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Al-Cu-Mg-Zn (Aluminum-Copper-Magnesium-Zinc)

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[2002Mur] developed a thermodynamic description of this quaternary system and computed a liquidus and a solidus projection and three isothermal sections at 460 °C. The isothermal sections were compared with the experimental results of [1947Str, 1956Wri]. [1991Kuz] determined two vertical sections at 6Zn-0.5Cu and 6Zn-1Cu (in mass%).

Ternary Systems

Updates on Al-Cu-Mg, Al-Cu-Zn and Al-Mg-Zn ternary systems appear in this issue. For the Cu-Mg-Zn system, [1997Lia] computed three isothermal sections at 800, 600, and 400 °C, a liquidus projection and several vertical sections. The vertical sections were compared with the published experimental data. In the Al-Cu-Mg system, four ternary phases are known: $Al_7Cu_3Mg_6$ (cubic, denoted Q), Al_2CuMg (BRe_3-type orthorhombic, denoted S), $(Al_xCu_{1-x})_{49}Mg_{32}$ ($0.76 < x < 0.91$) (cubic, denoted T), and $Al_5Cu_6Mg_2$ (Mg_2Zn_{11}-type cubic, denoted V). Further, along the 33.3 at% Mg line, all three Laves modifications occur. In the Al-Cu-Zn system, a ternary phase with rhombohedral symmetry and with the nominal composition Al_4Cu_3Zn (denoted τ) is known. A low-temperature form of τ (denoted τ′) is stable between 400 and room temperature. In the Al-Mg-Zn system, the T phase is cubic (space group $Im\bar{3}$) and has the nominal composition $(Al,Zn)_{49}Mg_{32}$. The φ phase has the nominal formula $Al_4Mg_{11}Zn_5$. The Laves phase $MgZn_2$ dissolves a few percent of Al.

Quaternary Phase Equilibria

[2002Mur] treated the T phase variants separately as $(Al,Cu)_{49}Mg_{32}$, $(Al,Zn)_{49}Mg_{32}$, and $(Al,Cu,Zn)_{49}Mg_{32}$ and derived Gibbs energy functions assuming a fixed composition for each variant. Similarly, the Mg_2Zn_{11} binary phase, the isomorphous V phase of the Al-Cu-Mg system, and the isomorphous quaternary phase Z were treated as separate phases. The Laves phases $MgCu_2$, $MgZn_2$, and the quaternary Laves solid solution were also treated as separate phases. As an approximation, all these phases were assigned a fixed composition and the Gibbs energy functions were derived. The details of the thermodynamic modeling and of the selection of experimental input data were not given. The computed liquidus and solidus projections of the subsystems Al-Mg-Zn and Al-Cu-Zn were given.

For the quaternary system, [2002Mur] plotted computed liquidus and solidus surfaces as projections from the Al

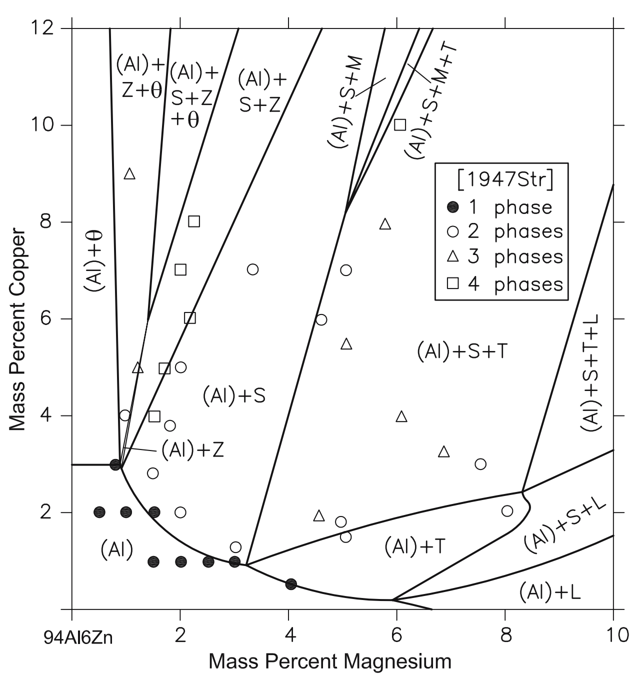

Fig. 1 Al-Cu-Mg-Zn computed isothermal section at 6 mass% Zn and 460 °C [2002Mur]

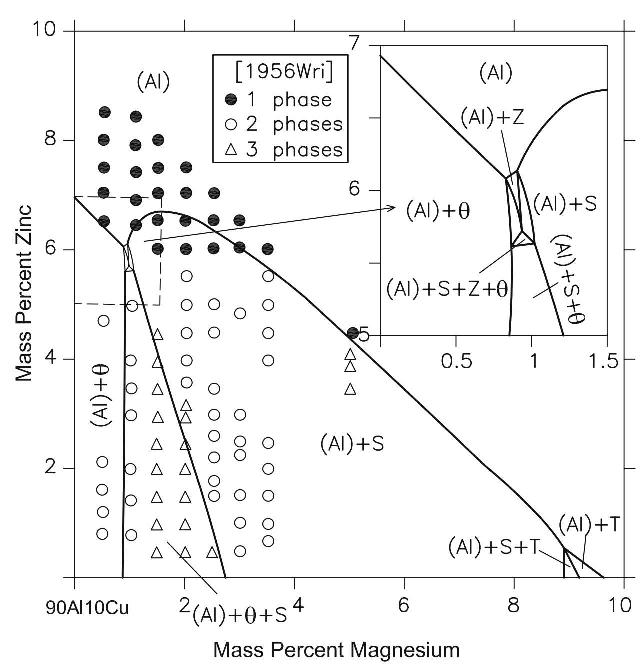

Fig. 2 Al-Cu-Mg-Zn computed isothermal section at 90 mass% Al and 460 °C [2002Mur]

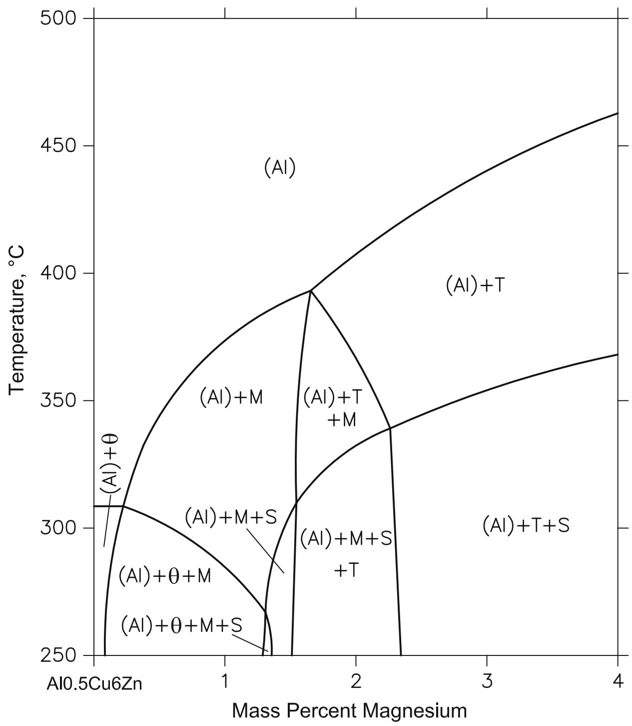

Fig. 3 Al-Cu-Mg-Zn polythermal section at 0.5Cu-6Zn (in mass%) [1991Kuz]

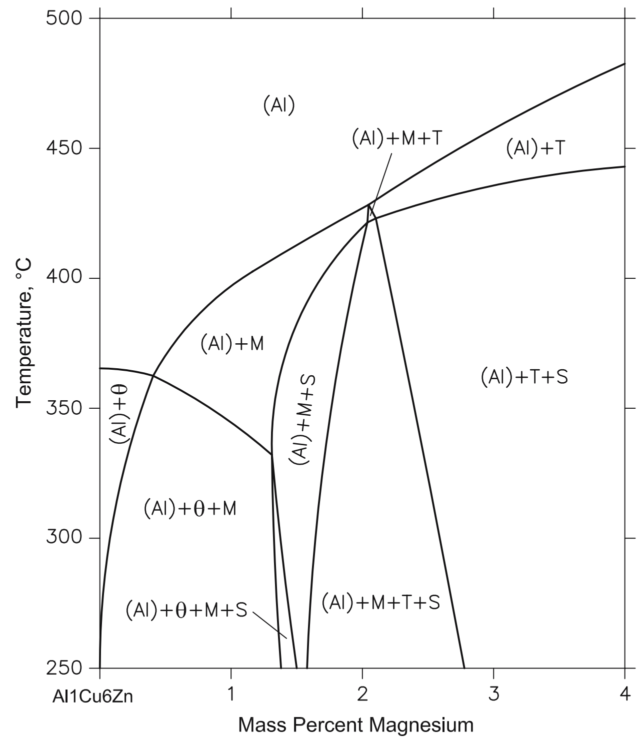

Fig. 4 Al-Cu-Mg-Zn polythermal section at 1Cu-6Zn (in mass%) [1991Kuz]

apex on to the base, where compositions of the solute (Cu, Mg and Zn) were normalized to total solute. The quaternary invariant reactions on the liquidus surface were listed with the computed reaction temperatures and compositions of the liquid and the (Al) solid solution. The liquidus and solidus surfaces depict separate regions for the three variants of the T phase and of the Laves phases. No direct comparison of the surfaces with the experimental data could be done.

[2002Mur] also computed three isothermal sections at 460 °C and compared them with the available experimental data. Figure 1 is a computed isothermal section at 6 mass% Zn and 460 °C, compared with the experimental data of [1947Str]. Figure 2 is an isothermal section at 90 mass% Al and 460 °C, compared with the experimental data of [1956Wri]. The third isothermal section was at 80 mass% Al, compared with the data of [1956Wri] (not shown here). The reasonable agreement with experimental results seen in Fig. 1 and 2 justifies the assertion of [2002Mur] that the model provides an interim tool for application to industrial problems, pending more experimental information about the separate existence of isomorphous phases and their homogeneity ranges.

[1991Kuz] studied the phase equilibria of this quaternary in the solid state, by determining the phases present in three alloys. The alloys contained a constant Cu of 1 mass%, Mg of 1.6 mass%, and 4, 6 and 8 mass% Zn, respectively. The alloys were annealed for 100 h at temperatures between 460 and 320 °C. The polythermal sections constructed by [1991Kuz] at 0.5Cu-6Zn and 1Cu-6Zn (in mass%) are shown in Fig. 3 and 4.

[2000Kra] calculated isothermal sections of this quaternary system for solidification under nonequilibrium conditions as a function of cooling rate.

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