

DESCRIPTION

TITLE OF THE INVENTION: PROBE AND PROBE CARD

TECHNICAL FIELD

5 [0001] The present disclosure relates to a probe and a probe card.

BACKGROUND ART

[0002] A probe card is a card (board) equipped with a
10 probe. The probe card is for connecting electrodes (power input electrode, signal output electrode, and ground electrode) of an electronic circuit of a semiconductor device formed on a semiconductor wafer, to a tester device, by probe pins.

15 Inspection of the electrical characteristics of the electronic circuit of the semiconductor device is performed by supplying a current to the semiconductor device so as to operate the semiconductor device and then confirming whether or not the semiconductor device outputs a predetermined
20 signal. In this inspection, a large current flows through a probe for power supply (power supply probe) and a probe for ground (ground probe).

In inspection of the semiconductor device, when a large current flows through the power supply probe and the
25 ground probe, such a failure that the probes are burned can

occur. Therefore, it is desired that a probe having a high tolerable current value is used for the probe card.

In order to increase the tolerable current value while keeping the mechanical strength of the probe, it is proposed to use a probe configured such that a conductive material having a low resistance value (e.g., copper, silver, gold, and alloys thereof) is used as an inner member, and a conductive material having a high resistance value and a high mechanical strength (e.g., a conductive material selected from rhodium, platinum, iridium, alloys thereof, palladium-cobalt alloy, palladium-nickel alloy, and nickel-phosphorus alloy, and preferably, rhodium) is provided around the outer periphery of the inner member (see, for example, Patent Document 1).

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CITATION LIST

PATENT DOCUMENT

[0003] Patent Document 1: Japanese Translation of PCT International Publication No. 2018-501490

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SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0004] As a probe is repeatedly used, a tip portion to contact with an electrode is gradually worn. In conventional probes, the surface of Cu is plated with Pd-Co, and when the

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tip portion is worn, Cu present inside is exposed. Then, Cu is oxidized, so that the condition in which the probe contacts with the electrode is changed. For preventing exposure of Cu, a predetermined part of the tip portion is
5 formed by Pd-Co. When the tip portion of the probe is formed by Pd-Co as described above, the probe becomes able to withstand wear. However, the Pd-Co part has a high resistance value, thus causing a new problem that heat is generated at this part.

10 [0005] Accordingly, as a probe for withstanding wear and solving the heat generation problem, it is proposed that Pd-Co is replaced with Ni-B, for example. However, when Pd-Co is merely replaced with Ni-B, separation occurs at the interface between Cu and the Ni-B plating layer, and
15 therefore the adhesion of the plating layer needs to be improved.

[0006] The present disclosure has been made to solve the above problems, and an object of the present disclosure is to provide a probe and a probe card that withstand wear, exhibit
20 reduced heat generation, and have improved adhesion between members.

MEANS TO SOLVE THE PROBLEM

[0007] A probe according to the present disclosure is a
25 probe having, at one end in a longitudinal direction, a

contact portion to contact with an electrode of an inspection target, and having, at another end in the longitudinal direction, a terminal portion to contact with a circuit board, the probe including: a low-high resistance portion
5 formed such that a low-resistance portion made of a first metal that is conductive is coated with a high-resistance portion made of a second metal that is conductive and has a higher resistivity than a resistivity of the low-resistance portion; and a middle-high resistance portion including a
10 middle-resistance portion connected to the low-resistance portion in the longitudinal direction of the probe, on the contact portion side of the low-high resistance portion, the middle-resistance portion being made of a third metal having a lower resistivity than the resistivity of the high-
15 resistance portion and having a higher resistivity than the resistivity of the low-resistance portion, and high-resistance portions provided on both side surfaces in one direction of the middle-resistance portion, and connected to the high-resistance portion of the low-high resistance
20 portion.

EFFECT OF THE INVENTION

[0008] The probe and the probe card according to the present disclosure make it possible to provide a probe and a
25 probe card that withstand wear, exhibit reduced heat

generation, and have improved adhesion between members.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] [FIG. 1] FIG. 1 schematically shows a state in
5 which an electronic circuit is inspected by a probe card
according to embodiment 1.

[FIG. 2] FIG. 2A is a perspective view of a probe
according to embodiment 1. FIG. 2B is a view of the probe
shown in FIG. 2A, as seen from a buckling direction Z+ side.

10 [FIG. 3] FIG. 3A is a schematic sectional view of
the probe, an upper guide, an intermediate guide, and a lower
guide. The probe is shown as a sectional view along line A-A
in FIG. 2A. FIG. 3B is a sectional view along line B-B in
FIG. 2A and along a direction perpendicular to a longitudinal
15 direction of a low-high resistance portion of the probe.
FIG. 3C is a sectional view along line C-C in FIG. 2A and
along a direction perpendicular to a longitudinal direction
of a middle-high resistance portion of the probe.

[FIG. 4] FIG. 4 is a sectional view of the guides
20 and the probe in a buckled state according to embodiment 1.

DESCRIPTION OF EMBODIMENTS

[0010] Embodiment 1

Hereinafter, a probe and a probe card according to
25 embodiment 1 will be described with reference to the

drawings.

FIG. 1 schematically shows a state in which an electronic circuit is inspected by a probe card 100 according to embodiment 1.

5 As used herein, the upper side on the drawing sheet in FIG. 1 is defined as "up", and the lower side on the drawing sheet is defined as "down". That is, an inspection target side as seen from the probe card 100 is defined as "down". For convenience sake, the left-right direction in
10 FIG. 1 is defined as a buckling direction Z, and in particular, in a case of discriminating between left and right, the left side in FIG. 1 is defined as a buckling direction Z+ side, and the right side in FIG. 1 is defined as a buckling direction Z- side. For convenience sake, a
15 direction from a front side to a back side of the drawing sheet and a direction opposite thereto are defined as a direction Y perpendicular to the buckling direction Z.

[0011] The probe card 100 includes multiple probes 20 to contact with electrodes C on an electronic circuit of a
20 semiconductor device formed on a semiconductor wafer W.

[0012] The probe card 100 includes a frame 10, an upper guide 11U attached to an upper end of the frame 10, a lower guide 11L attached to a lower end of the frame 10, an intermediate guide 11M attached between the upper guide 11U
25 and the lower guide 11L, and a wiring board 14. It suffices

that at least two guides are provided.

[0013] The upper guide 11U has a plurality of guide holes 11Uh extending therethrough in the up-down direction, and the intermediate guide 11M and the lower guide 11L also have a
5 plurality of guide holes 11Mh and 11Lh extending therethrough in the up-down direction. The wiring board 14 is located on the upper side of the frame 10. The wiring board 14 has, on a lower surface thereof, a plurality of probe connection pads 14P to contact with terminal portions 20T at upper ends of
10 the probes 20.

[0014] Then, the plurality of probes 20 are guided by being inserted through the guide holes 11Uh, the guide holes 11Mh, and the guide holes 11Lh, respectively. The probe 20 is a vertical probe disposed perpendicularly to the
15 inspection target (the electronic circuit formed on the semiconductor wafer W).

[0015] FIG. 2A is a perspective view of the probe 20. FIG. 2B is a view of the probe 20 shown in FIG. 2A, as seen from the buckling direction Z+ side.

20 The left-right direction in FIG. 2A is the buckling direction Z of the probe 20, i.e., a direction in which the probe 20 elastically deforms at the time of overdrive of the probe card 100.

FIG. 3A is a schematic sectional view of the probe
25 20, the upper guide 11U, the intermediate guide 11M, and the

lower guide 11L. The probe 20 is shown as a sectional view along A-A in FIG. 2A.

FIG. 3B is a sectional view along line B-B in FIG. 2A and along a direction perpendicular to a longitudinal direction X of a low-high resistance portion 20LH of the probe 20.

FIG. 3C is a sectional view along line C-C in FIG. 2A and along a direction perpendicular to the longitudinal direction X of a middle-high resistance portion 20MH of the probe 20.

FIG. 4 is a schematic sectional view of the probe 20, the upper guide 11U, the intermediate guide 11M, and the lower guide 11L and shows a state in which the probe 20 is buckled and deformed.

[0016] The probe 20 has a thin long shape. A center portion thereof is curved and upper and lower portions extend straight in the up-down direction. The curved center portion is an elastic deformation portion 20D. The probe 20 has a contact portion 20C at a lower end (one end). A terminal portion 20T is formed at an upper end (another end).

[0017] The contact portion 20C is a contact portion to contact with the inspection target. The terminal portion 20T is provided at an upper end of the probe 20, and is pressed in contact with the probe connection pad 14P of the wiring board 14 at the time of inspection. The elastic deformation

portion 20D is a part that is readily buckled and deformed as shown in FIG. 4 by being subjected to a compression force in the longitudinal direction X at the time of overdrive. At the time of overdrive, the elastic deformation portion 20D is
5 buckled and deformed in the buckling direction Z in accordance with a reaction force from the inspection target, so that the contact portion 20C moves back toward the terminal portion 20T side.

[0018] The probe 20 is conductive and is made of three
10 kinds of metals having different resistivities. One of the metals is a first metal having a low resistivity, such as Cu, Au, or Ag (copper, gold, or silver). Of the probe 20, a part formed by the first metal is a low-resistance portion 20L. Another one is a second metal, such as a Pd-Co (palladium-cobalt) alloy, which has a higher resistivity than the first
15 metal and is low in conductivity and high in mechanical strength. Of the probe 20, a part formed by the second metal is a high-resistance portion 20H. Still another one is a third metal, such as a Ni-B alloy, of which the hardness and
20 the resistivity are intermediate between those of the first metal and the second metal. Of the probe 20, a part formed by the third metal is a middle-resistance portion 20M.

[0019] The low-resistance portion 20L has a high conductivity and serves to increase the tolerable current
25 value of the probe 20. However, Cu is subject to oxidation,

and therefore the probe 20 cannot be formed using only the first metal. Accordingly, the low-resistance portion 20L is coated with the high-resistance portion 20H. The high-resistance portion 20H serves to keep the mechanical strength of the probe 20. The middle-resistance portion 20M has a resistance lower than that of the high-resistance portion 20H and higher than that of the low-resistance portion 20L, and serves to suppress heat generation at the contact portion 20C of the probe 20.

10 [0020] As shown in FIG. 3A and FIG. 3B, of the probe 20, a part to the terminal portion 20T side from a lower end (boundary K) of the low-high resistance portion 20LH, which is present below the intermediate guide 11M and above the lower guide 11L, is formed such that the periphery of the low-resistance portion 20L having a quadrangular prism shape is coated with the high-resistance portion 20H. This part is defined as the low-high resistance portion 20LH. The low-high resistance portion 20LH is inserted in the guide hole 11Lh of the lower guide 11L closest to the contact portion 20C side.

[0021] A part from the lower end (boundary K) of the low-high resistance portion 20LH to the contact portion 20C at the distal end has a rectangular sectional shape along a direction perpendicular to the longitudinal direction X of the probe 20. As shown in FIG. 3C, this part has an

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irregular three-layer structure in the buckling direction Z. That is, in the sectional view shown in FIG. 3C, high-resistance portions 20H having thin-sheet shapes are present on both sides in the buckling direction Z of the middle-resistance portion 20M, and the middle-resistance portion 20M is interposed therebetween. This part is defined as the middle-high resistance portion 20MH. The middle-resistance portion 20M is connected to the low-resistance portion 20L in the longitudinal direction X of the probe 20. No high-resistance portions 20H are provided on both side surfaces in the direction Y perpendicular to the buckling direction Z of the middle-high resistance portion 20MH.

[0022] The widths in the direction Y of the two high-resistance portions 20H of the middle-high resistance portion 20MH are different between the buckling direction Z+ side and the buckling direction Z- side. The width of the high-resistance portion 20H on the buckling direction Z- side is the same as the width in the direction Y of the middle-resistance portion 20M, but the width of the high-resistance portion 20H on the buckling direction Z+ side is smaller than the width in the direction Y of the middle-resistance portion 20M. Therefore, when the middle-high resistance portion 20MH is seen from the buckling direction Z- side, it appears that the middle-resistance portions 20M are present on both sides in the direction Y and the high-resistance portion 20H is

interposed therebetween. The high-resistance portion 20H of the middle-high resistance portion 20MH is formed flush with the high-resistance portion 20H such that the high-resistance portion 20H is embedded, along the longitudinal direction X of the probe 20, in a recess 20MR formed on the buckling direction Z+ side of the middle-resistance portion 20M. The recess 20MR may be provided also on the buckling direction Z- side so as to form the same structure as on the buckling direction Z+ side.

10 [0023] The probe 20 is manufactured using so-called MEMS (Micro Electro Mechanical Systems). The MEMS is a technology for manufacturing a fine three-dimensional structure using photolithography and sacrificial layer etching. The photolithography is a technology for working a fine pattern using a photoresist which is used in a semiconductor manufacturing process or the like. The sacrificial layer etching is such a technology that a lower layer called a sacrificial layer is formed, a layer to form a structure is formed thereon, and then only the sacrificial layer is removed by etching, thereby forming a three-dimensional structure.

[0024] For a process for forming layers including the sacrificial layer, a known plating technology can be used. For example, a substrate as a cathode and a metal piece as an anode are immersed in an electrolyte solution, and a voltage

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is applied between both electrodes, whereby metal ions in the electrolyte solution can be deposited on a substrate surface. Such processing is called electroplating, and this is a wet process in which a substrate is immersed in an electrolyte solution. Therefore, drying processing is performed after the plating processing.

[0025] The low-resistance portion 20L, the high-resistance portion 20H, and the middle-resistance portion 20M adjacent to each other are laminated through the above plating processing.

[0026] In the probe 20 and the probe card 100 according to embodiment 1, the middle-high resistance portion 20MH having a Ni-B alloy layer is provided under the low-high resistance portion 20LH of the probe 20 formed by coating the periphery of the low-resistance portion 20L with the high-resistance portion 20H, whereby heat generation at the tip portion of the probe can be suppressed.

[0027] In the middle-high resistance portion 20MH of the probe 20, the middle-resistance portion 20M is interposed in the buckling direction Z between the high-resistance portions 20H, whereby separation can be prevented from occurring at the plating interface of the low-resistance portion 20L and the middle-resistance portion 20M.

[0028] In the probe 20, the second metal forming the high-resistance portion 20H composing the low-high resistance

portion 20LH and the second metal composing the high-resistance portion 20H of the middle-high resistance portion 20MH, are formed continuously. Thus, rigidity of the probe 20 can be kept.

5 [0029] In the middle-high resistance portion 20MH of the probe 20, one of the high-resistance portions 20H of the middle-high resistance portion 20MH is formed flush with the high-resistance portion 20H such that the one high-resistance portion 20H is embedded in the recess 20MR formed at the
10 surface on the buckling direction Z+ side of the middle-resistance portion 20M. Thus, it is possible to ensure not only a mechanical strength with respect to the buckling direction Z but also a sufficient strength with respect to a force acting in the direction Y perpendicular to the buckling
15 direction Z.

[0030] In the present embodiment 1, the widths in the direction Y of the two high-resistance portions 20H of the middle-high resistance portion 20MH are different from each other. However, these widths may be the same. In this case,
20 the widths may be made equal to the width on the right side in FIG. 3C, or may be made equal to the width on the left side such that the high-resistance portions 20H on both sides in the buckling direction Z are embedded flush with the middle-resistance portion 20M.

25 [0031] Although the disclosure is described above in terms

of an exemplary embodiment, it should be understood that the various features, aspects, and functionality described in the embodiment are not limited in their applicability to the particular embodiment with which they are described, but
 5 instead can be applied alone or in various combinations to the embodiment of the disclosure.

It is therefore understood that numerous modifications which have not been exemplified can be devised without departing from the scope of the present disclosure.
 10 For example, at least one of the constituent components may be modified, added, or eliminated.

DESCRIPTION OF THE REFERENCE CHARACTERS

	[0032]	100	probe card
15		10	frame
		11U	upper guide
		11L	lower guide
		11M	intermediate guide
		11Uh, 11Mh, 11Lh	guide hole
20		14	wiring board
		14P	probe connection pad
		20	probe
		20C	contact portion
		20D	elastic deformation portion
25		20H	high-resistance portion

	20M	middle-resistance portion
	20L	low-resistance portion
	20LH	low-high resistance portion
	20MH	middle-high resistance portion
5	20MR	recess
	20T	terminal portion
	C	electrode
	W	semiconductor wafer
	X	longitudinal direction
10	Y	direction
	Z	buckling direction
	K	boundary

CLAIMS

[Claim 1] A probe having, at one end in a longitudinal direction, a contact portion to contact with an electrode of an inspection target, and having, at another end in the longitudinal direction, a terminal portion to contact with a circuit board, the probe comprising:

a low-high resistance portion formed such that a low-resistance portion made of a first metal that is conductive is coated with a high-resistance portion made of a second metal that is conductive and has a higher resistivity than a resistivity of the low-resistance portion; and

a middle-high resistance portion including a middle-resistance portion connected to the low-resistance portion in the longitudinal direction of the probe, on the contact portion side of the low-high resistance portion, the middle-resistance portion being made of a third metal having a lower resistivity than the resistivity of the high-resistance portion and having a higher resistivity than the resistivity of the low-resistance portion, and

high-resistance portions provided on both side surfaces in one direction of the middle-resistance portion, and connected to the high-resistance portion of the low-high resistance portion.

[Claim 2] The probe according to claim 1, wherein

the high-resistance portion of the middle-high resistance portion is embedded, along the longitudinal direction of the probe, in the middle-resistance portion, as seen in the one direction.

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[Claim 3] The probe according to claim 1, wherein

the high-resistance portion of the middle-high resistance portion is formed in a recess formed on at least one of the side surfaces in the one direction of the middle-
10 resistance portion.

[Claim 4] The probe according to any one of claims 1 to 3, wherein

the first metal is one of gold, silver, or copper,
15 the second metal is a Pd-Co alloy, and
the third metal is a Ni-B alloy.

[Claim 5] A probe card comprising:

a plurality of the probes according to claim 4; and
20 at least two guides each having a plurality of
guide holes in which the probes are respectively inserted so
as to be guided, wherein

the middle-high resistance portions are inserted in
the guide holes of the guide located closest to the contact
25 portion side.

[Claim 6] The probe card according to claim 5, wherein
the one direction is a buckling direction of the
probes.