

Description

SILVER-GOLD-PALLADIUM ALLOY BUMPING WIRE

Technical Field

[0001]

The present invention relates to a vertically pull-cut silver-gold-palladium alloy bumping wire and, particularly, to a stud bumping wire to be used for flip-chip connection of a semiconductor device.

Background Art

[0002]

Fig. 1 is a sectional view showing an ordinary stud bump mounting state.

A semiconductor device 32 and a circuit substrate 33 are electrically and mechanically connected to each other via a projected electrode (wire bump) 36 previously formed on an electrode pad of the semiconductor device 32, and the circuit substrate 33 and the projected electrode 36 are flip-chip connected to each other via a solder which is typically formed of a Pb-Sn alloy or a Sn-Ag alloy. In the flip-chip connection, metal bonding of the wire bump and the solder to each other is attained by mounting the chip after the formation of stud bump on the solder layers formed on the substrate electrode and melting the solder by heating.

After the flip chip connection, the wire bump is diffused into the solder in a high temperature usage such

as in a power semiconductor and an electric vehicle to cause a phenomenon called "solder erosion". Further, since the wire bump is diffused into aluminum (Al) of the chip electrode to form a fragile Au-Al intermetallic compound, there is a problem that a crack is developed at a bonding interface as the diffusion proceeds, resulting in generation of electrical conduction failure.

[0003]

As a process for forming the wire bump 36 of the above-described type, Japanese Unexamined Patent Application Publication No. 11-251350 (referred to as Patent Literature 2 below) proposes a vertical pull-cut technology for forming a bump through ball bonding by utilizing a wire bonding technology and using a wire for bump formation comprising Au, Ag, Cu, and the like as bonding wire.

[0004]

Fig. 2 is a sectional view showing the bump formation process of vertical pull-cut method according to the above-mentioned conventional technology. In a ball bonding device, a wire clumper 5 which moves integrally with a capillary 1 in X, Y, and Z directions is provided on a traveling path of a bumping wire 2 from a winding reel to the capillary, and the bumping wire 2 is drawn by a length corresponding to a desired bump shape or size while being clamped by the wire clumper 5 [(a) of Fig. 2]. Next, a spark current is supplied to a tip of a wire 51 to form an

initial ball 51a [(b) of Fig. 2]. Next, the initial ball 51a is transferred onto the electrode pad 34 [(c) of Fig. 2], and the ball 51a formed on the wire tip is pressure bonded to the electrode pad 34 [(d) of Fig. 2]. Next, the wire clasper 5 is slightly moved in a directly upward direction [(g) of Fig. 2] in a state where the wire is released from the wire clasper 5 [(f) of Fig. 2], and then the capillary 50 is pulled in a vertically upward direction together with the wire 51 in a state where the wire is clamped by the wire clasper [(g) of Fig. 2]. The wire is cut at a base of the ball when the capillary is moved vertically upward to complete a wire bump 36 [(h) of Fig. 2]. This is the vertical pull-cut method. After that, the wire is clamped by the wire clasper again (not shown) and moved to a next bonding position in the state where the wire is clamped by the wire clasper, and then a ball is formed by a spark discharge between a wire tip and a torch to be ready for next ball bonding.

[0005]

Examples of a material to be used for the above-described bumping wire include the one disclosed in Japanese Unexamined Patent Application Publication No. 2007-142271 (referred to as Patent Literature 1 below). The materials are "a bump forming material characterized by comprising 10 to 60 mass% of Au having purity of 99.99 mass% or more and at least one of 0.2% to 2% of Pd or Pt having purity of 99.9% or more and 0.05 to 1 mass% of Cu

having purity of 99.99 mass% or more, with the balance being Ag having purity of 99.99 mass% or more (claim 6)" and "a bump forming material characterized by comprising 10 to 60 mass% of Au having purity of 99.99 mass% or more, at least one of 0.2% to 2% of Pd or Pt having purity of 99.9% or more and 0.05 to 1 mass% of Cu having purity of 99.99 mass% or more, and at least one of 5 to 100 mass ppm of Ca, 1 to 20 mass ppm of Be, and 5 to 100 mass ppm of a rare earth element, with the balance being Ag having purity of 99.99 mass% or more (claim 8)". The bumping wires utilize the advantage of not entailing the phenomenon of solder erosion during solder melting to stabilize the Ag alloy wire bump by approximating the shape of a molten ball to a perfect sphere and thus to improve reliability of bonding between an Al pad and the Ag alloy ball as well as shorten a tail length of a silver-gold-palladium alloy bump to prevent a void on an interface between Ag and the solder without deterioration in solder erosion resistance of the silver-gold-palladium alloy bump (paragraph 0006 of the same publication).

[0006]

When the amount of added elements exceeds 10%, mechanical strength is increased to strengthen the bumping wire per se to enable thinning of the bump wire. However, the thinning of the wire from 25 μm to 20 μm and further to 15 μm causes chip breakage due to excessive hardness of the molten ball unless a refining heat treatment is performed.

On the other hand, when the refining heat treatment is performed on the thinned bumping wire in the same manner as in general bonding wires, the bumping wire becomes excessively soft to make it difficult to shorten the tail length of the bump.

Particularly, in the case of the silver-gold-palladium alloy bumping wire, a change ratio of an internal structure caused by the refining heat treatment is larger than that of a pure silver bumping wire. Therefore, a fluctuation in tail lengths of the silver-gold-palladium alloy bumps has been large even when the internal structure is not changed. Since the factor of the fluctuation in tail length of the silver-gold-palladium alloy bumping wire has not been clarified, it has been difficult to evenly shorten the tail lengths of the silver-gold-palladium alloy bumps by adjusting only the composition of the silver-gold-palladium alloy.

Therefore, in order to adjust the tail length of the silver-gold-palladium bump, a slit is provided in the bumping wire by forming a pair of sward-like projections on the capillary in Japanese Unexamined Patent Application Publication No. 11-251350 (referred to as Patent Literature 2 below), and the metal ball diameter is adjusted while leaving the length of the heat affected zone by the molten ball as it is in Japanese Unexamined Patent Application Publication No. 09-283526 (referred to as Patent Literature 3 below) in such a manner that a part of a metal wire just

above the metal ball of which crystal grains are coarsened due to the heat is within a position where the metal wire is pull-cut.

[0007]

As can be seen from the above examples, the object of keeping short the tail length of the silver-gold-palladium alloy bump by adjusting only the composition of the silver-gold-palladium alloy bumping wire has not been attained yet.

Citation List

Patent Literatures

[0008]

Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2007-142271

Patent Literature 2: Japanese Unexamined Patent Application Publication No. 11-251350

Patent Literature 3: Japanese Unexamined Patent Application Publication No. 09-283526

Summary of the Invention

Technical Problem

[0009]

An object of the invention of the present application is to provide a silver-gold-palladium alloy bumping wire which enables to shorten a tail length of a silver-gold-palladium alloy bump even when vertical pull-cut is performed in such a manner as to remarkably shorten a length of a heat affected zone after bonding of a molten

ball of the silver-gold-palladium alloy bumping wire.

Solution to Problem

[0010]

The inventors had found that a fluctuation in tail lengths of silver-gold palladium alloy bumps depends on Vickers hardness after a refining treatment and determined a composition of a silver-gold-palladium alloy bump of which Vickers hardness can be controlled based on the findings.

[0011]

A vertically pull-cut silver-gold-palladium bumping wire of the present invention is the one in which a silver-gold-palladium alloy comprises 1 to 9 mass% of gold (Au) and 0.5 to 5 mass% of palladium (Pd) with the balance being silver (Ag) having purity of 99.995 mass% or more (excluding the contained elements of Au and Pd), and Vickers hardness of the bumping wire before molten ball formation is 80 to 100 Hv.

[0012]

Preferably, the vertically pull-cut silver-gold-palladium bumping wire of the present invention is the one in which a silver-gold-palladium alloy comprises 6 to 9 mass% of gold (Au) and 2 to 4 mass% of palladium (Pd), with the balance being silver (Ag) having purity of 99.995 mass% or more (excluding the contained elements of Au, Pd, Ca, Be, La, Y, and Eu), and Vickers hardness of the bumping wire before molten ball formation is 80 to 100 Hv.

[0013]

Also, the vertically pull-cut silver-gold-palladium bumping wire of the present invention is the one in which a silver-gold-palladium alloy comprises 6 to 9 mass% of gold (Au), 2 to 4 mass% of palladium (Pd), and 1 to 30 mass ppm of at least one of calcium (Ca), beryllium (Be), lanthanum (La), yttrium (Y), and europium (Eu) in a total amount of 10 to 100 mass ppm, with the balance being silver (Ag) having purity of 99.995 mass% or more [excluding the trace additive element(s)], and Vickers hardness of the bumping wire before molten ball formation is 80 to 100 Hv.

[0014]

In the present invention, the phenomenon of being eroded by a solder (solder erosion) typically observed with a Pb-Sn alloy and a Sn-Ag alloy slowly proceeds in silver (Ag) alloy bumps in general as compared to in gold (Au) bumps since diffusion of silver (Ag) is slower than that of gold (Au) in the solder. Also, diffusion of the silver (Ag) alloy bump into an aluminum (Al) electrode on a semiconductor chip is slower than that of gold (Au) and the aluminum (Al) electrode. The diffusion into aluminum (Al) of the chip electrode is observed with the gold (Au) bump, and a fragile Au-Al intermetallic compound is formed by the diffusion to allow a crack to develop on a bonding interface of the molten ball as the diffusion of the intermetallic compound proceeds on the bonding interface, resulting in the problem of generation of electric

conduction failure. In the case of the silver (Ag) alloy bump, an effect of delaying the electrical conduction failure is clearly exhibited within the composition ranges of the present invention. Also, the silver-gold-palladium alloy of the present invention is capable of enhancing high temperature exposure resistance and enables reliability improvement.

[0015]

In the present invention, gold (Au) and palladium (Pd) are perfectly solid-soluted into silver (Ag) to form a homogeneous silver-gold-palladium alloy. Since an alloy in which each of the noble metal elements maintains high purity is obtained, it is possible to form a bumping wire by continuous wire drawing, and quality of the bumping wire is stable.

It is necessary that the purity of silver (Ag) is 99.995 mass% or more, and the elements such as gold (Au) and palladium (Pd) as well as calcium (Ca), beryllium (Be), lanthanum (La), yttrium (Y), and europium (Eu) are excluded from the purity. Preferably, the purity of silver (Ag) is 99.999 mass% or more. Examples of impurity elements in silver (Ag) having purity of 99.99 mass% or more include Al, Mg, In, Ni, Fe, Cu, Si, and Cr.

Since the content of gold (Au) is smaller than that of silver (Ag) by one digit, the purity of gold (Au) may be 99.99 mass% or more. Preferably, the purity of gold (Au) is 99.995 mass% or more.

Since the content of palladium (Pd) is smaller than that of gold (Au), the purity of palladium (Pd) may be 99.9 mass% or more. Preferably, the purity of palladium (Pd) is 99.99 mass% or more.

[0016]

In the present invention, gold (Au) suppresses sulfurization of silver (Ag) during exposure to atmosphere, particularly during high temperature exposure. In the silver-gold-palladium alloy of the present invention, the range of gold (Au) is set to 1 to 9 mass% because it is difficult to suppress sulfurization of silver (Ag) with the content of less than 1 mass% and because a fluctuation in bump heights of the silver-gold-palladium alloy bumps becomes too large when the content exceeds 9 mass%. The gold (Au) is preferably within the range of 6 to 9 mass%. Also, in order to prevent chip breakage during first bonding, the content of gold (Au) may preferably be larger than the content of palladium (Pd).

[0017]

In the present invention, palladium (Pd) improves bonding reliability between the molten ball of the bumping wire and the aluminum (Al) electrode on the semiconductor chip. When the palladium (Pd) is within the range of 0.5 to 5 mass%, a bonding property in the first bonding of the molten ball to the aluminum (Al) electrode is stabilized, and, further, it is possible to enhance high temperature exposure resistance after the bonding. More preferably,

palladium is within the range of 2 to 4 mass%.

[0018]

In the present invention, Vickers hardness of the bumping wire is necessarily 80 to 100 Hv. In the case where a composition of a bumping wire is that of the present invention, Vickers hardness of the wire finished by drawing without any refining heat treatment is about 100 to 120 Hv. Static strength and dynamic strength in molten ball deformation of the silver-gold-palladium alloy immediately after continuous wire drawing are excessively high to cause chip breakage of the aluminum (Al) electrode during the bonding in the first bonding of the molten ball to the aluminum (Al) electrode. On the other hand, in the case where the bumping wire of the present invention is subjected to perfect annealing, Vickers hardness of the bumping wire is about 50 to 70 Hv. In the present invention, the predetermined Vickers hardness is efficiently attained by achieving a final wire diameter by the continuous wire drawing and then subsequently passing the wire through a heat treatment furnace. It is considered that the range of Vickers hardness indicates a crystal structure which is in a recovery region and immediately before the start of recrystallization. The Vickers hardness of the bumping wire may preferably be 85 to 95 Hv.

The continuous wire drawing may preferably be cold working of 90% or more, more preferably 99% or more, of a

wire diameter before the continuous wire drawing. The continuous wire drawing may preferably be wire drawing through dies, particularly preferably wire drawing through diamond dies. It is possible to readily form elongated fine recrystallized structures arranged in a concentric pattern by the drawing. An internal crystal structure of the silver-gold-palladium alloy is not changed after the continuous wire drawing and after the refining heat treatment, which is confirmed by observation with a scanning electron microscope.

The aluminum (Al) electrode is a pad of an ordinary high purity aluminum (Al) metal, a pad of an aluminum alloy containing several percent of copper (Cu) or silicon (Si), a pad of each of the above alloys coated with a noble metal or with a single layer or multilayer coating of a soft metal or an alloy, such as silver (Ag) plating or palladium (Pd) plating, may be used.

[0019]

In the present invention, 1 to 30 mass ppm of at least one of calcium (Ca), beryllium (Be), lanthanum (La), yttrium (Y), and europium (Eu) may preferably be contained in a total amount of 10 to 100 mass ppm. The elements are equally capable of shortening the heat affected zone of the molten ball in the silver-gold-palladium alloy. In the case where at least one of the elements is contained in an amount of 1 to 30 mass ppm and in a total amount of less than 10 ppm, a fluctuation in neck heights of the silver-

gold-palladium alloy bumps is increased. On the other hand, in the case where at least one of the elements is contained in an amount of 1 to 30 mass ppm and in a total amount exceeding 100 mass ppm, mechanical strength of the bumping wire becomes excessively high to cause chip breakage of the aluminum (Al) electrode during the first bonding. Calcium (Ca) and europium (Eu) are more preferred from the viewpoint of the added elements for reducing the fluctuation in bump heights of silver-gold-palladium alloy bumps, and they may preferably be contained in an amount of 20 to 50 mass ppm from the viewpoint of additive amount.

[0020]

In the present invention, a wire diameter of the bumping wire may more preferably be 15 to 25 μm since there is a tendency that the fluctuation in tail lengths of silver-gold-palladium alloy bumps is increased by a very small temperature difference and that the effects of the composition and the Vickers hardness of the present invention are more prominently exhibited as the wire diameter of the bumping wire is reduced.

Advantageous Effects of Invention

[0021]

The bumping wire of the present invention is capable of stabilizing the fluctuation by shortening the bump height of the silver-gold-palladium alloy bump. Particularly, when the trace additive elements are contained, it is possible to attain a shorter height as the

bump height of the silver-gold-palladium alloy bump.

Since a ratio of palladium (Pd) is small in the bumping wire of the present invention, sphericity of the molten ball and the bonding property in the first bonding are favorable.

Description of Embodiments

[0022]

[Examples]

As Examples 1 to 20 and Comparative Examples 1 to 4 having the compositions shown in Table 1, alloys in each of which predetermined amounts of gold (Au) and palladium (Pd) and a predetermined amount of at least one of calcium (Ca), beryllium (Be), lanthanum (La), yttrium (Y), and europium (Eu) are contained with the balance being a predetermined amount of silver having purity of 99.995 mass% (excluding the above-described contained elements), and the components are solid-soluted were prepared.

A wire material in which purity of each of silver (Ag) and gold (Au) is 99.999 mass% or more and purity of palladium (Pd) is 99.99 mass% or more was used.

Each of the alloys was molten and subjected to continuous die casting to produce a silver-gold-palladium element wire having a diameter of 8 mm. After that, wire drawing processing was performed to attain a diameter of 20 to 25 μm . After that, the silver-gold-palladium alloy element wire was produced by performing a heat treatment for refining.

[0023]

[Table 1]

		wt%			Mass:ppm					Vickers hardness	Neck height		HAZ length	
		Ag	Au	Pd	Ca	Be	La	Y	Eu	Hv	Average value	Fluctuation	(Average value)	Solder erosion
1	Examples	Balance	8.5	3.5						95	60	○	50±10	○
2		Balance	7.0	3.2						90	60	○	60±15	○
3		Balance	6.3	2.8						85	70	○	70±15	○
4		Balance	8.8	2.4						90	60	○	50±10	○
5		Balance	6.4	3.8						90	60	○	60±15	○
6		Balance	8.4	3.6	15					90	60	○	50±10	○
7		Balance	6.9	3.3		10				90	60	○	60±15	○
8		Balance	6.1	3.1			7	14		85	70	○	70±15	○
9		Balance	7.5	2.9					13	90	60	○	60±15	○
10		Balance	7.7	3.9	10	5	15			90	60	○	50±10	○
11		Balance	7.3	2.2			10	15	15	85	70	○	70±15	○
12		Balance	8.1	2.7	2			6	4	90	60	○	50±10	○
13		Balance	8.3	3.7	18	18	18	8	28	95	60	○	50±15	○
14		Balance	1.2	0.7						83	90	△	100±15	○
15		Balance	2.1	3.5						85	80	△	80±15	○
16		Balance	3.2	1.7						85	80	△	80±15	○
17		Balance	4.1	4.8		13				85	70	○	70±15	○
18		Balance	4.9	0.9	5		5		5	85	80	△	80±15	○
19		Balance	5.3	1.2	3			17		85	80	△	70±15	○
20		Balance	5.7	4.6		17	17		17	90	60	○	60±15	○
1	Comparative Examples	Balance	0.7	4.5	13					65	80	×	80±15	Impossible to conduct the test due to large fluctuation in neck heights
2		Balance	1.1	5.3						130	50	×	40±15	Impossible to conduct the test due to large fluctuation in neck heights
3		Balance	6.5	0.3		2	2	2	2	65	80	×	70±15	Impossible to conduct the test due to large fluctuation in neck heights
4		Balance	5.9	4.9	25	25	25	25	25	110	60	×	60±15	Impossible to conduct the test due to large fluctuation in neck heights

[0024]

(Vickers Hardness)

The Vickers hardness shown in the table was attained by keeping the wire diameter of the bumping wire after the continuous wire drawing to 25 μ m and controlling a refining heat treatment temperature with the use of a temperature meter which was capable of measuring up to the first decimal place in both of Examples and Comparative Examples. A Vickers hardness meter (type MWK-G3; product of Akashi Co. Ltd.) was used for the measurement of Vickers hardness.

[0025]

[HAZ (Heat Affected Zone) Length]

An average value of 10 samples produced by keeping the wire diameter of the bumping wire to 25 μm and adjusting a diameter of a molten ball to be twice of the wire diameter in a N₂ gas atmosphere by using a bump bonder (UTC-3000; product of Shinkawa, Ltd.) was obtained.

[0026]

(Neck Height)

Wire bumps were formed by the unit of 100 (10 rows $\times$ 10 columns) by keeping the wire diameter of the bumping wire to 25 μm and performing thermocompression bonding-aided ultrasonic bonding of an Al-0.5% Cu alloy film to a Si chip by using the bump bonder (UTC-3000; product of Shinkawa, Ltd.) and using molten balls each having a diameter which was twice of the wire diameter and pressure bonding balls each having a diameter which was 2.5 times of the wire diameter. An average value and a fluctuation of the neck heights of the wire bumps were detected as the results shown in the table.

In the table, $\bigcirc$ represents those with fluctuation (σ) of 5 μm or less, $\triangle$ represents those with fluctuation (σ) of 8 μm or less and $\times$ represents those with fluctuation (σ) exceeding 5 μm .

[0027]

A heating test was performed by resembling reflow.

In order to reproduce flip-chip bonding, bonding was

performed by heating at a temperature which is 20°C higher than a melting point of a Sn solder for 30 seconds in a state where each Au alloy and each solder faces each other. After that, in order to reproduce the reflow, the heating treatment was repeated 10 times in total. The heating treatments were performed under temperature conditions of a temperature which was 20°C higher than a melting point of the solder and a retention time of 40 seconds. The heating treatments were performed by using a differential thermal analysis device (DSC-3100; product of MAC Science Corporation) and under an Ar gas atmosphere (flow rate: 50 ml/min).

[0028]

The wire bumps of Examples and Comparative Examples and the results of the tests are shown in the table.

Comparisons of the wire composition ranges, the conditions for Vickers hardness, and the average values and the fluctuations of neck heights of the results shown in the table of Examples and Comparative Examples are as follows.

Since the gold (Au) content is below the lower limit in Comparative Example 1, the fluctuation in neck heights is large to make it impossible to perform the solder erosion test.

Since the gold (Au) content and the palladium (Pd) content are above the upper limits in Comparative Example 2, the fluctuation in neck heights is large to make it

impossible to perform the solder erosion test.

Since the palladium (Pd) content is below the lower limit, the total amount of trace additive elements is below the lower limit, and the Vickers hardness is below the lower limit in Comparative Example 3, the fluctuation in neck heights is large to make it impossible to perform the solder erosion test.

Since the total amount of trace additive elements is above the upper limit in Comparative Example 4, the fluctuation in neck heights is large to make it impossible to perform the solder erosion test.

From the above results, it is confirmed that it is essential that the predetermined Vickers hardness is attained within the composition ranges of the wires of the present invention.

Industrial Applicability

[0029]

Since the present invention enables a short bump height and a reduced fluctuation, it is useful as a connection wire for a high density high speed bump, particularly, as a bumping wire having a wire diameter of 25 μm or less.

Brief Description of Drawings

[0030]

Fig. 1 is a sectional view showing an ordinary stud bump mounting state.

Fig. 2 are sectional views sequentially showing a

vertical pull-cut bump formation process steps according to a conventional technology.

Reference Signs List

[0031]

- 1: capillary
- 2: bumping wire
- 5: wire clamper
- 32: semiconductor device
- 33: circuit substrate
- 34: electrode pad
- 36: projection electrode (wire bump)
- 50: capillary
- 51: wire
- 51a: initial ball

Claims

1. A vertically pull-cut silver-gold-palladium alloy bumping wire characterized in that

a silver-gold-palladium alloy comprises 1 to 9 mass% of gold (Au) and 0.5 to 5 mass% of palladium (Pd) with the balance being silver (Ag) having purity of 99.995 mass% or more, and Vickers hardness of the bumping wire before molten ball formation is 80 to 100 Hv.

2. A vertically pull-cut silver-gold-palladium alloy bumping wire characterized in that

a silver-gold-palladium alloy comprises 6 to 9 mass% of gold (Au) and 2 to 4 mass% of palladium (Pd), with the balance being silver (Ag) having purity of 99.995 mass% or more, and Vickers hardness of the bumping wire before molten ball formation is 80 to 100 Hv.

3. A vertically pull-cut silver-gold-palladium alloy bumping wire characterized in that

a silver-gold-palladium alloy comprises 1 to 9 mass% of gold (Au), 0.5 to 5 mass% of palladium, and 1 to 30 mass ppm of at least one of calcium (Ca), beryllium (Be), lanthanum (La), yttrium (Y), and europium (Eu) in a total amount of 10 to 100 mass ppm, with the balance being silver (Ag) having purity of 99.995 mass% or more [excluding the trace additive element(s)], and Vickers hardness of the bumping wire before molten ball formation is 80 to 100 Hv.

4. A vertically pull-cut silver-gold-palladium alloy bumping wire characterized in that

a silver-gold-palladium alloy comprises 6 to 9 mass% of gold (Au), 2 to 4 mass% of palladium (Pd), and 1 to 30 mass ppm of at least one of calcium (Ca), beryllium (Be), lanthanum (La), yttrium (Y), and europium (Eu) in a total amount of 10 to 100 mass ppm, with the balance being silver (Ag) having purity of 99.995 mass% or more [excluding the trace additive element(s)], and Vickers hardness of the bumping wire before molten ball formation is 80 to 100 Hv.

5. The silver-gold-palladium alloy bumping wire according to any one of claim 1 to claim 4, wherein the purity of silver (Ag) is 99.999 mass% or more.

6. The silver-gold-palladium alloy bumping wire according to any one of claim 1 to claim 4, wherein the content of gold (Au) is higher than the content of palladium (Pd).

7. The silver-gold-palladium alloy bumping wire according to any one of claim 1 to claim 4, wherein the Vickers hardness of the bumping wire is 85 to 95 Hv.

8. The silver-gold-palladium alloy bumping wire according to any one of claim 1 to claim 4, wherein the bumping wire has a wire diameter of 15 to 25 μm .