivalent to the illustration shown in Figure 9.12, except that the solid phases are now solid solutions* (α *and* β) *rather than pure components* (A *and* B).

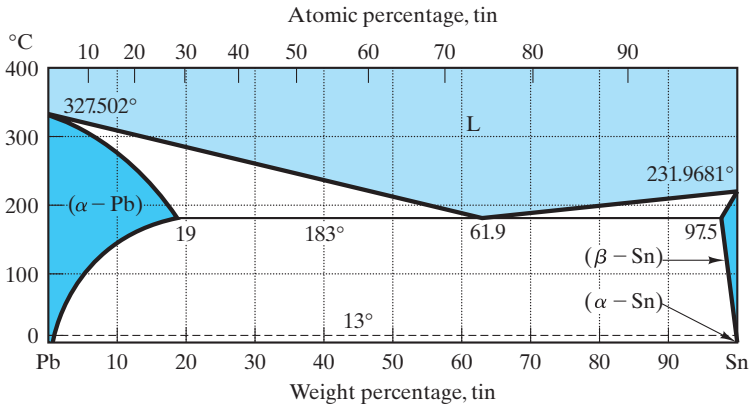

FIGURE 9.16 Pb–Sn *phase diagram. (After* Metals Handbook*, 8th ed., Vol. 8:* Metallography, Structures, and Phase Diagrams*, American Society for Metals, Metals Park, Ohio, 1973, and* Binary Alloy Phase Diagrams*, Vol. 2, T. B. Massalski, Ed., American Society for Metals, Metals Park, OH, 1986.)*

and filling seams and dents in automobile bodies. General-purpose solders are generally 40 or wt % tin. These solders have a characteristic pastelike consistency during application, associated with the two-phase liquid plus solid region just above the eutectic temperature. Their wide range of applications includes well-known examples from plumbing to electronics. Solders near the eutectic composition (approximately 60 wt % tin) are used for heat-sensitive electronic components that require minimum heat application. It should be noted that, when we arrive at the end of this book (Section 15.4 dealing with materials and our environment), some of these useful applications of lead solders are being constrained by environmental policy due to the toxicity of lead.