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(19) **United States**(12) **Patent Application Publication**
Park et al.(10) **Pub. No.: US 2012/0134874 A1**(43) **Pub. Date: May 31, 2012**(54) **ALUMINUM CASTING MATERIAL
COMPRISING TITANIUM BORIDE AND
METHOD OF MANUFACTURING THE SAME**(75) Inventors: **Hoon Mo Park**, Seongnam (KR);
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Seoul (KR)(21) Appl. No.: **13/026,604**(22) Filed: **Feb. 14, 2011**(30) **Foreign Application Priority Data**

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Publication Classification(51) **Int. Cl.****C22C 21/14** (2006.01)**C22C 1/02** (2006.01)**C22C 21/10** (2006.01)**C22C 21/02** (2006.01)**C22C 21/08** (2006.01)(52) **U.S. Cl. 420/537; 420/548; 420/544; 420/540**(57) **ABSTRACT**

Disclosed is an aluminum casting material including aluminum, silicon, titanium and boron, particularly 81-93 wt % of aluminum, 5-13 wt % of silicon, 1-3 wt % of titanium and 1-3 wt % of boron. The aluminum casting material has superior elasticity compared to that of a conventional aluminum alloy, even without employing a material of high cost such as carbon nanotube (CNT). While the application of the conventional aluminum alloy is largely restricted to a low pressure casting process, the aluminum material of the present invention can be applied to all common casting processes including a high pressure casting.

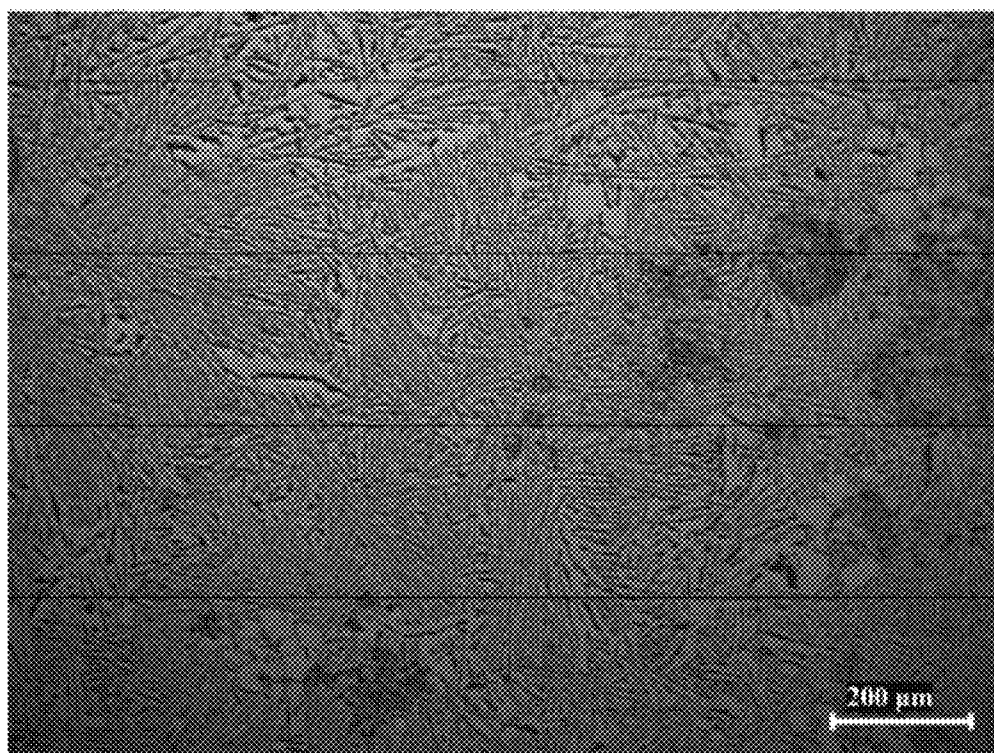


FIG. 1

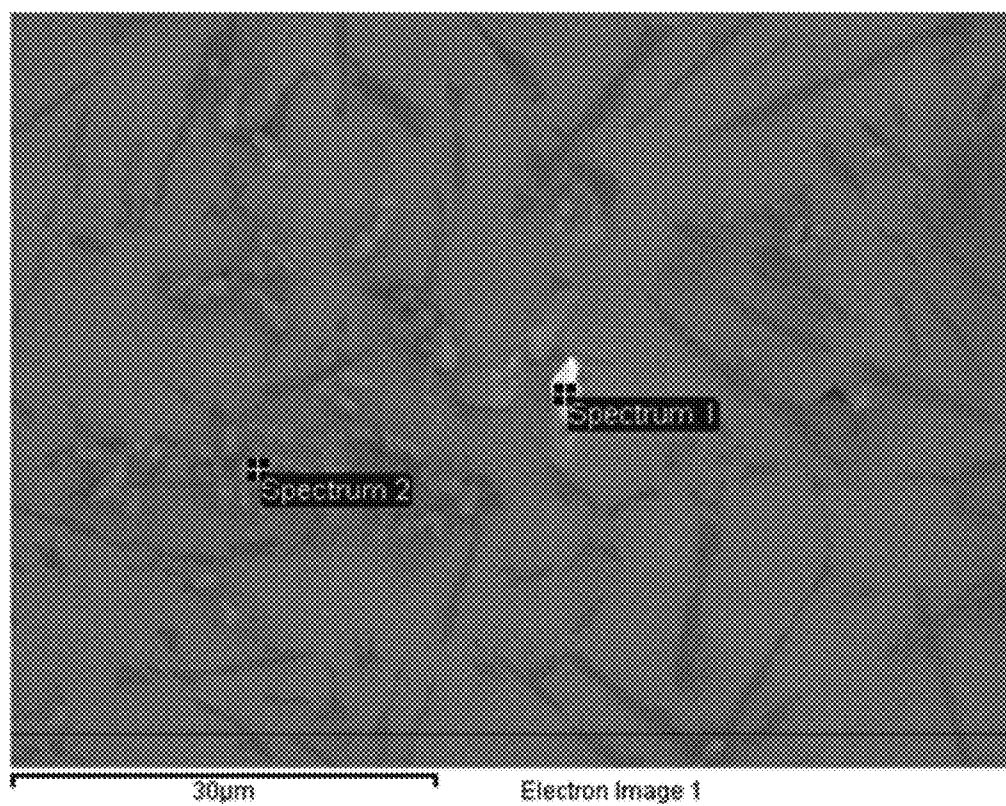


FIG. 2

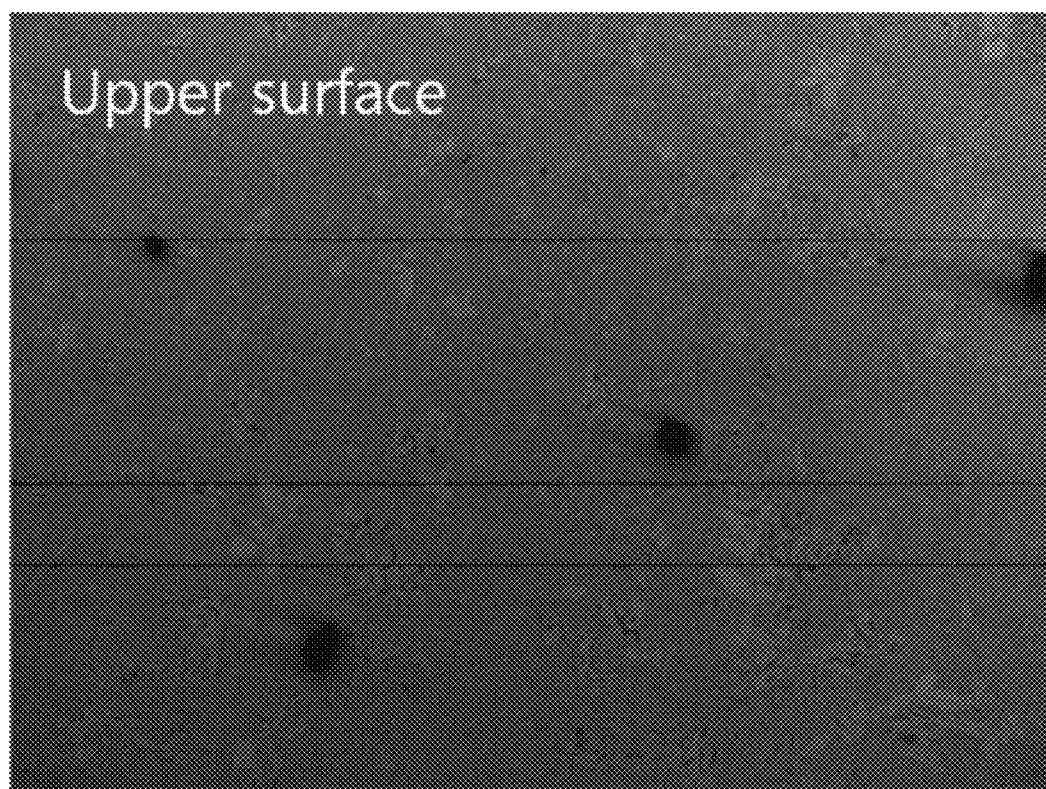


FIG. 3

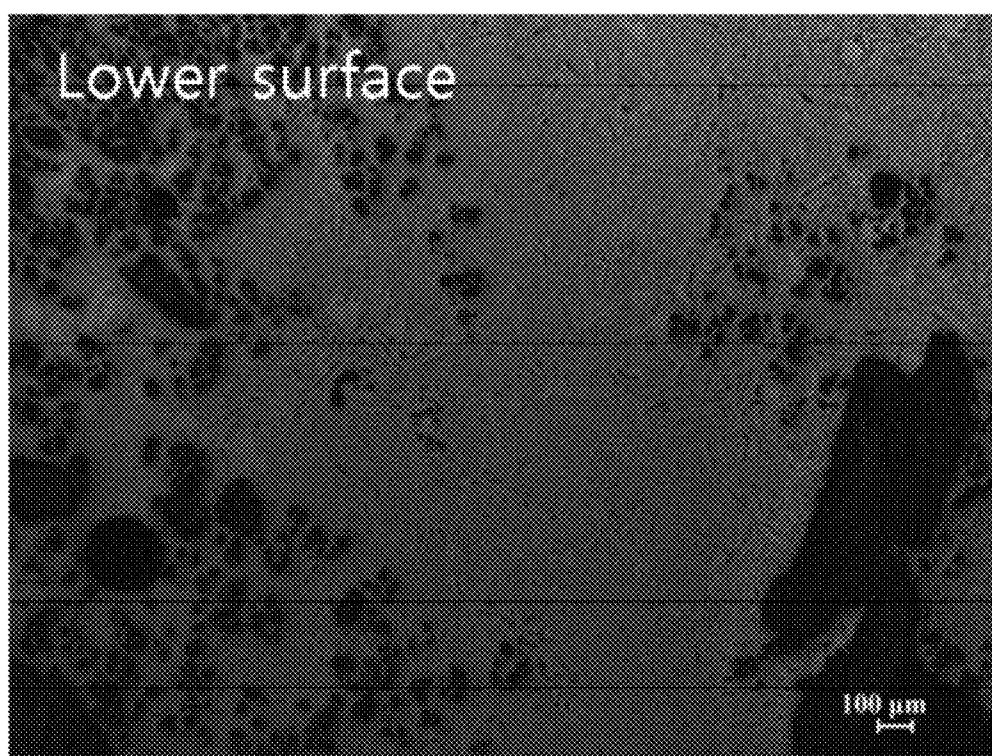


FIG. 4

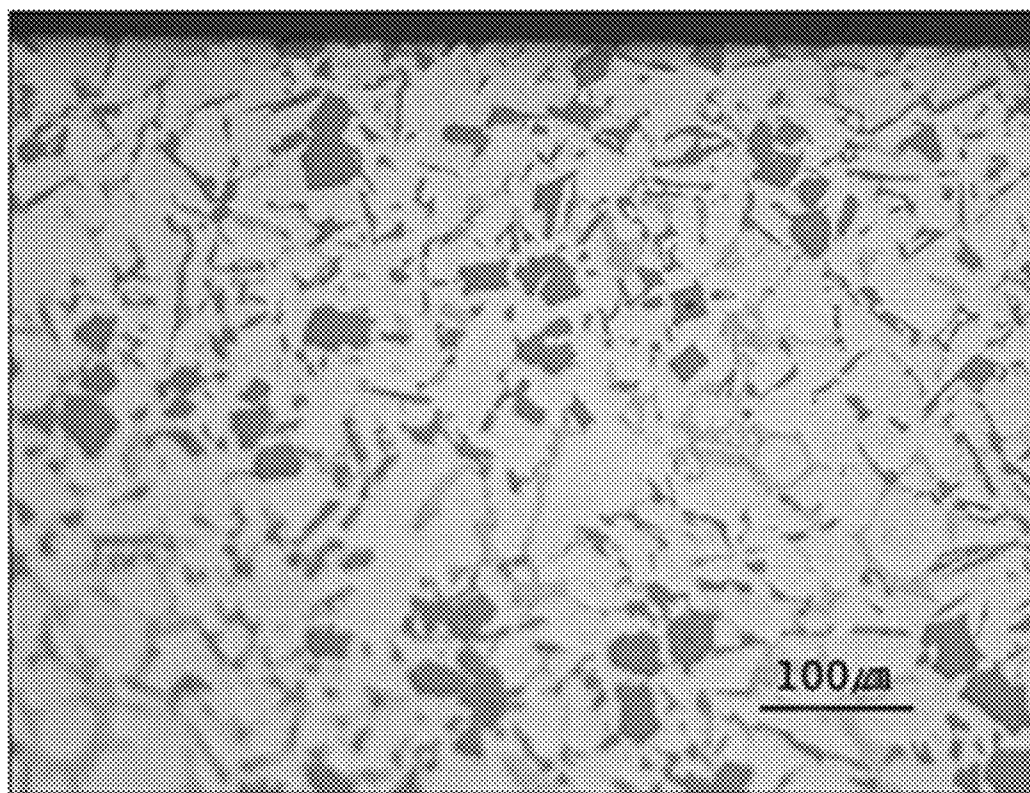


FIG. 5

ALUMINUM CASTING MATERIAL COMPRISING TITANIUM BORIDE AND METHOD OF MANUFACTURING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims under 35 U.S.C. §119(a) the benefit of Korean Patent Application No. 10-2010-0120927 filed Nov. 30, 2010, the entire contents of which are incorporated herein by reference.

BACKGROUND

[0002] (a) Technical Field

[0003] The present invention relates to high elasticity aluminum composite materials, particularly to such materials comprising titanium boride.

[0004] (b) Background Art

[0005] To comply with environmental and fuel economy standards and regulations, there has been a growing demand towards light weight vehicles. Light weight metals, such as aluminum alloy, have thus been used in manufacturing vehicles. However, conventional aluminum components have only been used for the manufacture of very limited vehicle parts such as housings of vehicle components, vehicle frames, and chassis because application of aluminum has been mainly focused on providing high strength for improvement in tensile strength, particularly representing properties of failure initiation and stabilization of production quality.

[0006] There have further been restrictions in the manufacture of light weight vehicles using conventional high strength materials because these materials generally do not meet the requirements for durability and noise/vibration harshness (NVH) characteristics. As a result, additional designs for improving strength when using such materials are necessary. In order to overcome the above problems, it has been essential that a high elasticity aluminum alloy with required strength and NVH properties be used.

[0007] Korean Patent Application Publication No. 2006-0046361 describes an aluminum casting material formed of an aluminum based master alloy comprising 8.0-11.5 wt % of silicon, manganese, magnesium, iron, copper, zinc, titanium, molybdenum, zirconium, strontium, or sodium, calcium, potassium phosphide, indium phosphide, and 1-2 wt % of titanium and 1-2 wt % of boron.

[0008] Korean Patent No. 1997-0001410 describes an aluminum casting material comprising 12-15 wt % of silicon, and TiB₂ type titanium of less than 0.1 wt %.

[0009] However, the conventional casting materials present disadvantages because they differ in wettability with the aluminum matrix, thus resulting in non-uniform dispersion. In addition, hypereutectic aluminum casting materials are largely limited in their application to a low pressure die casting process and present difficulties in processing due to the coarse silicon particles.

[0010] The above information disclosed in this Background section is only for enhancement of understanding of the background of the invention and therefore it may contain information that does not form the prior art that is already known in this country to a person of ordinary skill in the art.

SUMMARY OF THE DISCLOSURE

[0011] The present invention relates to an aluminum casting material having high elasticity and capable of being applied to a high pressure casting process, and a casting process thereof. The casting process can be in accordance with conventional casting processes.

[0012] The present invention also relates to a method for manufacturing the aluminum casting material.

[0013] In one aspect, the present invention provides an aluminum casting material comprising a combination of aluminum, silicon, titanium and boron. In particular, according to various aspects, an aluminum casting material is provided which comprises aluminum as a main component (i.e. being present in an amount greater than 50 wt %, particularly greater than about 60 wt %, more particularly greater than about 70 wt %, and even more particularly greater than about 75 wt %). According to various embodiments, the material comprises about 81-93 wt % of aluminum (Al), about 5-13 wt % of silicon (Si), about 1-3 wt % of titanium (Ti) and about 1-3 wt % of boron (B).

[0014] In another aspect, the present invention provides a method of manufacturing the aluminum casting material.

[0015] Other aspects and preferred embodiments of the invention are discussed infra.

[0016] It is understood that the term "vehicle" or other similar term as used herein is inclusive of motor vehicles in general such as passenger automobiles including sports utility vehicles (SUV), buses, trucks, various commercial vehicles, watercraft including a variety of boats and ships, aircraft, and the like, and includes hybrid vehicles, electric vehicles, plug-in hybrid electric vehicles, hydrogen-powered vehicles and other alternative fuel vehicles (e.g., fuels derived from resources other than petroleum).

[0017] According to the present invention, the aluminum casting material has superior elasticity compared to that of a conventional aluminum alloy, even without using a material of high cost such as carbon nanotube (CNT). Further, while the conventional aluminum alloy can generally only be used in a low pressure casting process, the aluminum material according to the present invention can be successfully applied to all common casting processes, even including high pressure casting.

[0018] The above and other features of the invention are discussed infra.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The above and other features of the present invention will now be described in detail with reference to certain exemplary embodiments thereof illustrated the accompanying drawings which are given hereinbelow by way of illustration only, and thus are not limitative of the present invention, and wherein:

[0020] FIG. 1 is a photograph using a scanning electron microscope which shows a surface of a casting material applied to casting according to EXAMPLE 5 of the present invention;

[0021] FIG. 2 is a photograph using a scanning electron microscope which shows a surface of casting material applied to casting according to EXAMPLE 5 of the present invention;

[0022] FIG. 3 is a photograph using a scanning electron microscope which shows an upper surface of casting material applied to casting according to EXAMPLE 1 of the present invention;

[0023] FIG. 4 is a photograph using a scanning electron microscope which shows a lower surface of casting material applied to casting according to EXAMPLE 1 of the present invention; and

[0024] FIG. 5 is a photograph using a scanning electron microscope which shows a surface of casting material applied to casting according to a COMPARATIVE EXAMPLE of the present invention.

[0025] It should be understood that the appended drawings are not necessarily to scale, presenting a somewhat simplified representation of various preferred features illustrative of the basic principles of the invention. The specific design features of the present invention as disclosed herein, including, for example, specific dimensions, orientations, locations, and shapes will be determined in part by the particular intended application and use environment.

DETAILED DESCRIPTION

[0026] Hereinafter reference will now be made in detail to various embodiments of the present invention, examples of which are illustrated in the accompanying drawings and described below. While the invention will be described in conjunction with exemplary embodiments, it will be understood that present description is not intended to limit the invention to those exemplary embodiments. On the contrary, the invention is intended to cover not only the exemplary embodiments, but also various alternatives, modifications, equivalents and other embodiments, which may be included within the spirit and scope of the invention as defined by the appended claims.

[0027] The present invention relates to aluminum casting material comprising a combination of aluminum, silicon, titanium, and boron. According to some embodiments, the aluminum casting material comprises about 81-93 wt % of aluminum (Al), about 5-13 wt % of silicon (Si), about 1-3 wt % of titanium (Ti) and about 1-3 wt % of boron (B).

[0028] Hereinafter, the above aluminum casting material will be described in detail with respect to the various elements of the material.

[0029] According to embodiments of the invention, the silicon is included in the aluminum casting material to beneficially provide its strength and casting properties to the material. As such, according to some embodiments, the silicon can be provided in an amount which is capable of providing the material with these properties. In particular, according to some embodiments, it is preferred that the aluminum casting material contain about 5-13 wt % of silicon. When the silicon content is less than 5 wt %, it may provide the material with insufficient or less than desired reinforcement and casting properties. On the other hand, if the silicon content is more than 13 wt %, for example as in the conventional arts, the casting material can be used only in a lower pressure casting process and cannot be successfully used in high production processes such as high pressure casting processes. Further, there may be a problem in molding and processability of the material at such higher silicon contents due to the coarseness of the silicon particles. According to certain embodiments, it is preferred that the aluminum casting material contain about 5.0-8.0 wt % of silicon, more preferably, 5.0-8.0 wt % of silicon.

[0030] The titanium and boron components of the aluminum casting material can be included so as to beneficially provide enhancement of elasticity of the aluminum casting material. For example, the titanium and boron can be pro-

vided in the form of a TiB_2 compound in the aluminum casting material. According to some embodiments, the present invention provides an aluminum casting material having a high elasticity by employing about 1 to 3 wt % titanium and boron, respectively, and more preferably about 2-3 wt % of titanium and boron, respectively. According to some embodiments of the present invention, casting materials of the present invention are provided with an increase in elasticity of at least 10% as compared to a casting material that does not contain titanium and boron, and in certain embodiments the elasticity is increased by at least 15% and even 20%.

[0031] In addition to aluminum, silicon, titanium and boron, the aluminum casting material may include additional materials for enhancing characteristics of various structured materials such as strength, elongation, fatigue, corrosion resistance, etc. for example, according to some embodiments, the aluminum casting material can include one or more of iron (Fe), copper (Cu), manganese (Mn), nickel (Ni), zinc (Zn), etc. Such materials may be added to the aluminum casting material in the proportion of 0.1-5 parts by wt relative to 100 parts by wt of the total aluminum casting material.

[0032] According to some embodiments, the casting material may be manufactured in such a manner that powder type titanium and boron are added to a molten metal which includes aluminum and silicon. In addition, the casting material may be prepared in such a manner that aluminum master alloy comprising a suitable amount such as about 80-96 wt % of aluminum, about 2-10 wt % of titanium and about 2-10 wt % of boron may be added into a molten metal comprising aluminum and silicon. In the case of the latter method, uniform TiB_2 particles may be formed instead of coarse TiB_2 particles, thus enhancing elasticity, strength, and durability of abrasion.

Examples 1 to 4

[0033] The following EXAMPLES illustrate the invention and are not intended to limit the same.

[0034] Aluminum casting material was prepared according to Table 1 below. After the molten metal including aluminum and silicon was prepared, powder type titanium and boron and the other materials were added to the molten metal at 700° C.

TABLE 1

Unit (g)	Si	Fe	Cu	Mn	Mg	Ni	Zn	Ti	B	Al
EX. 1	12	—	—	—	—	—	—	1.7	1.7	84.6
EX. 2	12	1.3	3	0.5	0.3	0.5	1.0	1.3	1.3	77.2
EX. 3	7.0	0.2	0.2	0.1	0.3	0.05	0.1	3.0	3.0	86.05
EX. 4	6.0	1.0	3.0	0.5	0.1	0.35	1.0	3.0	3.0	82.05

Example 5

[0035] In this case, although the casting material was prepared at the same ratio as in Example 1, after the molten metal including aluminum and silicon was prepared, aluminum master alloy comprising titanium, boron and aluminum was added to the molten metal at 700° C.

Comparative Examples 1 to 3

[0036] In this case, the casting material was prepared in the same manner as in Example 1, but the compound ratio of the aluminum casting material was prepared according to the following Table 2.

TABLE 2

Unit (g)	Si	Fe	Cu	Mn	Mg	Ni	Zn	Ti	B	Al
Comp. Ex. 1	12	—	—	—	—	—	—	—	—	88
Comp. Ex. 2	12	1.3	3	0.5	0.3	0.5	1.0	—	—	79.9
Comp. Ex. 3	17	0.5	4.5	0.2	0.5	0.1	0.2	0.007	0.007	77.0

Test Example 1

Comparison in Elasticity

[0037] The casting materials prepared in EXAMPLES 1-2 and COMPARATIVE EXAMPLES 1-2 were formed into specimens. Elasticity of the casting materials was evaluated by a resonant ultrasonic spectroscopy method, and the results are shown in the following Table 3. The resonant ultrasonic spectroscopy method is a measurement method by which a specimen is resonated in its interior by making ultrasonic waves penetrate into the edge of the specimen, thereby measuring modulus of elasticity in the specimen through analysis of the resultant spectrum.

TABLE 3

	Compensated	Measured Value			
	Module of direct elasticity (GPa)	Module of direct elasticity (GPa)	Module of transverse elasticity (GPa)	Modulus of elasticity of volume (GPa)	Density (g/cc)
Ex. 1	90	82	31	75	2.60
Comp. Ex. 1	82	72	29	51	2.55
Ex. 2	86	74	29	54	2.52
Comp. Ex. 2	76	68	28	43	2.57

[0038] As shown in the above Table 3, it was demonstrated that elasticity is increased to about 10 to 15% by the addition of titanium and boron in accordance with the present invention. The casting material may, thus, be provided with an increase in elasticity by about 20% compared to that of a conventional aluminum casting material (75 GPa).

Test Example 2

Comparison of Microstructure in Casting Application

[0039] The casting materials prepared in Examples 1 and 5 were prepared into specimens. The surfaces of the specimens were scanned by a scanning electron microscope and the resultant photographs are shown in FIGS. 1-4.

[0040] As shown in FIGS. 1 to 4, in Example 5, even after the enlargement of the image, the surface in the photograph was shown to be uniform. In contrast, in Example 1, it is shown that coarse TiB₂ particles resulted in partial sedimentation, thus revealing a non-uniform microstructure. The uni-

form property in the microstructure, as shown in the Example 5, demonstrates that the manufacturing method according to Example 5 has advantages in processing and mechanical characteristics.

[0041] Further, the casting material prepared in Comparative Example 3 was prepared into a specimen. The surface of the specimen was scanned by a scanning electron microscope and the resultant photograph is shown in FIG. 5. The formation of coarse silicon particles may contribute to the increase of elasticity, but due to uneven microstructure and coarse silicon particles, there may be problems in processing and molding. In addition, there is a further disadvantage in that the casting material can be used only in a low pressure casting for silicon particle distribution and molding control.

[0042] The invention has been described in detail with reference to preferred embodiments thereof. However, it will be appreciated by those skilled in the art that changes may be made in these embodiments without departing from the principles and spirit of the invention, the scope of which is defined in the appended claims and their equivalents.

What is claimed is:

1. An aluminum casting material, comprising about 81-93 wt % of aluminum, about 5-13 wt % of silicon, about 1-3 wt % of titanium and about 1-3 wt % of boron.

2. The aluminum casting material of claim 1, comprising about 86-91 wt % of aluminum, about 5-8 wt % of silicon, about 2-3 wt % of titanium and about 2-3 wt % of boron.

3. The aluminum casting material of claim 1, further comprising about 0.1-5 parts by weight of iron, copper, manganese, magnesium, nickel, or zinc relative to 100 parts by weight of the aluminum casting material.

4. A method of manufacturing the aluminum casting material of claim 1, the method comprising adding about 2-10 wt % of titanium and about 2-10 wt % of boron to a molten metal comprising aluminum and silicon, wherein the aluminum casting material comprises about 80-96 wt % of aluminum, and wherein the wt % are relative to the total weight of the aluminum casting material.

5. An aluminum casting material comprising aluminum, silicon, titanium and boron, wherein the aluminum casting material comprises up to 13 wt % silicon and at least 70 wt % aluminum.

6. The aluminum casting material of claim 5 comprising at least 75 wt % aluminum.

7. The aluminum casting material of claim 5 comprising 81-93 wt % aluminum.

8. The aluminum casting material of claim 5 comprising 5-13 wt % silicon.

9. The aluminum casting material of claim 5 comprising 5-8 wt % silicon.

10. The aluminum casting material of claim 5 wherein the titanium and boron are included in the aluminum casting material so as to increase the elasticity of the material by at least 10% compared to the material without the addition of titanium and boron.

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