KB Alloys

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Aluminum – Scandium – Master Alloy

KB Alloys has recently developed a proprietary method to manufacture conventional ingot metallurgy based aluminum-scandium master alloys. These alloys are designed to support the development of new and emerging aerospace and high performance aluminum alloys containing the element scandium. Currently an Al-2% Sc product available in standard waffle ingot form but the manufacturing process is sufficiently adaptable to meet the specific product requirements of the advanced aluminum alloy design community.

The international physical metallurgical community recognized the potential impact of scandium in controlling microstructure development and evolution of aluminum alloys in research conducted in the late 1950's and early 1960's[1]. It is now known that the decomposition of supersaturated Al-Sc solid solutions leads to the formation of the fully coherent, $L1_2 Al_3Sc$ phase (Figure 2). As a consequence, Al_3Sc precipitates as an extremely fine, homogenously 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 Sc 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 higher solubility in aluminum than many other transition and rare earth metal aluminide forming elements, it is capable of providing combinations of strength, toughness and microstructure control that were previously unobtainable via conventional alloying and processing methods. Sc 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 yet discovered.

Significant improvements to commercial 7XXX, 5XXX and related alloys have been developed through scandium additions in response to increasing demands in structural efficiency by air framers, aerospace designers, and developers of advanced commercial products. Through this development, KB Alloys is positioned to supply scandium master alloy products to meet the growing demand for high strength, high performance applications.

Product Specifications:

- Al-2 wt% Sc is a hypereutectic binary master alloy containing primary Al_3Sc crystals as the second phase (see Figure 2)
- Low residual impurity level as demanded for critical aerospace applications
- Waffle ingot 1.75" x 9" x 18" (45 x 230 x 460mm)
- Weight Approximately 17 lbs. (7.7 Kg.)

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

Performance

- The fine scale of the as cast microstructure provides for excellent Sc recovery and fast master alloy dissolution kinetics in conventional alloy practices.
  (See Figure 1)

Typical Metallography

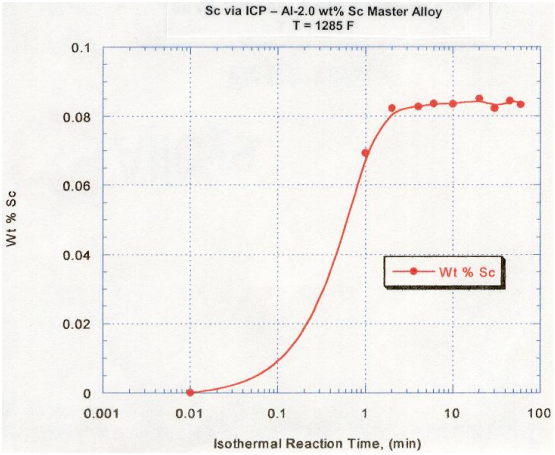
- D_{50} (Al_3Sc) <20 µm
- $D_{99.5}$ (Al_3Sc) < 75 µm
- Cuboidal/Octocuboidal morphology of primary phase (see micrograph) and limited decomposition via the cellular reaction

Chemistry

Sc 2.0±0.3; Fe 0.05 max., Si 0.05 max., Others Ea 0.05; Others Total 0.15; Aluminum Balance (P0404)

Typical Dissolution/Recovery

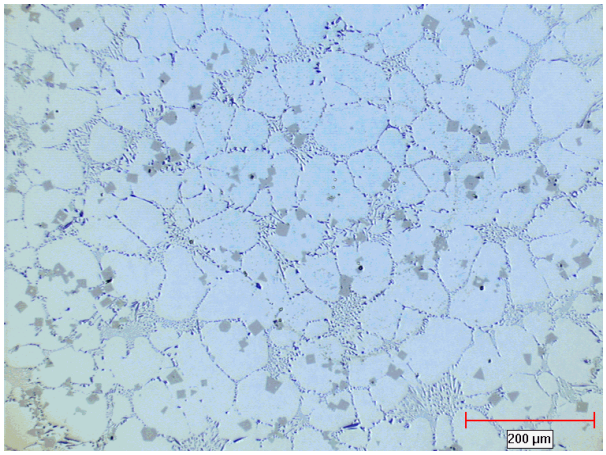
(Figure 1)



Target addition of 0.08 wt% Sc .

Typical Micro Structure at (100X)

(Figure 2)



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

For additional information or technical assistance, please call toll free or visit us at our web site.

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