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Al-Mg-Mn (Aluminum-Magnesium-Manganese)

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The recent thermodynamic assessments of this ternary system by [2007Du] and [2009Shu] were reviewed in the update by [2009Rag]. Subsequently, [2009Ren] reported an isothermal section at 400 °C by studying Mg-rich alloys. These results supplement those given in the above references and are reviewed here briefly.

Binary Systems

The Al-Mn phase diagram depicts the following intermediate phases: $Al_{12}Mn$ ($Al_{12}W$-type cubic), Al_6Mn (Al_6Mn-type orthorhombic), λAl_4Mn (hexagonal, space group $P6_3/m$), μAl_4Mn (hexagonal, $P6_3/mmc$), $Al_{11}Mn_4$(HT) (Al_3Mn-type orthorhombic), $Al_{11}Mn_4$(LT) ($Al_{11}Mn_4$-type triclinic), Al_8Mn_5 (Al_8Cr_5-type rhombohedral), γ (34.5-52 at.% Mn; bcc), and ε (55-72 at.% Mn; cph). The Al-Mg phase diagram has the following intermediate phases: Al_3Mg_2 (Al_3Mg_2-type cubic, labeled β), R or ε (rhombohedral) and $Al_{12}Mg_{17}$ (*A*12, αMn-type cubic, denoted γ). There are no intermediate phases in the Mg-Mn system.

Ternary Isothermal Section

With starting metals of 99.99% purity, [2009Ren] induction-melted four ternary alloys with Mg contents in the range of 65 to 88 at.%. A diffusion couple of Mn with a 55Mg-45Al (at.%) master alloy and the four ternary alloys were annealed at 400 °C for 446 or 672 h and quenched in water. The annealing experiments revealed tie-lines between (Mg) and (βMn) and between (Mg) and $Al_{11}Mn_4$(LT), but not between (Mg) and the intervening Al-Mn phase Al_8Mn_5. [2009Ren] attributed this to the very slow formation of Al_8Mn_5 and tentatively included this phase in the isothermal section constructed by them. This view is in line with the thermodynamic calculations of [2007Du], which show that the tie-line between (Mg) and Al_8Mn_5 is stable at 400 °C. However, there is the other possibility that a transition reaction in the solid-state (not revealed in the thermodynamic description) (Mg) + $Al_8Mn_5 \leftrightarrow$ (βMn) + $Al_{11}Mn_4$(LT) could have occurred above 400 °C. A narrow tie-triangle of Al_8Mn_5 + (βMn) + $Al_{11}Mn_4$(LT) along the Al-Mn side produced by this reaction would then preclude the equilibrium between (Mg) and Al_8Mn_5. The isothermal section constructed by [2009Ren] at 400 °C is shown unmodified in Fig. 1, in combination with the computed results of [2007Du] for Al-rich alloys.

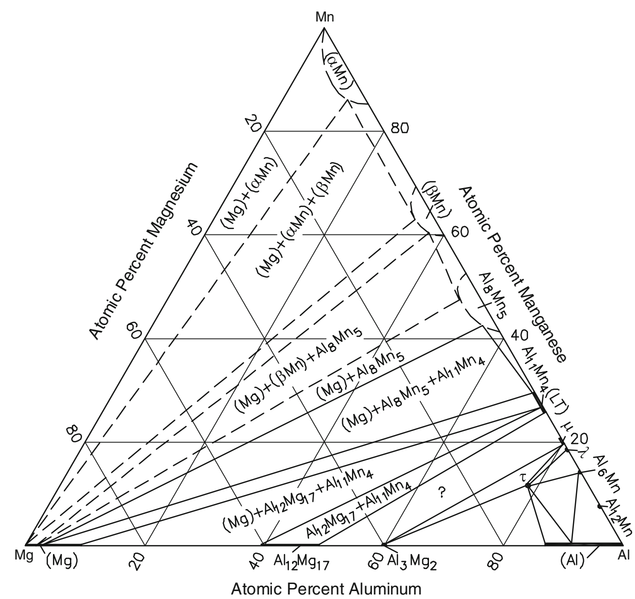

Fig. 1 Al-Mg-Mn isothermal section at 400 °C [2009Ren, 2007Du]

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