Introduction

The Al-rich corner of the Al-Li-Si ternary system was studied by [84Han], [76Kad], [76Dri], [49Bou1], and [49Bou2]. [76Kad] and [76Dri] constructed the liquidus surface and an isotherm at 550 °C for the Al-rich corner, using high-purity Al, Li, and Si and using thermal and microstructural analysis. However, their diagrams are inconsistent with those accepted for constituent binaries. For example, they assumed the Li concentration in the Al-Li eutectic to be between 8.4 and 9.9 wt.% Li, contrary to the 7.5 wt.% Li reported by [82Meal in their evaluation of the Al-Li system. The study of [84Han], which was more recent, assumed the Al-Li binary eutectic to be at 10 wt.% Li.

This evaluation is intended to correlate the existing data for the Al-Li-Si ternary system and to resolve inconsistencies among the ternary data and the accepted binary data.

Binary Systems

The constituent binary phase diagrams for the Li-Si and Al-Si systems are well established, as assessed by [Shunk] and [84Mur], respectively, and are adopted in this evaluation. The Al-Li system has been established with reasonable certainty [80Sch, 81Sch, 82Mca] with the evaluation of [80Sch, 81Sch] as reported by [90Goe] used here. Important phases and reactions (with their compositions) of the Al-Li system are summarized in "The Al-Li-Mn (Aluminum-Lithium-Manganese System," in this issue.

The Al-Li eutectic reaction at a composition of 7.5 wt.% Li and 600 ± 5 °C was established by [82Mca], contrary to the eutectic composition between 8.4 and 9.9 wt.% Li reported by [76Kad] and the 10 wt.% Li assumed by [84Han], [82Mca] tabulated a value of 8.29 wt.% (26 at.%) Li for the Al-Li eutectic, but the diagrams show 7.5 wt.% (24 at.%), which is assumed to be correct in this evaluation.

In the Li-Si system, Li4Si and Li2Si are known to form by a peritectic reaction at 635 °C and a eutectic reaction at 650 °C, respectively [Shunk]:

\[
\begin{align*}
\text{p}_1: \text{L} (47.46 \text{ wt.% Si}) + \text{Li}_2\text{Si} (66.84 \text{ wt.% Si}) &= \text{Li}_4\text{Si} (49 \text{ to } 50.5 \text{ wt.% Si}) + \text{Si} (50.5 \text{ to } 55 \text{ wt.% Si}) \\
&\rightarrow \text{Li}_4\text{Si} (49 \text{ to } 50.5 \text{ wt.% Si}) + \text{Si} (50.5 \text{ to } 55 \text{ wt.% Si}) \\
&\text{Li}_2\text{Si} (66.84 \text{ wt.% Si}) + \text{Si} (50.5 \text{ to } 55 \text{ wt.% Si})
\end{align*}
\]

\[
T = \text{Al}_2\text{Li}_3\text{Si}_2 \\
\text{(Now recognized as AlLiSi)}
\]

Fig. 1 Al-Li-Si polythermal section with constant content of 2 wt.% Si. From [76Kad].
Section II: Phase Diagram Evaluations

Fig. 2 Al-Li-Si polythermal section with constant content of 5 wt.% Li. From [76Kad].

Fig. 3 Al-Li-Si polythermal section with constant content of 5 wt.% Si. From [76Kad].

Fig. 4 Al-Li-Si polythermal section with constant content of 92 wt.% Al. From [76Kad].

**Ternary Diagrams**

From a study of the solidification of several Al-Li-Si alloys, [49Boo1] and [49Boo2] showed that invariant transformations take place at a temperature approximately 8 °C lower than that of the Al-Si eutectic (577 °C). He also reported the presence of a ternary compound, as an extension of AlLi up to the formula Al$_2$Li$_3$Si$_2$ (11.2 wt.% Li and 45.2 wt.% Si). [76Kad] and [76Dri] studied the phase equilibria and phase relationships at the Al-rich corner of the Al-Li-Si system, using high-purity alloys with up to 12 wt.% Li and Si and employing thermal analysis (under controlled heating and cooling conditions) and microscopy. From polythermal sections with constant contents of 2.0, 5.0, 7.0, and 11.5 wt.% Si; 3.0 and 5.0 wt.% Li; 92 wt.% Al and sections with a Si-to-Li ratio of 2.7 (some of which are shown in Fig. 1 to 4), [76Kad] constructed the liquidus projection, which is shown as dashed lines in Fig. 5. From their microstructural examination and thermal analysis results for the polythermal sections, they established the eutectic reactions: