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# Al-Fe-Mg-Mn-Si (Aluminum-Iron-Magnesium-Manganese-Silicon)

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The early investigation of this quinary system was by [1950Phr]. Barlock and Mondolfo [1975Bar] established the solid-state phase distribution in Al-rich alloys with 0.5 mass % Fe and Mn > Fe. Yan et al [2001Yan] presented a computed isopleth at constant mass % of 0.28 Fe, 0.34 Mn and 0.1 Si. Most recently, refining the quaternary assessments, [2005Du] provided a thermodynamic description of this quinary system and applied the same for describing the microstructural evolution in A356.1 and A356.2 commercial Al alloys.

## Quaternary Systems

Updates on the Al-Fe-Mg-Si and Al-Fe-Mn-Si systems appear in this issue [1950Phr] found no quaternary phase in the Al-Fe-Mg-Mn and Al-Mg-Mn-Si systems [2005Du] synthesized the thermodynamic parameters of these two quaternaries and the Fe-Mg-Mn-Si quaternary from the constituent ternary subsystems.

[1975Bar] prepared about 60 Al-rich quinary alloys with the compositions in the commercial range: Fe ≤ 1 %, Mg ≤ 10 %, Mn ≤ 2 % and Si ≤ 12 % (in mass %). The phase distribution in the solid state determined by [1975Bar] is shown in Fig. 1, valid for alloys with Fe~0.5 mass % and Mn > Fe. Any point within the triangle gives the relative concentration of Mg, Mn and Si in Al-rich alloys with 0.5 mass % Fe. With the condition Mn > Fe, Fe is dissolved in $MnAl_6$ and $Mn_2SiAl_9$ and occurs as the quaternary compound $Fe_2Mg_7Si_{10}Al_{18}$ (π). If Fe > Mn, [1975Bar] found that the Fe-containing binary and ternary compounds $FeAl_3$, $\alpha Al_8Fe_2Si$ and $\beta Al_5FeSi$ also appear.

Figure 2 shows an isopleth at 0.28Fe-0.34Mn-0.1Si (in mass %) computed by[2001Yan], using a multicomponent Al alloy database. In the commercial alloy A5182, the Mg content is about 5 mass %. The sequence of phase formation during cooling in this alloy is $L \rightarrow L + (Al) \rightarrow L + (Al) + FeAl_3 \rightarrow L + (Al) + FeAl_3 + Mg_2Si \rightarrow (Al) + FeAl_3 + Mg_2Si \rightarrow (Al) + FeAl_3 + Mg_2Si + MnAl_6$.

Du et al [2005Du] investigated the microstructure and microsegregation in an A356.1 alloy (91.95Al-0.46Fe-0.3Mg-0.32Mn-6.79Si, in mass %), by a directional solidification experiment at a growth rate 0.4445 mm $s^{-1}$ and a temperature gradient of 45 K $cm^{-1}$. The fraction of phases and the solute distribution in the phases were determined. A micromodel with equilibrium phase diagram calculations was used to predict the microstructures and microsegregation during cooling. The computed solidification and secondary dendrite arm coarsening agreed reasonably with the experimental results. Computed major reactions during solidification under nonequilibrium conditions for A356.1 and A356.2 commercial alloys showed reasonable agreement with the experimental results.

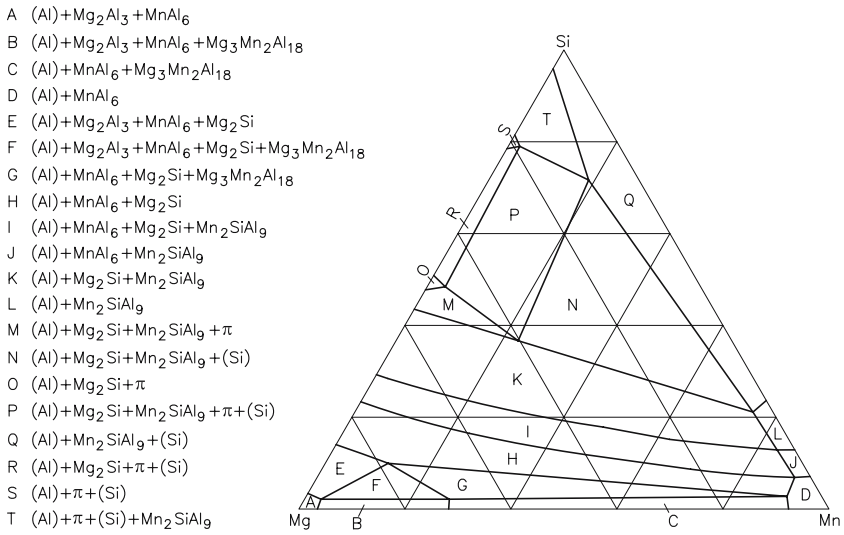


**Fig. 1** Al-Fe-Mg-Mn-Si phase distribution in the solid state. Points within the triangle give the relative concentration of Mg, Mn and Si in Al-rich alloys with 0.5 mass % Fe and Mn > Fe [1975Bar]

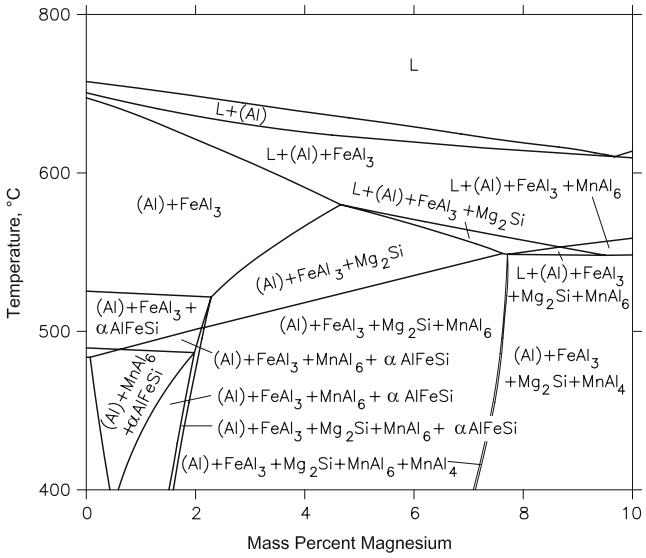


**Fig. 2** Al-Fe-Mg-Mn-Si computed isopleth at 0.28Fe-0.34Mn-0.1Si (in mass %) [2001Yan]

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