CHAPTER 10

BINARY SYNTECTIC SYSTEMS

Corresponding to the monotectic of the eutectic group, the *syntectic reaction* of the peritectic group consists, with rising temperature, in the decomposition of a solid phase into two immiscible liquids.

$$L_{\text{I}} + L_{\text{II}} \underset{\text{heating}}{\overset{\text{cooling}}{\rightleftharpoons}} \beta$$

This case is illustrated in Fig. 10-1. The termination in this diagram of the two-liquid field by an upper critical point is but one of several possibilities, as has been pointed out in Chap. 6. Likewise, the completion of the diagram with two eutectic reactions (dashed lines) is an arbitrary choice not involved in the syntectic itself.

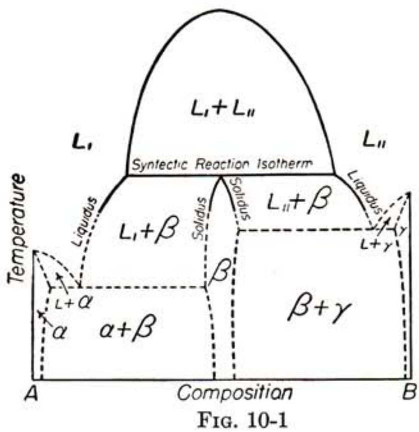

FIG. 10-1

No presently useful alloys occur within the range of any of the known syntectic reactions, and as a consequence, very little is known of their transformation behavior. It is easily seen from the phase diagram, however, that any molten alloy within the composition range of the syntectic line must separate into two liquids, presumably existing as separate layers in the container. Freezing should begin at the syntectic reaction isotherm, where L_{I} should react with L_{II} to form β. Ordinarily, the β would form at the interface between the liquid layers and tend to interfere with further reaction to the extent that no substantial layer of β would form except with very long time at the reaction temperature. Thus, it is to be expected that the "alloy" will freeze essentially in two independent parts with a minor reaction layer between. The L_{I} should freeze as a hypereutectic alloy of the $\alpha + \beta$ eutectic system, and the L_{II} as a hypoeutectic alloy of the $\beta + \gamma$ eutectic system. Only the relative proportions of the two liquids would change with composition from one end of the

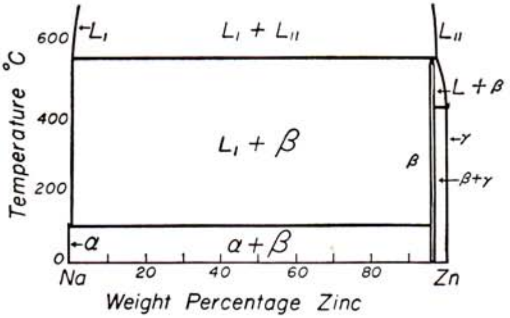

FIG. 10-2. Phase diagram of the system sodium-zinc.

syntectic line to the other; i.e., there would be nothing to distinguish the syntectic alloy from compositions on either side of it (except, of course, upon the attainment of true equilibrium).

Perhaps the best known example of the relatively rare syntectic is that found in the system sodium-zinc (Fig. 10-2). Here again, as was found to be the case in the peritectoid of the silver-aluminum system (Chap. 9) the composition of the low-temperature phase β overlaps that of one of the high-temperature liquid phases L_{II}. Above the syntectic temperature an "alloy" composed of equal parts of sodium and zinc exists in the form of two liquid layers L_I and L_{II}. Upon cooling, the zinc-rich liquid L_{II} transforms immediately and quantitatively to solid β, leaving the sodium-rich layer L_I unchanged until it finally freezes as a limiting eutectic just below the melting temperature of sodium. Since this change is effected virtually without the aid of diffusion, it is not delayed by interposing a layer of solid between the two liquid layers. The resulting microstructure is composed of a one-phased layer of β in line contact with a nearly one-phased layer of α (sodium) (Fig. 10-3).

FIG. 10-3. Microstructure at the junction between the two layers in a cast "alloy" composed of equal parts of sodium and zinc. The lower layer is the β (compound) phase; the upper layer is nearly pure sodium. Dark spots in the β layer are inclusions of sodium. Magnification 75.