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(54) **Highly heat-conductive alloy for pressure casting and cast alloy thereof**

(57) A highly heat-conductive alloy for pressure casting is provided including Cu in an amount of 0.10% or less, Si in an amount of 5% to 16%, Mg in an amount of 0.20% or less, Zn in an amount of 0.10% or less, Fe

in an amount of 0.20% to 1.0%, Mn in an amount of 0.20% or less, Ni in an amount of 0.05% or less, Ti in an amount of 0.05% or less, Pb in an amount of 0.06% or less, Sn in an amount of 0.05% or less, Cr in an amount of 0.10%, and Al forming the balance.

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Description**BACKGROUND OF THE INVENTION****Field of the Invention**

[0001] The present invention relates to an aluminum alloy and a casting alloy thereof which are best-suited for materials of members required to have heat-dissipating characteristics, such as cabinets for accommodating electronic components, a heat-receiving block and a heat sink, for use in computers, electronic apparatus and the like.

Description of the Related Art

[0002] Current electronic apparatuses on the down-sizing, higher speed and higher density trend generate an increasing amount of heat. Cooling of each electronic component itself in such an electronic apparatus is indispensable in maintaining the performance of the apparatus. Accordingly, a heat-dissipating member bearing such an electronic component is required to have a high heat conductivity.

[0003] Conventional heat-dissipating members of this type, for example, a heat-dissipating member having a multiplicity of fins on one side or opposite sides thereof, generally comprise an extruded product of highly heat-conductive pure aluminum or a malleable aluminum alloy, which, however, exhibit very poor castability. Users cut such an extruded product to a desired size and machine a portion of the extruded product on which an electronic component is to be mounted. Such machining becomes costly when massive amounts of extruded products are machined, thus resulting in a problem of increased costs as a whole.

[0004] Use of diecast aluminum has been studied in attempt to overcome such a problem. Diecast aluminum, however, cannot meet the requirements because the heat conductivity thereof is very low, or about 1/2 times the heat conductivity (250 W/(m·°C)) of pure aluminum or lower as seen in Table 1.

Table 1

HEAT CONDUCTIVITIES OF DIECAST ALUMINUM ALLOYS AND PURE ALUMINUM	
	Heat Conductivity W/(m·°C)
ADC1	121
ADC3	113
ADC5	96
ADC6	138
ADC 10	96
ADC 12	96
ACD 14	134
Pure Al	250

[0005] Accordingly, it is a first object of the present invention to provide a highly heat-conductive aluminum alloy for pressure casting having a heat conductivity of 150 W/(m·°C) or higher which can be used as a material for a heat-dissipating component instead of pure aluminum.

[0006] A second object of the present invention is to provide a cast aluminum alloy obtained from the above alloy.

SUMMARY OF THE INVENTION

[0007] According to the present invention, there is provided a highly heat-conductive alloy for pressure casting comprising Cu in an amount of 0.10% or less, Si in an amount of 5% to 16%, Mg in an amount of 0.20% or less, Zn in an amount of 0.10% or less, Fe in an amount of 0.20% to 1.0%, Mn in an amount of 0.20% or less, Ni in an amount of 0.05% or less, Ti in an amount of 0.05% or less, Pb in an amount of 0.06% or less, Sn in an amount of 0.05% or less, Cr in an amount of 0.10%, and Al forming the balance.

[0008] The aluminum alloy for pressure casting according to the present invention is excellent in heat conductivity as well as in castability and seizure proofness and hence is useful as a material for heat-dissipating members. In the above chemical composition, Al, Si and Fe are principal components, while other components are impurities. Since

the heat conductivity of the alloy lowers as the amounts of impurities increase, lower contents of impurities are more desirable. However, the contents of impurities are determined taking the balance with costs into consideration. The alloy having the principal components in respective amounts as specified above meets the requirements as to castability, seizure proofness and heat conductivity. By pressure-casting the aluminum alloy of the invention, it is possible to allow mass production of heat-dissipating members having a high heat conductivity for use in electronic components.

[0009] It is to be noted that "%" as used in the present invention means "% by weight" throughout the specification and claims.

[0010] These and other objects, features and attendant advantages of the present invention will become apparent from the reading of the following detailed description taken in connection with the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

Fig. 1 is a graph showing the relationship between the heat conductivity and the Si content in an example of the invention and a comparative example;

Fig. 2 is a graph showing the relationship between the heat conductivity and the Mn content in an example of the invention and a comparative example; and

Fig. 3 is a graph showing the relationship between the heat conductivity and the Mg content in an example of the invention and a comparative example.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0012] The present invention will now be described in detail. Table 2 shows the chemical composition and the heat conductivity of each of examples 1 to 6 (samples Nos. 12 to 15, 25 and diecast product) within the scope of the present invention and each of comparative examples 1 to 14 (samples Nos. 1 to 8 and 16 to 21). The diecast product was obtained by diecasting an aluminum alloy having a chemical composition within the scope of the invention, and the data of the diecast product in Table 2 was obtained by analyzing the chemical composition of the diecast product thus obtained. As seen from Table 2, the aluminum alloy of the present invention, even when diecast, exhibited a heat conductivity higher than the target heat conductivity (150 W/(m ·°C)).

Table 2

Chemical Composition												
SN*	Cu	Si	Mg	Zn	Fe	Mn	Ni	Ti	Pb	Sn	Cr	HC*
1	0.00	0.06	0.01	0.01	0.10	0.00	0.00	0.00	0.01	0.00	0.00	252
2	0.00	1.39	0.01	0.01	0.10	0.00	0.00	0.00	0.01	0.00	0.00	207
3	0.00	6.81	0.01	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	185
4	0.00	11.58	0.01	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	174
5	0.00	0.06	0.01	0.01	0.62	0.00	0.00	0.00	0.02	0.00	0.00	231
6	0.00	0.06	0.01	0.02	0.10	0.40	0.00	0.00	0.01	0.00	0.00	178
7	0.00	13.85	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	186
8	0.00	15.36	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	182
12	0.00	13.80	0.01	0.00	0.58	0.00	0.00	0.00	0.00	0.00	0.00	178
13	0.00	13.69	0.01	0.00	0.92	0.00	0.00	0.00	0.00	0.00	0.00	169
14	0.05	13.92	0.07	0.05	0.55	0.05	0.05	0.05	0.06	0.05	0.06	158
15	0.12	13.61	0.11	0.09	0.54	0.10	0.05	0.05	0.06	0.05	0.09	151
16	0.50	13.14	0.20	0.22	0.53	0.20	0.05	0.05	0.06	0.05	0.09	144
17	1.14	13.32	0.38	0.53	0.49	0.31	0.05	0.05	0.07	0.06	0.09	133
18	0.11	13.77	0.12	0.10	0.54	0.22	0.05	0.05	0.07	0.06	0.08	146

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Table 2 (continued)

Chemical Composition												
SN*	Cu	Si	Mg	Zn	Fe	Mn	Ni	Ti	Pb	Sn	Cr	HC*
19	0.10	13.55	0.12	0.09	0.52	0.32	0.05	0.05	0.07	0.06	0.08	139
20	0.10	13.63	0.24	0.10	0.51	0.11	0.05	0.05	0.07	0.06	0.08	146
21	0.10	13.60	0.35	0.09	0.51	0.11	0.05	0.05	0.08	0.06	0.08	146
25	0.00	13.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	195
DP*	0.00	12.62	0.01	0.00	0.58	0.00	0.00	0.01	0.00	0.00	0.00	168
Remarks: SN* indicates sample No.; HC* indicates heat conductivity (W/(m·°C)); and DP* indicates diecast product.												

[0013] In the above Table 2, sample Nos. 1 to 8 correspond to comparative examples 1 to 8, respectively, samples Nos. 12 to 15 correspond to examples 1 to 4, respectively, samples Nos. 16 to 21 correspond to comparative examples 9 to 14, respectively, and sample No. 25 and diecast product correspond to examples 5 and 6, respectively.

[0014] As described above, the alloy for pressure casting according to the present invention is required to have superior castability, seizure proofness and heat conductivity. Pure aluminum (comparative example 1) exhibits a heat conductivity of 252 W/(m·°C), which is the highest. This value decreases when an additional element is incorporated in aluminum. Fig. 1 is a graph showing the relationship between the content of Si and the heat conductivity. As shown, the heat conductivity steeply drops until the Si content reaches about 1%, and then gradually lowers until the Si content reaches about 7%. When the Si content is between 5% and 16%, substantially the same level of heat conductivity, or 170 W/(m·°C) or higher, is maintained. Therefore, this range of Si content satisfies the requirement as to heat conductivity.

[0015] Si is an additive that contributes to an improvement in the castability of an alloy, and an alloy for pressure casting, in general, is required to contain Si in an amount of 5% or more so as to exhibit an improved castability. It is known that the fluidity of an alloy becomes maximum when the Si content is about 15%, and therefore, the castability of the alloy lowers when the Si content is 16% or more. Accordingly, an optimum Si content is between 5% and 16% when the castability and the heat conductivity are taken into consideration.

[0016] When optimum conditions of both the castability and the heat conductivity are taken into consideration, a practically preferable range of Si content is between 11% and 14%.

[0017] The alloy for pressure casting according to the present invention is also required to have a seizure proofness, which prevents a casting from seizing the mold to allow smooth release of the casting therefrom. Fe or Mn is known to be effective in imparting an alloy with such a seizure proofness. Since Fe impairs the heat conductivity less than Mn as seen from comparative examples 5 and 6, Fe is more preferable than Mn. According to examples 1 to 6, an adequate Fe content that satisfies the requirements of both the heat conductivity and the seizure proofness is 0.2 to 1.0%.

[0018] As shown in Fig. 2 (see example 4 and comparative examples 11 and 12), the heat conductivity lowers to 146 W/(m·°C), which is lower than the target level, when the content of Mn reaches 0.22%. In view of this, the Mn content in the alloy of the invention is required to be not more than 0.20%.

[0019] As shown in Fig. 3 (see example 4 and comparative examples 13 and 14), the heat conductivity lowers to 146 W/(m·°C), which is lower than the target level as described above, when the content of Mg reaches 0.24%. In view of this, the Mg content in the alloy of the invention is required to be not more than 0.20%.

[0020] The heat conductivity is improved more as the content of each of other impurities decreases. However, the higher the purity becomes with lesser contents of impurities, the more the cost is required. In view of this, the alloy of the invention needs to permit inclusion of impurities to such an extent as not to impair the target heat conductivity. Specifically, the alloy of the invention permits inclusion of Cu in an amount of not more than 0.1%, Zn in an amount of not more than 0.1%, Ti in an amount of not more than 0.05%, Pb in an amount of not more than 0.06%, Sn in an amount of not more than 0.05%, Cr in an amount of not more than 0.10%, and Ni in an amount of not more than 0.05%.

[0021] As has been described above, the alloy of the invention containing Al, Si and Fe and other impurities in respective amounts specified above satisfied the requirement of heat conductivity without impairment of the castability and seizure proofness that are required in diecasting.

[0022] While only certain presently preferred embodiments of the present invention have been described in detail, as will be apparent for those skilled in the art, certain changes and modifications may be made in embodiment without departing from the scope of the invention as defined by the following claims.

Claims

1. A highly heat-conductive alloy for pressure casting comprising Cu in an amount of 0.10% or less, Si in an amount of 5% to 16%, Mg in an amount of 0.20% or less, Zn in an amount of 0.10% or less, Fe in an amount of 0.20% to 1.0%, Mn in an amount of 0.20% or less, Ni in an amount of 0.05% or less, Ti in an amount of 0.05% or less, Pb in an amount of 0.06% or less, Sn in an amount of 0.05% or less, Cr in an amount of 0.10%, and Al forming the balance.
2. A cast aluminum alloy obtained by pressure casting an alloy as recited in claim 1.

Fig.1

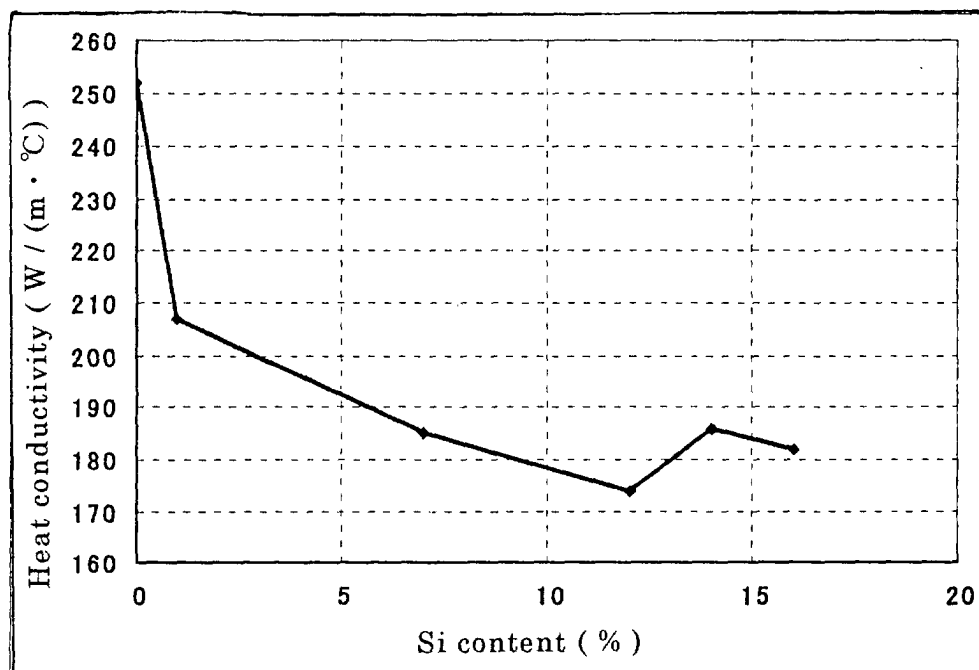


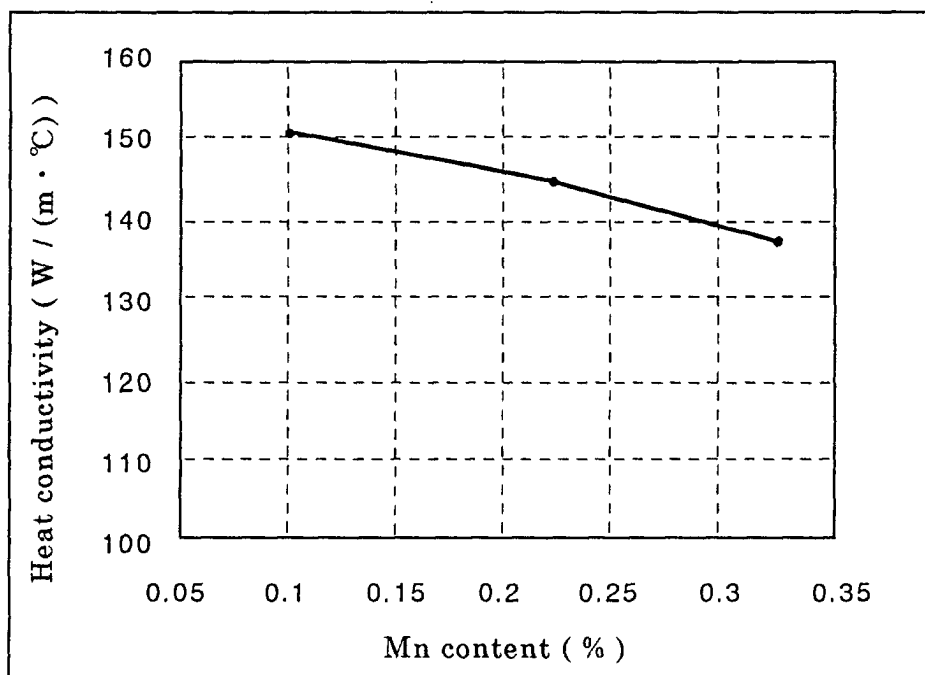
Fig.2

Fig.3