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ALUMINUM-TITANIUM MASTER ALLOYS

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1 Claim. (Cl. 75—138)

This invention relates to aluminum-titanium alloys and is particularly concerned with such alloys in which the titanium content is between about 6% and about 20%.

Titanium is extensively used in aluminum alloys as a grain refining agent. For this purpose, it is added in amounts up to about 0.25% to alloys such as those of the Al-Zn, Al-Zn-Mg and Al-Cu types. A method used widely by producers of aluminum alloys for introducing the desired amount of titanium into the alloys has been the addition to the molten alloy of so-called master alloys containing 2½%–6% titanium with the remainder aluminum. These master alloys have, prior to the present invention, been made by diluting a 50% Ti-50% Al alloy with molten aluminum at temperatures of 2200° F. to 2400° F. Since this is a relatively expensive method of preparation and since, because of the low titanium content, they must be used in rather large amounts, such master alloys have not been entirely satisfactory commercially. Use of Al-Ti alloys of this type containing more than about 6% titanium has not been feasible because of the slow rates at which such alloys dissolve in molten aluminum and aluminum alloys at the preferred working temperatures of 1300° F.–1400° F. and the low recoveries of dissolved titanium in the final alloys.

It is an object of the present invention to provide Al-Ti master alloys containing from about 6% to 20% titanium which are readily soluble in aluminum and aluminum alloys at the desired working temperatures.

Another object of the present invention is to provide Al-Ti master alloys containing from 6% to 20% titanium which have novel and useful structures.

A further object of the present invention is to provide Al-Ti master alloys containing 6% to 20% titanium which are useful for the addition of titanium to aluminum and aluminum base alloys.

Other objects and advantages of the present invention will be apparent from the following description thereof.

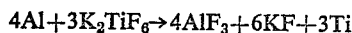
It has been discovered that, unlike the master alloys discussed above, Al-Ti master alloys containing about 6% to 20% titanium which are produced by a process of an entirely different type not hitherto used for this purpose readily dissolve in molten aluminum and aluminum alloys at the normal working temperatures of 1300° F.–1400° F. These soluble master alloys, it has been found, have a structure that is quite unlike the structure of Al-Ti alloys of similar composition formed by mixing the molten metals.

The difference in structure mentioned above is readily seen by comparison under the microscope of unetched specimens of the two types of alloys. In so examining Al-Ti master alloys made by the process of the present invention it will be observed that the intermetallic compound Al₃Ti appears as light particles which are relatively small and nodular or rounded in shape. In contrast, the Al₃Ti particles in an Al-Ti master alloy made by the previously used method of diluting a 50% Ti-50% Al alloy with molten aluminum at temperatures between 2200° F. and 2400° F. are large and acicular or

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needle-like. This is found to be the case even though the titanium contents of the two alloys are approximately identical. Moreover, it has been ascertained that the same difference in structure is found in alloys of the two types where the titanium contents range from approximately 20% down to about 6%, the Al₃Ti particles in alloys produced by the present process being present essentially in nodular or rounded form.

The novel master alloys of the present invention are produced by reacting an alkali-metal fluotitanate such as K₂TiF₆ with aluminum. While the precise reaction involved is not certain, it is believed that it may proceed with some of the aluminum according to the following equation:



The titanium thus liberated combines, of course, with aluminum to form the intermetallic compound Al₃Ti.

The following examples illustrate the use of the above-described method in producing novel Al-Ti master alloys according to the present invention.

Example 1

46 parts of aluminum was melted in a graphite crucible and 25.5 parts of potassium fluotitanate (K₂TiF₆) was added thereto in small increments with stirring, the temperature of the bath being maintained at about 1500° F. or above. After all the K₂TiF₆ was mixed in, the molten spent salt on top of the bath was ladled off and the metal was poured into cast-iron ingot molds. The ingots thus produced were analyzed and found to contain 6.3% titanium.

Example 2

Aluminum (90 parts) was melted in a graphite crucible and brought to a temperature of 1600° F. To the molten metal there was added 50 parts of K₂TiF₆ in increments with stirring after each addition. When the addition was completed the supernatant spent salt was decanted from the crucible and the metal was poured into cast iron ingot molds. Analysis of the ingots showed an 11.6% titanium content.

Example 3

Forty parts of aluminum was placed in a graphite crucible and heated to 1300° F. Then 51 parts of K₂TiF₆ was added, a little at a time, to the molten aluminum while maintaining the temperature. The K₂TiF₆ was stirred into the bath and when the addition was completed the crucible and contents were allowed to cool. The pig or ingot of metal removed from the cooled crucible was analyzed and 19.1% Ti was found.

In tests of novel master alloys produced in accordance with the present invention it has been found that, when added to molten aluminum at temperatures of 1300° F.–1400° F., they dissolve readily and give high recoveries of dissolved titanium. In a number of such tests the dissolved titanium content of the finished aluminum alloys averaged 95% of theoretical content based on the amount of master alloy added. Comparative tests employing master alloys containing from 6%–20% Ti made by dilution of 50% Al-50% Ti alloys showed recoveries of between 20% and 10% (average 14%) of theoretical. Solution of the latter master alloys was very slow in all cases and in a test with such a master alloy containing 27% Ti the master alloy did not even melt.

It will be evident from the foregoing that by the present invention there are provided novel and improved Al-Ti master alloys which are quite useful as alloying addition agents. These novel master alloys are characterized by being readily soluble in molten aluminum and aluminum alloys at the normal working temperatures of 1300° F.–1400° F. with resulting high titanium recovery.

They also are characterized by the occurrence of the Al_3Ti of the alloy essentially in dispersed nodular particles instead of the essentially acicular form characteristic of known master alloys of similar compositions.

Aluminum-titanium master alloys containing more than about 20% Ti can be produced by the process described above. However, excessively high temperatures are required since the melting points of such alloys are high. Their use is, therefore, not ordinarily practical. Likewise, of course, other alkali metal fluotitanates may be used in making Al-Ti master alloys according to the invention. Potassium fluotitanate is preferred merely because of its greater availability.

Where, in the specification and the appended claim, parts or percentages are stated or referred to, it is to be understood that these are parts or percentages by weight.

I claim:

An Al-Ti master alloy containing 6% to about 20% titanium with the balance substantially aluminum and characterized by being readily dissolved in aluminum at temperatures of 1300° F.-1400° F. and by the appearance in said master alloy of the Al_3Ti constituent essentially in nodular particles.

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