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DEGASIFICATION OF Al–Zr AND Al–Ti ALLOYING COMPOSITION FOR INCREASE OF MECHANICAL PROPERTIES OF CONSTRUCTIONAL Al 27-1 ALLOY

The preliminary refining of Al–Zr and Al–Ti alloying compositions leads to increase of mechanical properties of Al27-1 alloy.

Keywords: refining, master alloys Al–Zr and Al–Ti, mechanical properties, alloy Al27-1.

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SIZE, FORM AND DISTRIBUTION OF INTERMETALLIC PARTICLES OF $TiAl_3$ IN ALUMINIUM-TITANIUM ALLOYING COMPOSITION

This article presents an evaluation of the size, form and quantity of the particles of titanium aluminide $TiAI_3$ in rod inoculating alloying composition, used in semi-continuous casting of ingots of aluminum and aluminum-based alloys.

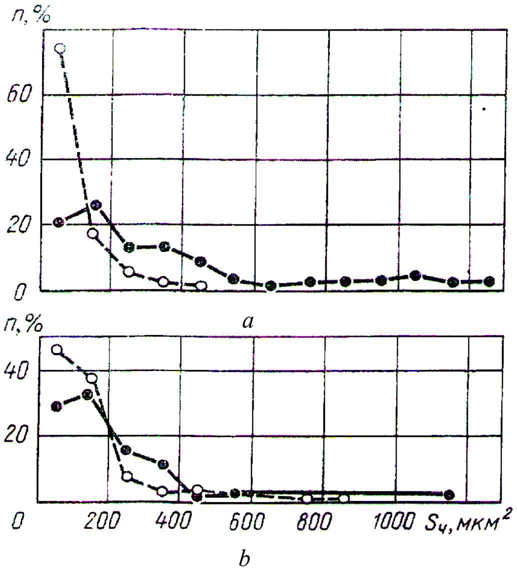
Keywords: ingots of aluminum and aluminum-base alloys, alloying compositions, titanium aluminide.

By the semi-continuous method of casting the aluminum alloys ingots for fining its structure and following improvement the technological characteristics as a consequence (that is the prevention of cracks appearance) and rising the mechanical properties of work pieces made of these ingots by methods of no cutting shaping, at the stage of preparing alloys the inoculations are added in it [1].

Using as an example known Ti- and B-containing master alloys [2] it has been shown that their quality has a strong influence on the quality of cast parts of aluminum alloys inoculated particles of $TiAl_3$ and AlB_2 that are contained respectively in these master alloys. The basic qualities indices of master alloys is the size, form and distribution of the particles of inoculating compounds.

Two master alloys containing 5.0 and 3.5 % Ti (rods with a diam. of 9.5 and 8.0 mm, respectively) produced by different methods were investigated. The area of the titanium aluminide particles was determined by the method of random intercepts [3] on specimens of cross sections of the rods (at 200×) both in the original condition and after immersion of them and holding for 60 sec in molten aluminum (700 °C) with subsequent hardening in water with ice (at 0 °C). The rods were held in molten aluminum for the purpose of establishing the influence of thermal action on the size of the $TiAI_3$ particles in inoculation of the master alloy in the aluminum during casting of ingots. In this case the specimens were prepared on cross sections of the rods at ~ minimum distance from the boundary of fusion of them.

The analysis of the measurement results shows that in the original rod containing 5 % Ti the quantity of titanium aluminide particles with the smallest area (0…100 μm^2) is 20.43 % (see Figure). Heating of the rod causes an increase in the quantity of particles of this size group by 3.6 times (to 74.19 %). A larger quantity of particles (29.04 %) corresponds to this range of sizes in the original bar of the master alloy with 3,5 % Ti than in the first master alloy but heating causes an increase in the quantity of them to a lesser degree (to 46.25 %).



Histograms of the distribution of the areas of titanium aluminide $TiAI_3$ particles in the inoculating rod master alloys (*n* is the frequency of cases):
a – ∅ 9.5 mm with a 5 % Ti content; *b* – ∅ 8.0 mm with a 3.5 % Ti content; • – original condition; o – after immersion of the rod in molten aluminum (700 °C) and hardening in water with ice (0 °C)

In this case it may be seen (see Figure) that the quantity of the finest titanium aluminide particles in the master alloy with 5 % Ti is 1.6 times greater than in that with 3.5 % Ti. It was also established that heating of the rods leads to solution of the coarsest particles. For example, while in the alloy with 5 % Ti the largest area of a particle in the original rod is 1 285.92 μm^2, heating causes a decrease in it by 3.1 times (to 411,84 μm^2) and in the bar of alloy with 3.5 % Ti by 1.3 times (from 1 152.00 to 881,28 μm^2). The particles of titanium aluminide are less elongated in the master alloy with 5 % Ti, which may be seen from an analysis of the ratios of the length to the width of their cross sections l / h. For example, while for the alloy with 5 % Ti after heating of the rod $l / h = 1…5$, for the alloy with 3.5 % Ti $l/h = 1…25$.

The difference in the dimensions of the titanium aluminide particles influenced the degree of refinement of the structure of a 70 × 430 mm cross section ingot case by the semicontinuous method of А6П aluminum with a withdrawal rate of 95…100 mm/min (А6П aluminum: Al ≥ 99.6 %; impurities, ≤: 0.25 % Fe; 0.18 % Si; 0.010 % Cu; 0.05 % Zn; 0.020 % Ti; total ≤ 0.40 %; П – intermediate product).

The rods were placed in te molten metal during flow of it along the runner from the mixer to the mold at a rate providing a titanium content of 0.056…0.060 %. In rating the grain structure on transverse template of the ingots it was established that without inoculation the number of grains per mm^2 of specimen area is 4.4 in the peripheral zone, 28.1 in the intermediate, and 13.1 in the center.

With inoculation of the molten material by master alloy with 5 % Ti the number of grains in these zones increases to 47.7; 74.9, and 51.6, respectively, while addition of the master alloy with 3.5 % Ti causes less of an effect of grain refinement to 38.5; 73.9, and 35.5 per mm^2, respectively.

Conclusions:

1. In heating of titanium-containing inoculating rods to the operating temperature by immersion of them in molten aluminum the size of the titanium aluminide $TiAl_3$ particles decreases, which improves the inoculation effect.

2. The effect of refinement of the structure of the aluminum in casting of ingots is greater with the use of a rod master alloy with finer and less elongated compact titanium aluminide particles.

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ВЕЛИЧИНА, ФОРМА И РАСПРЕДЕЛЕНИЕ ЧАСТИЦ ИНТЕРМЕТАЛЛИДА $TiAl_3$ В ЛИГАТУРЕ АЛЮМИНИЙ-ТИТАН

Представлена оценка величины, формы и распределения частиц алюминида титана $TiAl_3$ в прутковой лигатуре алюминий–титан, используемой при полунепрерывном литье слитков из алюминия и алюминиевых сплавов.

Ключевые слова: слитки из алюминия и алюминиевых сплавов, лигатуры, алюминид титана.