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Al-Mg-Nd (Aluminum-Magnesium-Neodymium)

V. Raghavan

Among the previous work on this system, [1981Zar] determined a partial isothermal section at 400 °C for Nd concentration up to 33.3 at.%. More recently, [1988Odi] determined a full isothermal section at 400 °C. [1996Odi] constructed a liquidus projection and several pseudobinary sections in the Al-Mg-$NdAl_2$ region.

Binary Systems

The Al-Mg phase diagram [1998Lia] has the following intermediate phases: Mg_2Al_3 (cubic, labeled β), R or ε (rhombohedral), and $Mg_{17}Al_{12}$ (*A*12, αMn-type cubic, denoted γ). The Al-Nd phase diagram reassessed with new additional experimental input by [2005Gao] shows the following intermediate compounds: Nd_3Al ($D0_{19}$, Ni_3Sn-type hexagonal), Nd_2Al (*C*23, Co_2Si-type orthorhombic), NdAl (ErAl-type orthorhombic), $NdAl_2$ (*C*15, $MgCu_2$-type cubic), $\alpha NdAl_3$ (Ni_3Sn-type hexagonal), $\beta NdAl_3$ (stable between 1205 and 888 °C), $NdAl_4$ or βNd_3Al_{11} ($D1_3$, Al_4Ba-type tetragonal), and αNd_3Al_{11} (αLa_3Al_{11}-type orthorhombic). The Mg-Nd phase diagram [2005Gor] depicts the following intermediate phases: $Mg_{41}Nd_5$ ($Mg_{41}Ce_5$-type tetragonal), Mg_3Nd ($D0_3$, BiF_3-type cubic), Mg_2Nd (*C*15, $MgCu_2$-type cubic), and MgNd (*B*2, CsCl-type cubic).

Ternary Phase Equilibria

With starting metals of 99.995% Al, 99.95% Mg and 99.98% Nd, [1988Odi] arc-melted 87 alloys and annealed them at 400 °C for 480 h. The phase equilibria were studied mainly by x-ray powder diffraction. The isothermal section at 400 °C constructed by [1988Odi] is redrawn in Fig. 1 to comply with the accepted binary data. Mg_2Nd is not stable at 400 °C. It is possible that the phase based on Mg_2Nd (labeled λ here) is stable in the ternary region only. The phase relationships in this region shown in Fig. 1 are tentative. A ternary compound $Al_2Mg_{0.88}Nd_{0.12}$ (denoted τ in Fig. 1) is stable at this temperature. It has the $MgZn_2$-type hexagonal structure, with the lattice parameters of a = 0.5526 nm and c = 0.8922 nm [1988Odi].

In addition to the alloys used by [1988Odi], more recently [1996Odi] prepared 60 more alloys by the same procedure. The phase equilibria were studied with metallography, differential thermal analysis, and x-ray powder

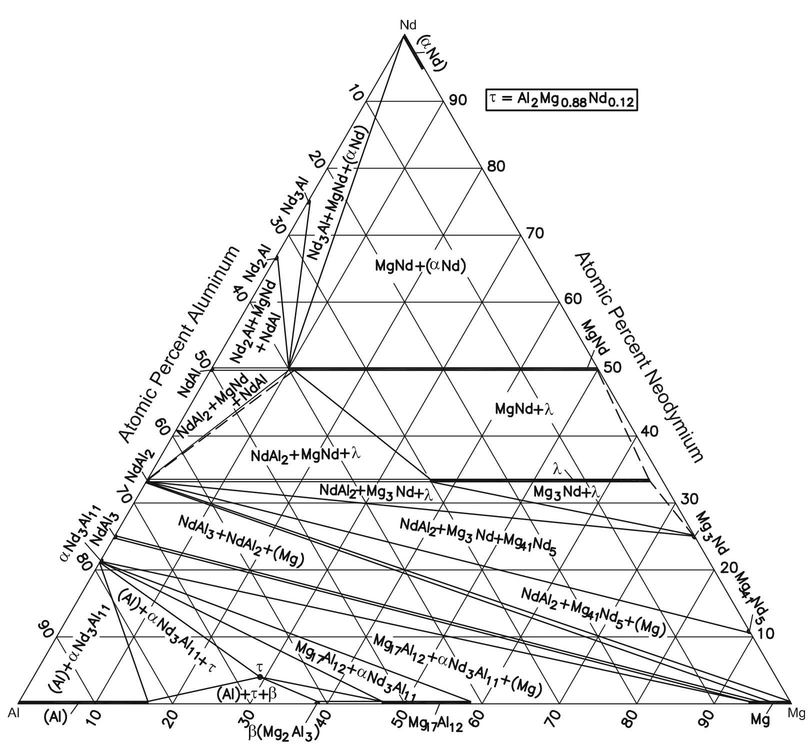

Fig. 1 Al-Mg-Nd isothermal section at 400 °C [1988Odi]. Narrow two-phase regions are omitted

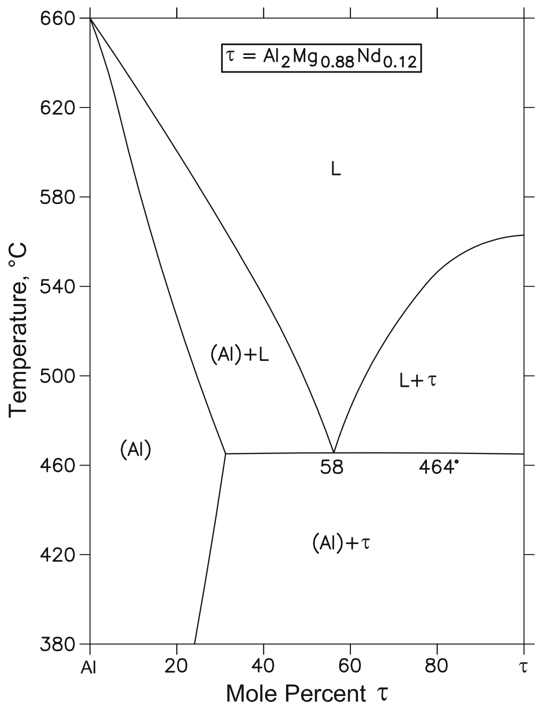

Fig. 2 Al-Mg-Nd pseudobinary section along the Al-τ join [1996Odi]

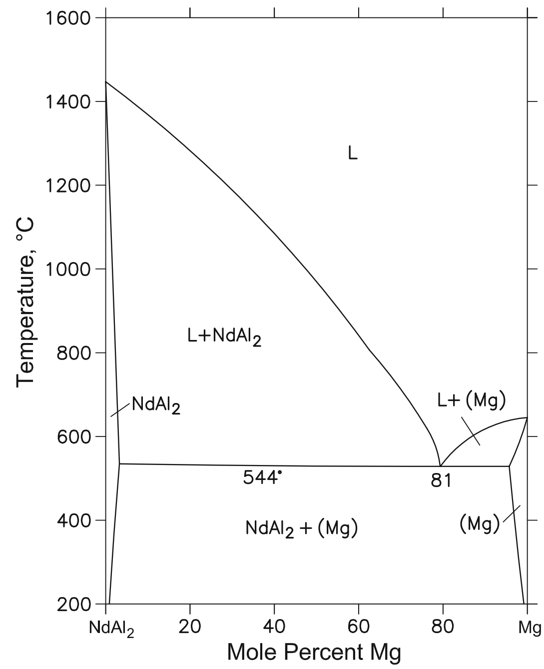

Fig. 3 Al-Mg-Nd pseudobinary section along the $NdAl_2$-Mg join [1996Odi]

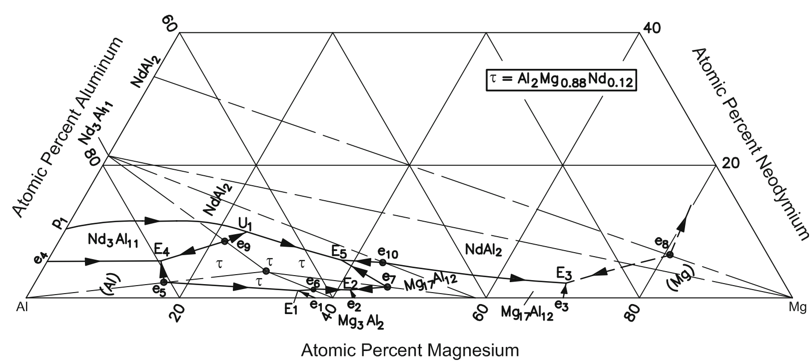

Fig. 4 Al-Mg-Nd liquidus projection in the Al-Mg-$NdAl_2$ region [1996Odi]

diffraction. Four pseudobinary sections of the simple eutectic type were determined by [1996Odi] along Al-τ, τ-Mg_2Al_3, τ-$Mg_{17}Al_{12}$, and $NdAl_2$-Mg joins. The sections along Al-τ and $NdAl_2$-Mg joins are redrawn in Fig. 2 and 3. The eutectic temperatures for the τ-Mg_2Al_3 and τ-$Mg_{17}Al_{12}$ sections (not shown here) are 439 and 440 °C, respectively. The eutectic compositions are 75 mol% Mg_2Al_3 and 62 mol% $Mg_{17}Al_{12}$, respectively [1996Odi].

The liquidus projection determined by [1996Odi] for the Al-Mg-$NdAl_2$ region is redrawn in Fig. 4. The final solidification in the Al-Mg_2Al_3-τ, Mg_2Al_3-$Mg_{17}Al_{12}$-τ, $Mg_{17}Al_{12}$-Mg-Nd_3Al_{11}, Al-Nd_3Al_{11}-τ, and $Mg_{17}Al_{12}$-Nd_3Al_{11}-τ subregions are through ternary eutectic reactions E_1, E_2, E_3, E_4, and E_5 respectively, all occurring between 435 and 438 °C.

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