



Aluminum Grain Refiner Master Alloys

ALUMINUM TITANIUM BORON ALLOYS

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A RECENT SUCCESS

Minex has pioneered and patented production process of Al-TiB master alloys with uni-directional stirring induction furnace. Effective control of melt stirring during production of Al-TiB assures high degree of grain refiner particles homogeneity in aluminum matrix.

Most effective way to provide a fine and uniform as-cast grain structure is to add nucleating agents to the melt to control crystal formation during solidification. Minex has developed wide range of aluminum based master alloys, in various forms for convenient additions to aluminum melt.

Highly nucleating agents for grain refining of master alloys are alloys containing titanium and boron in aluminum matrix. Treatment with these alloys is universally accepted.

GENERAL

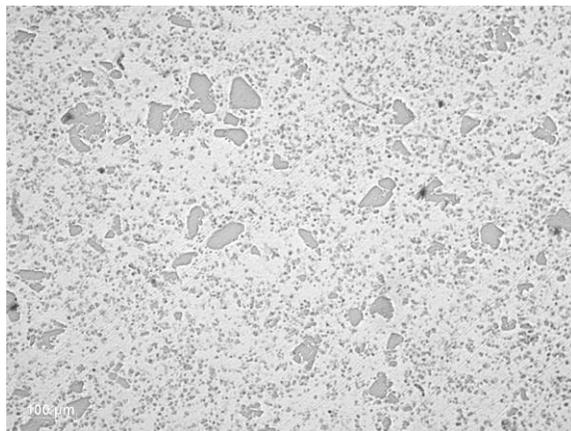
In casthouse applications, the control of grain size is essential in maintaining product consistency and quality, in reducing cost and maintaining high levels of productivity. Controlled addition of Al-TiB master alloy in aluminum releases nucleating particles that promote equiaxed, fine grained structures in cast alloys, thus restricting formation of columnar crystals. Al-TiB grain refiner alloy improves homogeneity and allows uniform distribution of alloying elements, reduce porosity and eliminate hot tearing in cast structures, improves responsiveness to subsequent heat treatment and enhance mechanical properties and machinability in the fabrication process.

There are two types of particles seen in microstructure of Al-TiB:

TiB₂ particles – grain refining nuclei – typically 1-2 microns in size, which do not dissolve in liquid aluminum

TiAl₃ plates / grains – typically 30-60 microns in size, which readily dissolved in liquid aluminum. These particles play an important role in the grain refining process.

Typical Al-TiB master alloy micrograph at 100x magnification is clearly showing TiAl₃ grain size distribution in aluminum matrix.



Al-TiB Micrograph



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After 1 min



After 3 min



After 5 min

Grain refinement with addition of 0.01% Ti addition

Grain Refinement after Al-TiB addition in aluminum melt



ADVANTAGES OF AL-TiB FOR GRAIN REFINING

Grain refinement of aluminum alloys provide number of technical and economical advantages.

Improved feeding: finer grains promote an easier flow of the molten metal feeding the shrinkage during the final stages of solidification resulting in smaller and more uniform dispersed shrinkage porosity.

Reduced ingot cracking: fine grains provide a complex network of grain boundaries, reducing the tendency of crack initiation and propagation. This results in the virtual elimination of centerline cracking in DC-cast ingots even at high casting speeds

Reduced porosity: as voids from internal shrinkage or dissolved gas are intergranular, fine grains inhibit the concentration of porous zones to improve soundness of casting

Better homogeneity: with a fine as cast grain size, second phases and impurities accumulating along the grain boundaries during solidification are finer and more uniformly distributed.

Improved mechanical properties: grain boundaries are high energy areas along which fracture cracks can initiate and propagate easily. Small randomly orientated grains minimize this tendency and provide improved ductility in the form of uniform and total elongation, reduction in area and fracture toughness. Further in some cases grain refining can provide uniform directional properties and improved machinability.

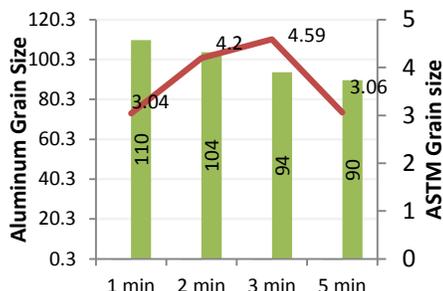
Reduced costs: improvement which results from grain refinement of the cast products result in increased yields of products and reduced product cost

PRODUCT DESCRIPTION

Al-TiB master alloy with different titanium to boron ratios from 3:1 to 5:0.2 are produced to accommodate needs users plant. Proper selection of grain refiner alloy, need consideration for chemistry of alloy to be treated, the purity and portion of scrap or secondary aluminum used, the desired grain size in the product and melting / casting process used. Minex produces Al-TiB in waffle, cast bar, cut rods and continuous rods form.

Minex's rod products are manufactured through specialised uni-directional stirring induction furnace providing effective utilisation of power to alloy output ratio and improved salt recoveries with controlled and uniform grain structures in aluminum matrix, followed by proprietary process. The grain refiner rods are suitable for continuous additions through launder for continuous casting operations. The performance of the rod products are illustrated in the adjacent photographs .

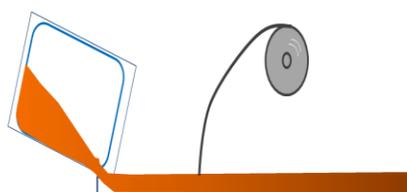
COMPOSITION OF ALLOY



ALLOY	COMPOSITION				APPLICATION
AL-TiB 5/1	Ti B	4.5-5.5 0.8-1.2	Si Fe V	0.20 0.30 0.02	Highly efficient and versatile refiner for wide range of castings
AL-TiB 5/0.2	Ti B	4.5-5.5 0.15-0.25	Si Fe V	0.20 0.30 0.02	Powerful grain refiner for boride sensitive applications as foils, canstock and surface critical profiles
AL-TiB 3/1	Ti B	2.5-3.5 0.8-1.2	Si Fe V	0.20 0.30 0.02	An efficient and cost effective refiner for many applications

AA TP1 test results

Grain refinement AA-TP1 test result: AA TP1 test is carried for 10 kgs of aluminum melt at 715 °C and 0.01% Ti is added from Al-TiB wire rod. Equal time interval samples are water quenched and results are shown.



Coiled rod additions

Technical Assistance

Minex's experienced technical and sales staff are available to assist in selection of proper grain refiner alloy and in determination of optimum amount required for the alloy to be treated.

Contact us – works

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PRODUCT FORMS

FORMS ALLOYS	COILED ROD 9.5MM	CUT ROD 9.5MM	CAST BAR	WAFFLE INGOT
AL-TiB 5/1	✓	✓	✓	✓
AL-TiB 5/0.2	✓	✓	✓	✓
AL-TiB 3/1	✓			✓

Coiled rod

9.5 mm diameter rod in standard 180 kgs coils. These are developed for addition into the metal transfer lunder in continuous or semi continuous casting operations enabling continuous grain refining within 1-2 minutes of addition. Due to its properties rod is suited for start-stop semi continuous addition in automated castings lines.

Cut rods

9.5 mm diameter rod cut into 50cm (100 gms) or 100 cm (200 gms) pieces. Ideally suited for foundries to make accurate grain refiner additions to ladle and crucibles. Combining easy handling with superior metallurgical products. Exact additions are made by simply stirring the required number of rods into the melt.

Cast bars and waffle ingots

For furnace additions Al-TiB as castbar or waffle ingot is added as the melt treatment is completed, usually within 20 minutes prior to casting ensuring reliable grain refinement of ingots.



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