ALUMINUM SCANDIUM

AMG Aluminum has developed and commercialized a proprietary method to manufacture aluminum scandium master alloys. High quality Al-2% Sc products are available in standard waffle ingot form; however, the manufacturing process is sufficiently adaptable to satisfy specific product requirements of the advanced aluminum alloy design community. Due to the rapid dissolution and excellent recovery, binary hypereutectic Al-2% Sc master alloy waffles are ideally suited to meet the needs of aluminum companies that manufacture alloys for aerospace and other high performance alloy applications. Demand for high performance sports equipment and aerospace applications have generated an increased demand for Al-Sc master alloys. Developments of both ingot-cast and shape-cast aluminum alloys that contain scandium at concentrations of 0.01% to 1% or higher are ongoing.

In the early 1960s[1] the international metallurgical community recognized the potential of scandium in controlling microstructure of aluminum alloys. It is known that the decomposition of supersaturated Al-Sc solid solutions leads to the formation of the fully coherent, $L1_2$ Al_3Sc phase. As a consequence, Al_3Sc precipitates as an extremely fine, homegeneously distributed (<20 nm typically) and elastically hard intermetallic compound, in number densities approaching those observed for GP zones (i.e. greater than 1×10^{16} cm^{-3}). In addition, the diffusivity of scandium in aluminum is relatively low and Al_3Sc has a small elastic misfit with the aluminum matrix. Thus, the strengthening phase is highly resistant to diffusional growth and coarsening at elevated temperatures. Because scandium possesses a relatively high solubility in aluminum, it is capable of providing combinations of strength, toughness, and microstructure control that were previously unobtainable via conventional alloying and processing methods. Scandium additions to aluminum provide the highest strength increase of any element on an atomic fraction added basis, and Al_3Sc is among the most potent inhibitors of recrystallization and grain growth.

Significant improvements in properties of commercial 5XXX, 7XXX and other high performance alloys have been achieved through scandium additions in response to increased demands for structural efficiency in aircraft and aerospace components as well as other applications. AMG Aluminum is a leading supplier of aluminum scandium master alloys to meet the growing demand for high strength, high performance applications.

[1] L.A. Willey U.S. Patent 3,619,181 (1971)

Product Specifications

- Al-2% Sc is a hypereutectic binary master alloy containing primary Al_3Sc crystals as the second phase as shown in Figure 1
- Low residual impurity level as demanded for critical aerospace applications
- Waffle ingot (to facilitate alloying)
- Weight approximately 17 lbs (7.7 kg)

Performance

- The fine scale of the as cast microstructure provides for excellent Sc recovery and fast master alloy dissolution using conventional alloying practices
- Figure 2 shows complete dissolution of scandium was achieved within 2 minutes
- T_{mp} (659°C) 1220°F; T_{liq} (805°C) 1480°F

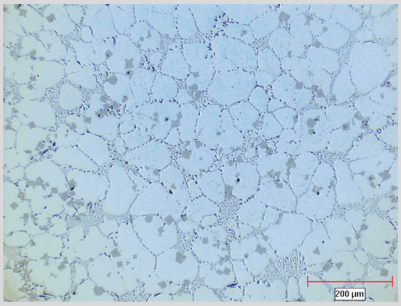
Typical Metallography

- D50 (Al_3Sc) <20 µm
- D99.5 (Al_3Sc) <75 µm
- Cuboidal/Octocuboidal morphology of primary Al_3Sc phase (Figure 3)

Chemistry by Weight %

- Sc 2.0±0.3; Fe 0.05 max.; Si 0.05 max.
- Others each 0.05; Others total 0.15;
- Aluminum balance

Typical Micro Structure at (100X)
(Figure 1)



Al-2% Sc master alloy, as cast ingot microstructure. Discrete cuboidal phase is Al_3Sc, and lamellar structure is evidence of the discontinuous precipitation of Al_3Sc during ingot processing.

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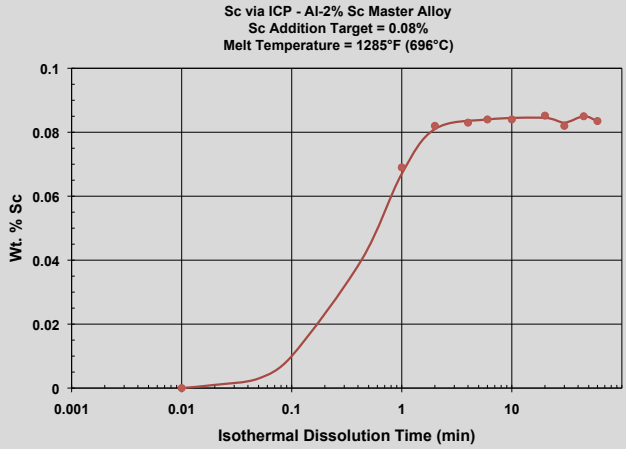
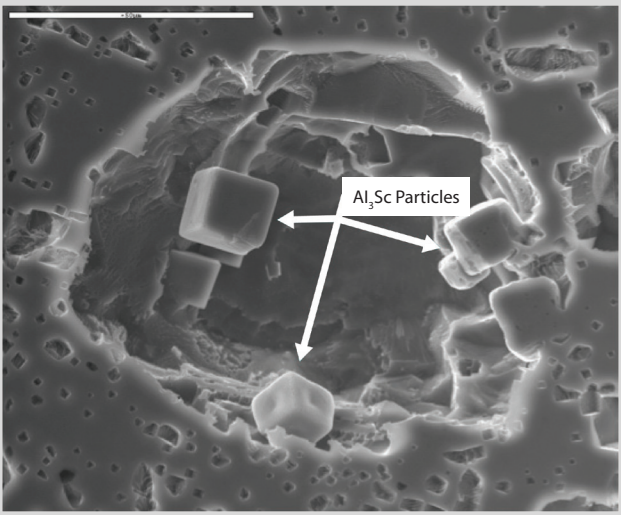
Typical Dissolution and Recovery of Scandium

(Figure 2)



SEM Micrograph of Al_3Sc

(Figure 3)



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