KINETICS OF PRECIPITATION IN MAGNESIUM-ALUMINUM ALLOYS FROM ANALYSIS OF HIGH TEMPERATURE X-RAY DIFFRACTION DATA

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Using *in situ* high temperature x-ray diffraction, alloys AM60B (die cast) and AZ91D (gravity cast) were shown to precipitate significant volume fractions of $Mg_{17}Al_{12}$ β-phase within the temperature regime of interest (175 - 325 C). The fine grain size of the die cast AM60B permitted the x-ray diffraction data to be analyzed by a quantitative Rietveld analysis using the GSAS program, wherein two coexisting phases were defined as the hexagonal close-packed solid solution Mg-Al (space group P63/mmc) and the cubic β-phase $Mg_{17}Al_{12}$ (space group I-43m).

The refinement strategy was to begin with the as-cast pattern at room temperature and refine the background (3 coefficients), the histogram scale factor (1 coefficient), the lattice parameters of the two phases (1 and 2 coefficients, respectively), and the phase fractions (1 coefficient). The profile parameters and diffractometer constants were established for these samples and experimental conditions and fixed accordingly. For the first pattern at a given temperature, both of the phases' lattice parameters were allowed to be refined, but in subsequent patterns the lattice parameter of the β-phase $Mg_{17}Al_{12}$ was constant, while that of the h.c.p. matrix changed as the solid solution composition reached its equilibrium value. Thus the refined parameters for one scan were used as the starting parameters for the next scan, which minimized the time to converge to a solution. For the purpose of this investigation, a refined χ^2 of between 4 and 8 was deemed an acceptable target for estimation of lattice parameters and phase fraction.

For temperatures of 250 C or less, the volume fraction of the β-phase was observed to grow rapidly during the start of the anneal and then asymptotically approach the equilibrium volume fraction. The volume fractions were input to an adapted Avrami equation. The resulting fit parameters can be used to predict the amount of precipitation that will occur under given service or aging conditions. At temperatures of 275 C or more, it was observed that the as -cast β-phase actually dissolved back into solution.

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