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Al-Pb-Zn (Aluminum-Lead-Zinc)

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The only experimental information on this system is the liquidus projection bounding the liquid miscibility gap determined by [1943Dan]. Recently, [2005Liu] derived ternary interaction parameters for this system starting from the binary parameters, using a general solution model. They computed a liquidus projection and several isothermal and vertical sections. [2005Gro] computed a liquidus projection by extrapolation of the binary parameters, without introducing any ternary parameter.

Binary Systems

The Al-Pb system depicts a liquid miscibility gap with the critical temperature above 1500 °C. A monotectic reaction occurs at 658.9 °C, where the Al-rich liquid L′ decomposes into (Al) and a Pb-rich liquid L″. The final solidification of L″ to (Al) + (Pb) occurs at 326.5 °C. In the Al-Zn system, solidification occurs through a eutectic reaction at ~381 °C yielding (Zn) and (Al). On solidification, (Al) has more than 60 at.% of dissolved Zn. At lower temperatures, this solid solution exhibits a miscibility gap, with a critical temperature at 351.5 °C and a monotectoid reaction at 277 °C: (Al)′ ↔ (Al) + (Zn). The Pb-Zn system exhibits a liquid miscibility gap and a monotectic reaction at 417.8 °C, where the Zn-rich liquid L′ decomposes to (Zn) and a Pb-rich liquid L″. The final eutectic solidification is at ~319 °C, where L″ solidifies to (Zn) + (Pb). Computed phase diagrams of the above binary systems were given by [2005Liu].

Ternary Phase Equilibria

In their thermodynamic calculation, [2005Liu] accepted the binary descriptions of [1984McA] (Al-Pb), [2000Mat] (Al-Zn), and [2003Dav] (Pb-Zn). By using the "general solution model" (GSM) of [1996Cho], [2005Liu] derived and listed the ternary interaction parameters for the liquid, face-centered cubic (fcc) and close-packed hexagonal (cph) phases. In contrast to the conventional extrapolation procedure, GSM uses the excess Gibbs energy data of the constituent binaries to predict the ternary thermodynamic properties.

A liquidus projection, three isothermal sections at 827, 527, and 307 °C, and four vertical sections at constant atom ratios of Al/Zn = 1 and Al/Pb = 1, and at constant 0.05 at.% Al and 2 at.% Zn respectively were computed by [2005Liu]. The computed liquidus projection is shown in Fig. 1. It is in satisfactory agreement with that calculated by [2005Gro] using the conventional extrapolation of the binary data without introducing ternary interaction parameters. In Fig. 1, the liquid immiscibility region is present over most of the triangle. Figure 2 shows the details of the liquidus projection near the Pb corner. The ternary monotectic reaction M′: L′ ↔ L″ + (Pb) + (Zn) at 381 °C is followed by the ternary eutectic reaction E: L″ ↔ (Al) + (Pb) + (Zn) at 319 °C. Figures 3-5 show the three isothermal sections [2005Liu]. At 827 °C (Fig. 3), the

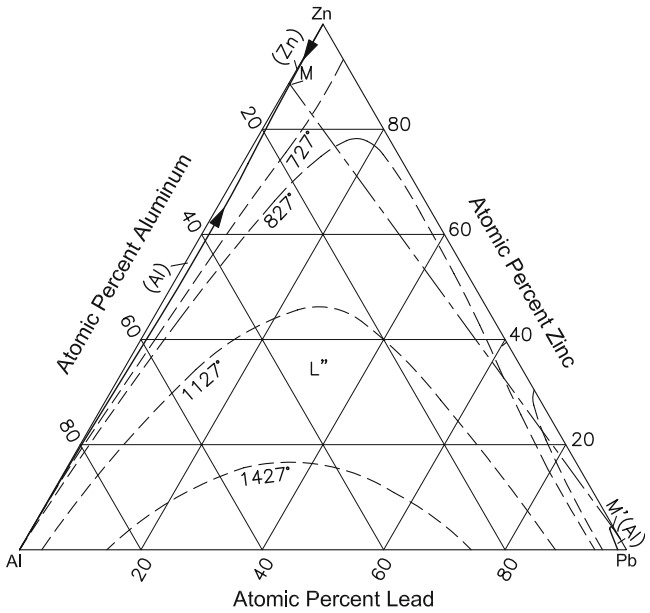

Fig. 1 Al-Pb-Zn computed liquidus projection [2005Liu]

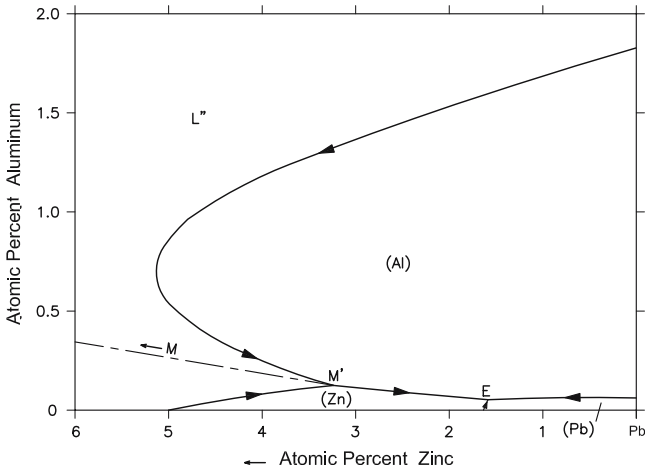

Fig. 2 Al-Pb-Zn computed liquidus projection near the Pb corner [2005Liu]

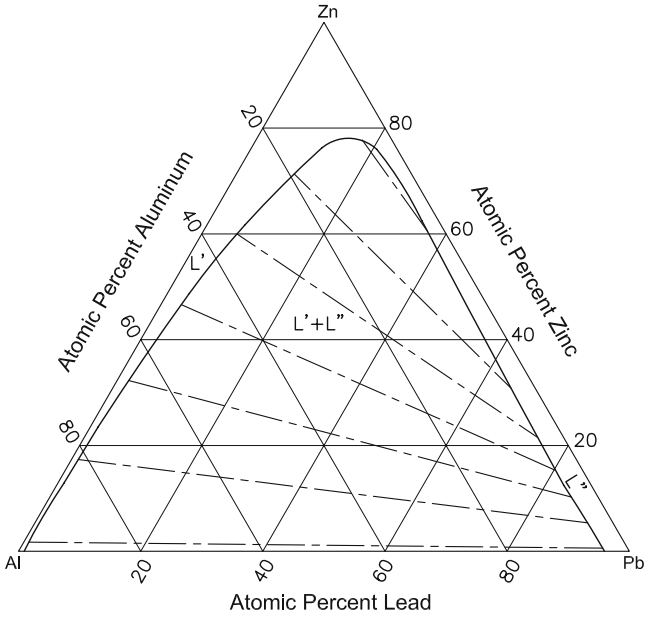

Fig. 3 Al-Pb-Zn computed isothermal section at 827 °C [2005Liu]

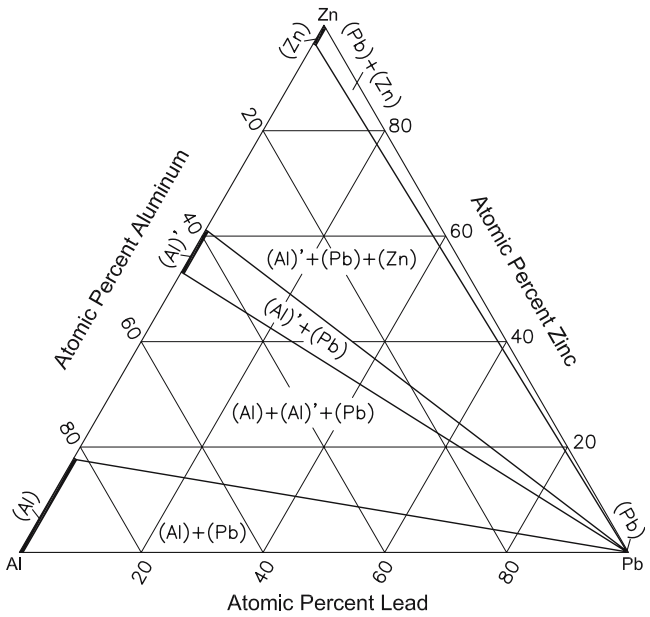

Fig. 5 Al-Pb-Zn computed isothermal section at 307 °C [2005Liu]

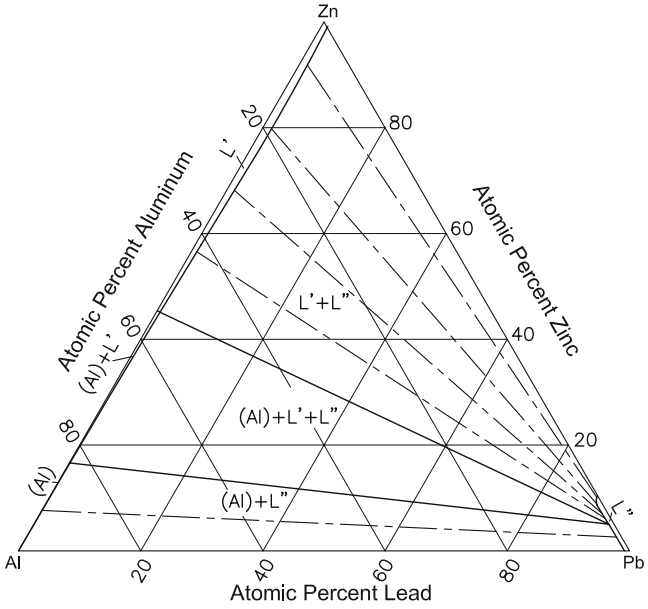

Fig. 4 Al-Pb-Zn computed isothermal section at 527 °C [2005Liu]

liquid miscibility gap originating from the Al-Pb side is present. At 527 °C (Fig. 4), along the Al-Pb side, the fcc solid solution (Al) is in equilibrium with the Pb-rich liquid L″. With increasing Zn, the three-phase field of L′ (Al-Zn liquid) + L″ + (Al) is stable. With further increase in Zn, the liquid immiscibility region of (L′ + L″) is stable. At 307 °C (Fig. 5), no liquid is present. The three-phase fields of (Pb) + (Al) + (Al)′ (all three are fcc phases!) and (Pb) + (Al)′ + (Zn) are stable [2005Liu].

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