Al – Mn (Aluminum – Manganese)

Phase diagram
For a discussion of the phase diagram and the crystal structure of intermediate phases see [97 Kre], [94 Oka] and [97 Oka]. The phase diagram reassessed by Liu et al. [99 Liu] on the basis of recent experimental results is reproduced in Fig. 1.

An enlarged version of the Mn-rich part is given in Fig. 2 (see [96 Liu]).

By mechanically alloying of pure Al and Mg powders Suryanarayana et al. [91 Sur] succeeded in preparing solid solutions with up to 18.5 at% Mn. By aging at room temperature a metastable fcc phase is obtained with lattice parameter
\[ a = 0.4472 \text{ nm}. \]
At temperatures > 623 K the solid solution transforms into the equilibrium phase Al₆Mn.

Minamino et al. [91 Min] have investigated the solubility of Mn in (Al) at high pressure. The results are plotted in Fig. 3.

Thermodynamics
Meschel et al. [93 Mes] have determined calorimetrically the standard enthalpies of formation of Al₂Mn₃ and AlMn₄. The values are
\[ \Delta H_{298}^{\circ} = -23.4 \pm 0.8 \text{ kJ g-atom}^{-1} \text{ and} \]
\[ \Delta H_{298}^{\circ} = -15.1 \pm 1.0 \text{ kJ g-atom}^{-1}, \]
respectively.

Chastel et al. [94 Cha], using the Knudsen cell mass spectrometry, have determined thermodynamic activities of liquid Al-Mn alloys in the temperature range from 1250 K to 1550 K. The results obtained at 1520 K are plotted in Fig. 4.

Optimizing thermodynamic data and phase equilibria of the Al-Mn system, Jansson [92 Jan] obtained the following results:
1) Calculated enthalpies of mixing of liquid alloys at 1626 K, which are in very good agreement with experimental \( \Delta H^\circ \)-values found by [73 Esi] (see Fig. 5).
2) Thermodynamic activities of Al in liquid Al-Mn alloys at 1570 K. The calculated data are in good agreement with experimental \( d^\circ_{\text{Al}} \) values published by Batalin et al. [72 Bat] (see Fig. 6).
3) Solubility of Mn in fcc-Al (see Fig. 7). There is good agreement with data from different authors.
4) Calculated parts of the phase diagram (see Fig. 8 and Fig. 9). These calculated results are in agreement with experimental data, too [71 Göd], [60 Kös], [87 Mur].

At least [92 Jan] has calculated enthalpies of formation of intermediate phases. In Table 1 the results are compared with experimental data published by [60 Kub].
Table 1. Al–Mn. Calculated enthalpies of formation of intermediate phases compared with experimental $\Delta H^\circ$-values in kJ g-atom$^{-1}$. Experimental data taken from [60 Kub].

<table>
<thead>
<tr>
<th>Phase</th>
<th>$\Delta H^\circ$ Calculated [92 Jan]</th>
<th>$\Delta H^\circ$ Calculated [60 Kub]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al$_6$Mn</td>
<td>-15.00</td>
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</tr>
<tr>
<td>Al$_4$Mn</td>
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</tr>
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<td>Al$_8$Mn$_5$</td>
<td>-23.74</td>
<td>-20.71; -22.01</td>
</tr>
</tbody>
</table>

Figures

Fig. 1. Al–Mn. Phase equilibria Al-Mn reassessed by Liu et al. [99 Liu].

Fig. 2. Al–Mn. The Mn-rich part of the phase diagram in an enlarged version [96 Liu].
Fig. 3. Al–Mn. Solubility of Mn in (Al) at 0.1 MPa and 2.1 GPa [91 Min].

Fig. 4. Al–Mn. Thermodynamic activities of the components in liquid Al-Mn alloys at $T = 1520$ K [94 Cha].
**Fig. 5. Al–Mn.** Calculated enthalpies of mixing of liquid alloys at 1626 K [92 Jan] [73 Esi].

**Fig. 6. Al–Mn.** Calculated thermodynamic activities of Al at 1570 K [72 Bat] [92 Jan].
Fig. 7. Al–Mn. Solubility of Mn in fcc-Al [92 Jan].

Fig. 8. Al–Mn. Calculated Al-rich part of the phase diagram [92 Jan].

Fig. 9. Al–Mn. Calculated part of the phase diagram [92 Jan].

References