Research Programs

Microstructure Evolution in Magnesium Casting Alloys

Research Team:

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The goal of this project is to characterize the solidification paths and the as-cast microstructures of commercial magnesium foundry alloys. A combination of microstructure and cooling curve analyses were used to establish the various reaction temperatures and the phases involved in the solidification of magnesium foundry alloys. Moreover, quenched samples were examined at various stages during their solidification in order to completely characterize the evolution of microstructure and to study specific solidification events in magnesium foundry alloys. Dendrite coherency, and other casting characteristics of magnesium casting alloys was investigated. This research resulted in a compilation of data that is a valuable guide for users of magnesium foundry alloys as well as alloy designers. As an integral part of this research, equipment for non-equilibrium thermal analysis of Mg alloys was designed, built and tested (Figure 1). Figure 2 shows an example of the thermal data obtained from the equipment shown in Figure 1, and Figure 3 shows an example of the micrographs used in conjunction with thermal analysis to characterize the solidification behavior of magnesium alloys.

Publications

Y.W. Riddle and M.M. Makhlouf, "Characterizing Solidification by Non-Equilibrium Thermal Analysis," Magnesium Technology 2003, edited by H.I. Kaplan, The 132nd TMS Annual Meeting, pp. 101-106, San Diego, California, March 2003.

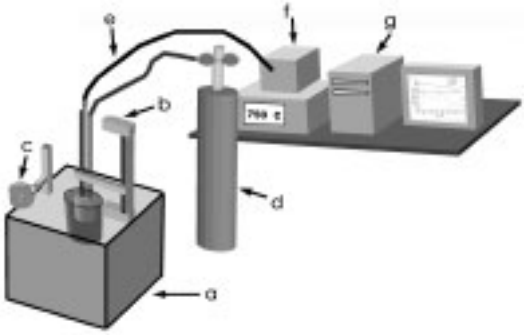

Figure 1 Thermal analysis and data collection/analysis equipment. (a) furnace, (b) crucible loading and holding arm, (c) cooling rate control coil, (d) cover gas, (e) thermocouples, (f) data collection, (g) computer.

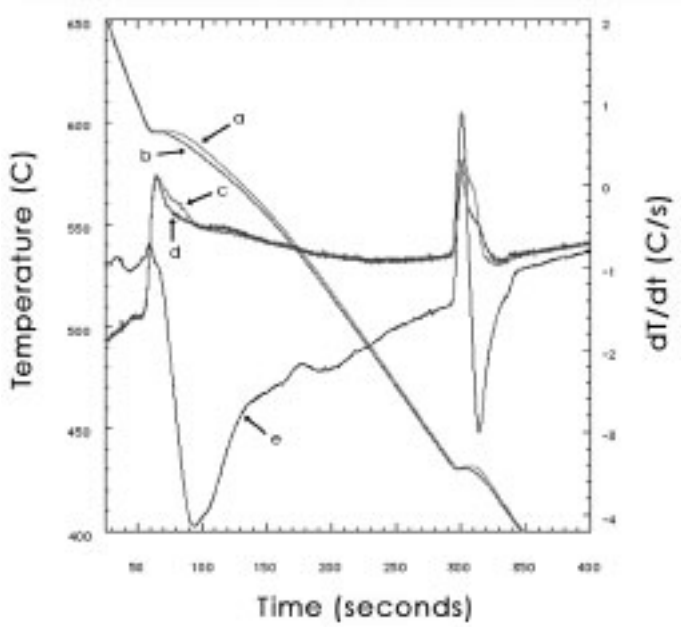

Figure 2 Thermal analysis of AZ91E solidification. (a) T_c, (b) T_w, (c) dT_c/dt, (d) dT_w/dt, and (e) $\Delta T=T_w-T_c$.

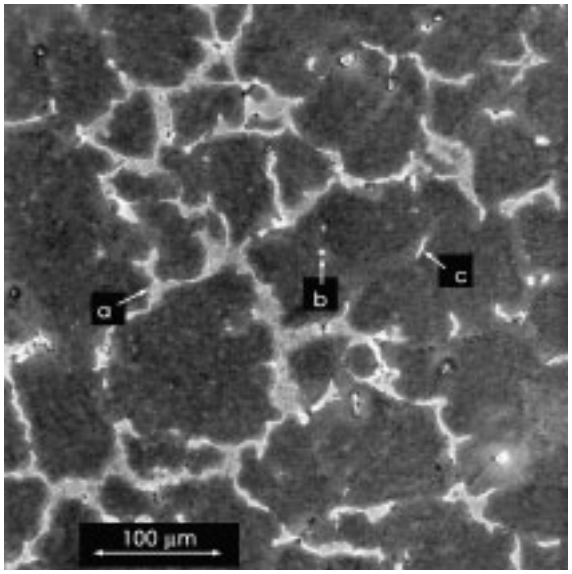

Figure 3 SEM image of as-cast AZ91E indicating (a) β-$Al_{12}Mg_{17}$, (b) sphere-like (at%) 1Mg-54Al-45Mn phase, (c) needle-like (at%) 13Mg-61Al-25Mn phase.