

Al-Bi-Pb (Aluminum-Bismuth-Lead)

V. Raghavan

Ternary alloys with a four-phase monotectic reaction having two different solidified liquids in the microstructure can possess interesting properties. In their search for monotectic ternary aluminum alloys, [2005Gro] computed the liquidus surface of this system.

Binary Systems

The Al-Bi phase diagram [Massalski2] depicts a liquid miscibility gap with the critical temperature at 1037 °C. A monotectic reaction occurs at 658 °C, where an Al-rich liquid L_1 decomposes to (Al) and a Bi-rich liquid L_2 . The

final solidification is at the Bi-end through the eutectic reaction at 270 °C: $L_2 \leftrightarrow (\text{Al}) + (\text{Bi})$. The liquid miscibility gap in the Al-Pb system [Massalski2] has a critical temperature of 1566 °C. In the monotectic reaction at 659 °C, the Al-rich liquid L_1 decomposes into (Al) and a Pb-rich liquid L_2 . The final solidification of L_2 to (Al) + (Pb) occurs at 327 °C. The Bi-Pb system [1994Oka] has an intermediate phase ϵ (cph) with a Bi range of ~26-43 at.%. The peritectic formation of ϵ is followed by the eutectic reaction at 127.5 °C: $L \leftrightarrow \epsilon + (\text{Bi})$.

Liquidus Projection

In their thermodynamic calculation, [2005Gro] employed the binary interaction parameters from the published literature. The liquidus projection shown in Fig. 1 was computed by extrapolation of the binary data, without introducing any new parameters. The monotectic line limiting the primary area of (Al) lies very close to the Al corner and is not seen in Fig. 1. The monotectic line in the Al-lean region $m'_1 m'_2$ extends from the Al-Pb side up to the Al-Bi side with a very small drop in temperature. The eutectic monvariant lines from the Al-Pb and Al-Bi sides run very close to the Bi-Pb side and are expected to undergo two invariant reactions close to 39 and 56 at.% Bi, where they meet the peritectic and eutectic lines originating from the Bi-Pb side.

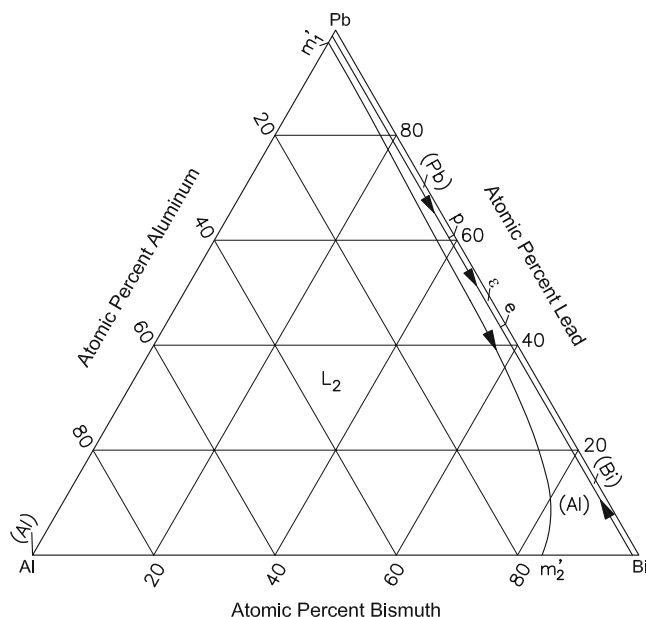


Fig. 1 Al-Bi-Pb computed liquidus projection [2005Gro]

References

- 1994Oka: H. Okamoto, Comment on Bi-Pb (Bismuth-Lead), *J. Phase Equilibria.*, 1994, **15**(3), p 361-362
- 2005Gro: J. Grobner and R. Schmid-Fetzer, Phase Transformations in Ternary Monotectic Aluminum Alloys, *JOM*, 2005, **57**(9), p 19-23