

明 細 書

高強度半田合金

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技術分野

本発明は、機械的強度の強い高強度半田合金に関する。

背景技術

従来、本出願人は、機械的強度の強い高強度半田合金を特願平 5 - 6 7 5
10 5 2 号で提案した。

上述の特願平 5 - 6 7 5 5 2 号で提案した高強度半田合金の構成成分は、
A g と G e の合計が 0 . 8 ~ 7 . 0 (A g と G e 共に 0 重量%より大) であ
り、この結果得られた半田合金の機械的強度は、大幅に強化された。

そこで、本発明は、より機械的強度が強く、かつ、濡れ性の優れた高強度
15 半田合金を提供することを目的とする。

発明の開示

本発明は、S i が、0 . 0 0 0 5 ~ 0 . 3 5 重量%、
A g が、0 ~ 5 . 0 重量%、
20 S b が、0 ~ 1 0 . 0 重量%、
B i が、0 ~ 1 0 . 0 重量%、
S n が、2 0 ~ 9 5 重量%、
P b が、0 ~ 7 0 重量%、
C a が、0 ~ 0 . 5 重量%、から成ることを特徴とする高強度半田合金で
25 ある。

本発明者等は、特願平 5 - 6 7 5 5 2 号の『高強度半田合金』で、示され
るように G e 添加によって半田合金の機械的性質の高強度化に成功した。
しかし、半田こてを用いる半田付け作業においては、現用の半田こては
C u から成るロッドに F e のめっきを施したものが用いられているため、半

田合金中の添加Geと半田こてのFeとが反応を起こし、半田こて表面に除去しにくい化合物層がこびりつき易いことが判明した。従って、半田の機械的強度の強化を計るための半田合金への添加元素を検討してみた結果、Siの添加効果を発見した。

- 5 Siのような高融点金属(1,414℃)をSn-Pb半田合金(共晶溶融温度183℃)に添加することは奇想天外のことであるかもしれない。しかし、Siの微少な添加は半田合金の特性に大きな影響を与えることが数多くの研究から判明した。

10 Siを0.0005~0.35重量%となるように添加すると、以下の効果を生じる。

(1) Siを含有する半田合金から成る半田接合部の強度は、従来の半田合金の少なくとも2倍近くに向上する。

(2) 半田にとって濡れ性の優れていることは、極めて大切であるが、特に、Siは半田合金の濡れ性を高める。この効果はごく少量のPbを含む
15 合金の場合には、一層顕著に発揮される。

(3) Cuから成るロッドにFeのめっきを施した市販の半田こてを用い、本発明による含Si半田合金で作業したとき、たとえ長時間作業を継続したとしても、半田こての表面に化合物層を生じず、作業を継続できる。

(4) 合金中に還元力の強いSiを含むためSiの還元効果によって、半
20 田付け後の接合部にブローホールは存在しない。このことによって半田付け部の信頼性は向上する。

このようにSiの添加は半田合金に画期的な影響を与えるが、もともとSiは還元元素であるので、半田付けに際して、還元効果が発揮される還元元素としては、通常、Al, Mn, Si, P等が考えられるが、Al,
25 Mnについては、その効果が認められず、半田付け部表面上に除去困難な酸化物層を生じ、半田合金として実用化不可能であるということが判明した。

Pについては、半田への添加元素としてはすでに実用化されているが、Siの添加効果には及ばない。

半田合金の溶融温度が183℃であるのに対し、Siの溶融温度は、1,

- 4 1 4℃であるため、S n - P b系半田合金にS iを添加するためには、C a - S i合金、例えば、S iの溶融温度と比較して低温度である溶融温度1 0 1 2℃のC a S i₂化合物を用いるのが良い。このため、S iと同時にC aが、半田合金中に残留することになるが、添加されたC aとしては、
- 5 半田合金の強度を高める上で、相乗効果がある。特に、このことは、半田合金としてP bを含む場合に発揮される。

平軸受合金として知られるP bベース合金（B a h nメタル）には、その強度を高めるためにC aを添加することが知られている。

- 本発明合金の作製については、S i添加のため、A g - S nの共晶合金
- 10 (S i 4.5重量%、A g 95.5重量%；共晶温度830℃)を母合金として用いることもできる。このときには、S iを0.001%添加のときには、A gとしては0.21%が含まれることになるが、A gは半田合金の結晶微細化に貢献する。

- 上述したようにS i添加については、合金製作の上でかなり溶融温度を高める必要があるので、比較的沸点の高いS n含有量の高い半田合金の場合には、その添加効果が大きい。
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- この研究結果から本発明は、S iが、0.0005～0.35重量%含むことが大きな特徴で、その他A gが、0～5.0重量%、S bが、0～10.0重量%、B iが、0～10.0重量%、S nが、20～95重量
- 20 %、P bが、0～70重量%、C aが、0～0.5重量%、から構成されていることを特徴とする高強度半田合金とした。

本発明は、以上説明したように、以下の効果を奏する。

- (1) S iを含有する半田合金から成る半田接合部の強度は、従来の半田合金の少なくとも2倍近くに向上する。
- 25 (2) 半田にとって濡れ性の優れていることは、極めて大切であるが、特に、S iは半田合金の濡れ性を高める。この効果はごく少量のP bでも存在するときには顕著である。

(3) C uバー材の表面にF eめっきを施した市販の半田こてを用いて半田付けを行ったとき、半田こての表面に化合物層などが発生しないため、半

田こてを清浄状態で長期に亘って使用可能である。

(4) 添加元素としての Si はもともと強力な還元性能を持つので、Si 含有半田合金を用いて作業を行うと、半田接合部において起こりがちのブローホールの発生を完全に防止できる。このときの Si 含有量として
5 は、0.0005 重量%という僅少量であろうと、その添加効果を明確に認めうる。

(5) 環境問題に対応する Pb フリーの半田合金が要求されている現在、Sn-低 Pb 半田合金の開発において、Si 添加による新半田合金という本発明の貢献は大きい。

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発明を実施するための最良の形態

以下、本発明を、その実施例に基づいて説明する。

本実施例では、Pb が 10 重量%、Sn が 90 重量%から成る半田合金に Si が、0.003 重量%となるように CaSi₂ 合金を用いて添加した。

15 この Si を添加した半田合金を用いて、脂入り半田線を作り、この拡がり試験 (JIS Z-3197-1986) を行った。試験板上に試料を載せ、半田の液相線温度より 40~50℃ 高い温度で加熱し、約 30 秒間融解して試験板上に拡がらせた。テスト後の拡がり面をプランメータで測った。

20 この結果によると、Sn-Pb 合金 (Sn が重量 90%、Pb が重量 10%) のみである時には、1.8 cm²であったのに対し、Si を含有させた本実施例の半田合金では 2.2 cm²となり、約 20% もその拡がり性が向上した。

次いで上記二種の合金を用いて、直径 1 mm の合金線を作って引張り試験を
25 行った。この結果引張り強度として前者の本発明の実施例は、7.8 kgf/mm²、Sn-Pb 合金 (Sn が重量 90%、Pb が重量 10%) は、5.3 kgf/mm² であり、約 43% の強度増加を示した。

次に、Si 添加による半田接合部の機械的強度の向上について他の実施例にて検討してみる。Sn が、63 重量%、Pb が、37 重量%から成る半

田合金にS iが、0.008重量%、A gが1.68重量%となるように添加した。これはA g-S n共晶合金（熔融温度830℃）を用いてS iを添加した場合であって、比較のためS n-P b合金（S nが重量60%、P bが重量40%）の半田合金も同一条件下で試料作製した。両合金を用いて直径1mmの合金線を作った。

これらの引張り試験を行った結果、S iを含有しない従来の半田合金では4.2 kgf/cm²であるに対し、このS iを含有する本実施例の半田合金から成る半田合金線では、6.8 kgf/cm²で、約62%という大きな強度増加が見られた。

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請 求 の 範 囲

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Siが、0.0005～0.35重量%、

Agが、0～5.0重量%、

5 Sbが、0～10.0重量%、

Biが、0～10.0重量%、

Snが、20～95重量%、

Pbが、0～70重量%、

Caが、0～0.5重量%、から成ることを特徴とする高強度半田合金。

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SPECIFICATION

High Strength Solder Alloy

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Technical Field

The present invention relates to a high strength solder alloy the mechanical strength of which is high.

Background Technology

10 We, the applicants, proposed a high strength solder alloy the mechanical strength of which was high in our Japanese patent application No.67552/1993 recently.

As for the constituents of the high strength solder alloy proposed in the above Japanese patent application
15 No.67552/1993, the total weight percentage of Ag and Ge is 0.8 to 7.0 wt.% (each of Ag and Ge is bigger than 0 wt.%), which results in the remarkable enhancement of the mechanical strength of the solder alloy.

Then, the purpose of the present invention is to propose
20 a high strength solder alloy the mechanical strength of which is higher and the wetness property of which is more excellent.

Disclosure of the Invention

25 The high strength solder alloy according to the present invention is characterized in that it comprises :

Si of 0.0005 to 0.35 wt.%

Ag of 0 to 5.0 wt.%

Sb of 0 to 10.0 wt.%

30 Bi of 0 to 10.0 wt.%



Sn of 20 to 95 wt.%

Pb of 0 to 70 wt.%

and Ca of 0 to 0.5 wt.%

We, inventors, succeeded in improving the mechanical
5 property of the solder alloy by adding Ge as disclosed in
the above Japanese patent application No.67552/1993
related to "high strength solder alloy". But it has
been clarified that as the soldering tool the rod of
which, made of Cu, is plated with Fe is used during the
10 soldering work by using the soldering tool at present,
Ge added in the solder alloy and Fe with which the
soldering tool surface is plated react resulting in the
easy formation of the unremovable compound layer on the
soldering tool surface. In order to solve the problem,
15 therefore, we searched the additive material necessary
for enhancing the mechanical strength of the solder
alloy and as a result, we have found that the addition
of Si is effective.

It may be novel to add high melting point metal such as
20 Si (1,414 °C) to Sn-Pb solder alloy (eutectic melting
point : 183 °C). But it has been clarified through many
investigations that the addition of very small amount of
Si to the solder alloy gives a big influence on the solder
alloy characteristics.

25 The addition of Si of 0.0005 to 0.35 wt.% brings the
following effects.

(1) the strength of the soldered joint which consists of
solder alloy including Si is at least two times higher
than that of the conventional one.

30 (2) Si causes the enhancement of the wetness property



of the solder alloy particularly which is very important for the soldering. In case the solder alloy includes further very small amount of Pb, the effect of the enhancement of the wetness property becomes further
5 remarkable.

(3) When soldering work is carried out by using a conventional soldering tool with a rod made of copper plated with Fe and solder alloy including Si according to the present invention, no chemical compound layer is
10 formed on the surface of the soldering rod although the soldering work continues for a long time.

(4) Because of the effect of strong reducibility of Si the solder alloy includes, no blow hole exists at the soldered joint, which results in enhancing the reliability
15 of the soldered joint.

Thus the addition of Si gives an epochal effect to the solder alloy resulting from the reducibility of Si. It is thought that as reducible elements which can give a reduction effect to solder alloy Al, Mn, Si, P, etc. are
20 used normally, but it has been clarified that Al and Mn can not give such an effect to it and causes the formation of unremovable oxide layer at the surface of the soldered part and that they can not be used practically as a reducible element.

25 P is already in practical use as an additive element to solder alloy, but its reducible effect is less than that of Si.

While the melting point of solder alloy is 183°C , that of Si is $1,414^{\circ}\text{C}$. Accordingly, in order to add Si to Sn-Pb
30 solder alloy, Ca-Si alloy, such as CaSi , compound the



melting point of which is 1,012 °C lower than that of Si,
is preferably used. In this method, Ca remains in solder
alloy together with Si, and cooperates to enhance the
strength of solder alloy, which is remarkable particularly
5 in case the solder alloy includes Pb.

It is known that Ca is added to Pb base alloy (Bahn
metal) which is known as a plane bearing alloy for the
purpose of the enhancement of its strength.

According to the present invention, for the purpose of
10 the addition of Si to the solder alloy Ag-Sn eutectic
alloy (Si 4.5 wt.%, Ag 95.5 wt.% ; eutectic temperature
830 °C) may be also used as the mother alloy. In this
method, when the additive ratio of Si is 0.001 %, Ag of
0.21 % is included by the solder alloy and contributes to
15 fine crystallization of it.

In the method for adding Si as described above, it is
necessary to raise the melting point to a large extent for
making the alloy. Therefore in case the solder alloy
which includes lager amount of Sn the boiling point of
20 which is relatively high, its addition effect is larger.

The high strength solder alloy according to the present
invention based on this investigation is mainly
characterized in that it comprises Si of 0.0005 to 0.35
wt.%, and next characterized in that as the other elements
25 Ag of 0 to 5.0 wt.%, Sb of 0 to 10.0 wt.%, Bi of 0 to 10.0
wt.%, Sn of 20 to 95 wt.%, Pb of 0 to 70 wt.% and Ca of
0 to 0.5 wt.%.

The effects of the present invention abstracted from the
above description are as follows :

30 (1) The strength of the soldered joint comprising the



solder alloy with Si in it is at least about 2 times higher than that comprising the conventional solder alloy.

(2) Si enhances the wetness property of the solder alloy which is very important for the soldering. The presence of
5 very small amount of Pb makes this effect remarkable.

(3) When soldering work is carried out by using a conventional soldering tool comprising Cu soldering rod plated with Fe, no compound layer is produced on the surface of the soldering rod, which makes it possible to
10 be used in a clean state for a long time.

(4) As Si to be added has in itself a strong reducibility property, when soldering work is carried out by using the solder alloy including Si, the production of the blow hole which is otherwise apt to produce at the
15 soldered joint can be prevented completely. Even if Si content is then very small amount such as 0.0005 wt.%, its addition effect can be recognized definitely.

(5) As from environmental viewpoint Pb-free solder alloy is required at present, the new solder alloy including Si
20 according to the present invention contributes to the development of Sn-low Pb solder alloy.

Best Condition for Working the Invention

We explain the present invention below referring to its
25 some embodiments.

In an embodiment, CaSi_2 alloy which includes Si was added to soldering alloy comprising Pb of 10 wt.% and Sn of 90 wt.% so that Si content might be 0.003 wt.%.

We made a solder line including fat by using solder
30 alloy including Si and performed a tension test (JIS Z



-3197-1986) by using it. We put the test piece on a test plate, heated it at a temperature which is 40 to 50 °C higher than the liquid phase line temperature of it, put it in its melting state for about 30 seconds and then
5 spread it on the test plate. We measured the area of the spread solder alloy after the test with a planimeter.

According to this test result, while the spread area for Sn-Pb alloy without any other elements (Sn 90 wt.%, Pb
10 10 wt.%) is 1.8 cm², that for the solder alloy including for this embodiment is 2.2 cm² which is about 20 % higher than the former resulting in the improvement of the spreading property.

Next, by using the above two kinds of alloys, we made
15 two alloy lines of 1 mm in diameter for test and performed tension tests for them. According to the test result, while the tensile strength of Sn-Pb alloy (Sn 90 wt.%, Pb 10 wt.%) is 5.3 kgf/mm², that of the solder alloy for the present invention is 7.8 kgf/mm² which is about 43 %
20 higher than the former.

Next, we check another embodiment related to the improvement of the mechanical strength of the soldered joint including Si. We added Si and Ag to the solder alloy comprising Sn of 63 wt. and Pb of 37 wt.% so that Si
25 and Ag might become 0.008 wt.% and 1.68 wt.% respectively.

This is the case in which Si is added to the solder alloy in the presence of Ag-Sn eutectic alloy (melting point : 830 °C). We also made a test piece of conventional Sn-Pb solder alloy (Sn 60 wt.%, Pb 40 wt.%) under the same
30 condition for comparison. We made an alloy line of 1 mm in



diameter for each alloy.

According to the tension test result for these alloys,
while the tensile strength of the conventional solder
alloy without Si is 4.2 kgf/mm², that of the solder alloy
5 including Si for the present invention is 6.8 kgf/mm²
which is about 62 % higher than the former.

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CLAIM

1. High strength solder alloy characterized in that it
comprises:

	Si of	0.0005	to	0.35	wt.%,
5	Ag of	0	to	5.0	wt.%,
	Sb of	0	to	10.0	wt.%,
	Bi of	0	to	10.0	wt.%,
	Sn of	20	to	95	wt.%,
	Pb of	0	to	70	wt.%,
10	and Ca of	0	to	0.5	wt.%,

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ABSTRACT

The purpose of the present invention is to propose a high strength solder alloy which has a stronger mechanical strength and an excellent wetness property.

- 5 The high strength solder alloy according to the present invention is characterized in that it comprises Si of 0.0005 to 0.35 wt.%, Ag of 0 to 5.0 wt.%, Sb of 0 to 10.0 wt.%, Bi of 0 to 10.0 wt.%, Sn of 20 to 95 wt.%, Pb of 0 to 70 wt.% and Ca of 0 to 0.5 wt.%.

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20 a high strength solder alloy the mechanical strength of which is higher and the wetness property of which is more excellent.

Disclosure of the Invention

25 The high strength solder alloy according to the present invention is characterized in that it comprises :

Si of 0.001 to 0.35 wt.%

the total of Ag,Sb,Bi,Ca of 1.0 to 20.0 wt.%

Pb of 1.0 to 50.0 wt.%

30 and Sn of the rest.

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Date : **18 OCT 1996**

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It may be novel to add high melting point metal such as
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of the solder alloy particularly which is very important for the soldering. In case the solder alloy includes further very small amount of Pb, the effect of the enhancement of the wetness property becomes further
5 remarkable.

(3) When soldering work is carried out by using a conventional soldering tool with a rod made of copper plated with Fe and solder alloy including Si according to the present invention, no chemical compound layer is
10 formed on the surface of the soldering rod although the soldering work continues for a long time.

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15 of the soldered joint.

Thus the addition of Si gives an epochal effect to the solder alloy resulting from the reducibility of Si. It is thought that as reducible elements which can give a reduction effect to solder alloy Al, Mn, Si, P, etc. are
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-3197-1986) by using it. We put the test piece on a test plate, heated it at a temperature which is 40 to 50 °C higher than the liquid phase line temperature of it, put it in its melting state for about 30 seconds and then spread it on the test plate. We measured the area of the spread solder alloy after the test with a planimeter.

According to this test result, while the spread area for Sn-Pb alloy without any other elements (Sn 90 wt.%, Pb 10 wt.%) is 1.8 cm², that for the solder alloy including for this embodiment is 2.2 cm² which is about 20 % higher than the former resulting in the improvement of the spreading property.

Next, by using the above two kinds of alloys, we made two alloy lines of 1 mm in diameter for test and performed tension tests for them. According to the test result, while the tensile strength of Sn-Pb alloy (Sn 90 wt.%, Pb 10 wt.%) is 5.3 kgf/mm², that of the solder alloy for the present invention is 7.8 kgf/mm² which is about 43 % higher than the former.

Next, we check another embodiment related to the improvement of the mechanical strength of the soldered joint including Si. We added Si and Ag to the solder alloy comprising Sn of 63 wt. and Pb of 37 wt.% so that Si and Ag might become 0.008 wt.% and 1.68 wt.% respectively.

This is the case in which Si is added to the solder alloy in the presence of Ag-Sn eutectic alloy (melting point : 830 °C). We also made a test piece of conventional Sn-Pb solder alloy (Sn 60 wt.%, Pb 40 wt.%) under the same condition for comparison. We made an alloy line of 1 mm in

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diameter for each alloy.

According to the tension test result for these alloys, while the tensile strength of the conventional solder alloy without Si is 4.2 kgf/mm², that of the solder alloy 5 including Si for the present invention is 6.8 kgf/mm² which is about 62 % higher than the former.

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CLAIM

1. High strength solder alloy characterized in that it comprises:

Si of 0.001 to 0.35 wt.%,

5 the total of Ag, Sb, Bi, Ca of 1.0 to 20.0 wt.%,

Pb of 1.0 to 50.0 wt.%,

and Sn of the rest.

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SPECIFICATION

High Strength Solder Alloy

5 Technical Field

The present invention relates to a high strength solder alloy the mechanical strength of which is high.

Background Technology

10 We, the applicants, proposed a high strength solder alloy the mechanical strength of which was high in our Japanese patent application No.67552/1993 recently.

As for the constituents of the high strength solder alloy proposed in the above Japanese patent application
15 No.67552/1993, the total weight percentage of Ag and Ge is 0.8 to 7.0 wt.% (each of Ag and Ge is bigger than 0 wt.%), which results in the remarkable enhancement of the mechanical strength of the solder alloy.

Then, the purpose of the present invention is to propose
20 a high strength solder alloy the mechanical strength of which is higher and the wetness property of which is more excellent.

Disclosure of the Invention

25 The high strength solder alloy according to the present invention is characterized in that it comprises :

Si of 0.0005 to 0.008 wt.%

Ag of 0 to 5.0 wt.%

Sb of 0 to 10.0 wt.%

30 Bi of 0 to 10.0 wt.%

Sn of 20 to 95 wt.%

Pb of 0 to 70 wt.%

and Ca of 0 to 0.5 wt.%

We, inventors, succeeded in improving the mechanical
5 property of the solder alloy by adding Ge as disclosed in
the above Japanese patent application No.67552/1993
related to "high strength solder alloy". But it has
been clarified that as the soldering tool the rod of
which, made of Cu, is plated with Fe is used during the
10 soldering work by using the soldering tool at present,
Ge added in the solder alloy and Fe with which the
soldering tool surface is plated react resulting in the
easy formation of the unremovable compound layer on the
soldering tool surface. In order to solve the problem,
15 therefore, we searched the additive material necessary
for enhancing the mechanical strength of the solder
alloy and as a result, we have found that the addition
of Si is effective.

It may be novel to add high melting point metal such as
20 Si (1,414 °C) to Sn-Pb solder alloy (eutectic melting
point : 183 °C). But it has been clarified through many
investigations that the addition of very small amount of
Si to the solder alloy gives a big influence on the solder
alloy characteristics.

25 The addition of Si of 0.0005 to 0.008 wt.% brings the
following effects.

(1) the strength of the soldered joint which consists of
solder alloy including Si is at least two times higher
than that of the conventional one.

30 (2) Si causes the enhancement of the wetness property

of the solder alloy particularly which is very important for the soldering. In case the solder alloy includes further very small amount of Pb, the effect of the enhancement of the wetness property becomes further
5 remarkable.

(3) When soldering work is carried out by using a conventional soldering tool with a rod made of copper plated with Fe and solder alloy including Si according to the present invention, no chemical compound layer is
10 formed on the surface of the soldering rod although the soldering work continues for a long time.

(4) Because of the effect of strong reducibility of Si the solder alloy includes, no blow hole exists at the soldered joint, which results in enhancing the reliability
15 of the soldered joint.

Thus the addition of Si gives an epochal effect to the solder alloy resulting from the reducibility of Si. It is thought that as reducible elements which can give a reduction effect to solder alloy Al, Mn, Si, P, etc. are
20 used normally, but it has been clarified that Al and Mn can not give such an effect to it and causes the formation of unremovable oxide layer at the surface of the soldered part and that they can not be used practically as a reducible element.

25 P is already in practical use as an additive element to solder alloy, but its reducible effect is less than that of Si.

While the melting point of solder alloy is 183 °C, that of Si is 1,414°C. Accordingly, in order to add Si to Sn-Pb
30 solder alloy, Ca-Si alloy, such as CaSi, compound the

melting point of which is 1,012 °C lower than that of Si, is preferably used. In this method, Ca remains in solder alloy together with Si, and cooperates to enhance the strength of solder alloy, which is remarkable particularly in case the solder alloy includes Pb.

It is known that Ca is added to Pb base alloy (Bahn metal) which is known as a plane bearing alloy for the purpose of the enhancement of its strength.

According to the present invention, for the purpose of the addition of Si to the solder alloy Ag-Sn eutectic alloy (Si 4.5 wt.%, Ag 95.5 wt.% ; eutectic temperature 830 °C) may be also used as the mother alloy. In this method, when the additive ratio of Si is 0.001 %, Ag of 0.21 % is included by the solder alloy and contributes to fine crystallization of it.

In the method for adding Si as described above, it is necessary to raise the melting point to a large extent for making the alloy. Therefore in case the solder alloy which includes larger amount of Sn the boiling point of which is relatively high, its addition effect is larger.

The high strength solder alloy according to the present invention based on this investigation is mainly characterized in that it comprises Si of 0.0005 to 0.008 wt.%, and next characterized in that as the other elements Ag of 0 to 5.0 wt.%, Sb of 0 to 10.0 wt.%, Bi of 0 to 10.0 wt.%, Sn of 20 to 95 wt.%, Pb of 0 to 70 wt.% and Ca of 0 to 0.5 wt.%.

The effects of the present invention abstracted from the above description are as follows :

(1) The strength of the soldered joint comprising the

solder alloy with Si in it is at least about 2 times higher than that comprising the conventional solder alloy.

(2) Si enhances the wetness property of the solder alloy which is very important for the soldering. The presence of
5 very small amount of Pb makes this effect remarkable.

(3) When soldering work is carried out by using a conventional soldering tool comprising Cu soldering rod plated with Fe, no compound layer is produced on the surface of the soldering rod, which makes it possible to
10 be used in a clean state for a long time.

(4) As Si to be added has in itself a strong reducibility property, when soldering work is carried out by using the solder alloy including Si, the production of the blow hole which is otherwise apt to produce at the
15 soldered joint can be prevented completely. Even if Si content is then very small amount such as 0.0005 wt.%, its addition effect can be recognized definitely.

(5) As from environmental viewpoint Pb-free solder alloy is required at present, the new solder alloy including Si
20 according to the present invention contributes to the development of Sn-low Pb solder alloy.

Best Condition for Working the Invention

We explain the present invention below referring to its
25 some embodiments.

In an embodiment, CaSi_2 alloy which includes Si was added to soldering alloy comprising Pb of 10 wt.% and Sn of 90 wt.% so that Si content might be 0.003 wt.%.

We made a solder line including fat by using solder
30 alloy including Si and performed a tension test (JIS Z

-3197-1986) by using it. We put the test piece on a test plate, heated it at a temperature which is 40 to 50 °C higher than the liquid phase line temperature of it, put it in its melting state for about 30 seconds and then spread it on the test plate. We measured the area of the spread solder alloy after the test with a planimeter.

According to this test result, while the spread area for Sn-Pb alloy without any other elements (Sn 90 wt.%, Pb 10 wt.%) is 1.8 cm², that for the solder alloy including for this embodiment is 2.2 cm² which is about 20 % higher than the former resulting in the improvement of the spreading property.

Next, by using the above two kinds of alloys, we made two alloy lines of 1 mm in diameter for test and performed tension tests for them. According to the test result, while the tensile strength of Sn-Pb alloy (Sn 90 wt.%, Pb 10 wt.%) is 5.3 kgf/mm², that of the solder alloy for the present invention is 7.8 kgf/mm² which is about 43 % higher than the former.

Next, we check another embodiment related to the improvement of the mechanical strength of the soldered joint including Si. We added Si and Ag to the solder alloy comprising Sn of 63 wt. and Pb of 37 wt.% so that Si and Ag might become 0.008 wt.% and 1.68 wt.% respectively.

This is the case in which Si is added to the solder alloy in the presence of Ag-Sn eutectic alloy (melting point : 830 °C). We also made a test piece of conventional Sn-Pb solder alloy (Sn 60 wt.%, Pb 40 wt.%) under the same condition for comparison. We made an alloy line of 1 mm in

diameter for each alloy.

According to the tension test result for these alloys,
while the tensile strength of the conventional solder
alloy without Si is 4.2 kgf/mm², that of the solder alloy
5 including Si for the present invention is 6.8 kgf/mm²
which is about 62 % higher than the former.

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CLAIM

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	Si of	0.0005	to	<u>0.008</u>	wt.%,
5	Ag of	0	to	5.0	wt.%,
	Sb of	0	to	10.0	wt.%,
	Bi of	0	to	10.0	wt.%,
	Sn of	20	to	95	wt.%,
	Pb of	0	to	70	wt.%,
10	and Ca of	0	to	0.5	wt.%,

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ABSTRACT

The purpose of the present invention is to propose a high strength solder alloy which has a stronger mechanical strength and an excellent wetness property.

- 5 The high strength solder alloy according to the present invention is characterized in that it comprises Si of 0.0005 to 0.008 wt.%, Ag of 0 to 5.0 wt.%, Sb of 0 to 10.0 wt.%, Bi of 0 to 10.0 wt.%, Sn of 20 to 95 wt.%, Pb of 0 to 70 wt.% and Ca of 0 to 0.5 wt.%.

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HIGH STRENGTH SOLDER ALLOY

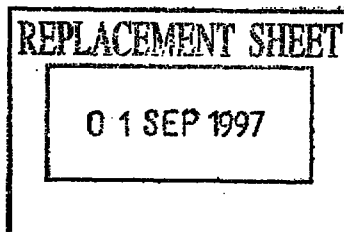
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ABSTRACT

The purpose of the present invention is to propose a high strength solder alloy which has a stronger mechanical strength and an excellent wetness property.

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