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Title: Contact probe for a testing head

## DESCRIPTION

### Field of application

The present invention refers to a contact probe for a testing head.

- 5 The invention refers in particular, but not exclusively, to a contact probe for a testing head for a testing apparatus of electronic devices integrated on wafers and the following description is made with reference to this field of application with the only purpose of simplifying its exposition.

### Prior art

- 10 As it is well known, a testing head (probe head) is essentially a device adapted to place a plurality of contact pads of a microstructure, in particular an electronic device that is integrated on a wafer, into electrical contact with corresponding channels of a testing machine performing the working test thereof, in particular the electrical one, or generically the  
15 test.

- The test, which is performed on integrated devices, is particularly useful to detect and isolate defective devices yet in the manufacturing step. Generally, the testing heads are thus used to electrically test the devices that are integrated on a wafer before cutting and assembling them inside a  
20 chip containing package.

A testing head usually comprises a large number of contact elements or contact probes made of wires of special alloys having good electrical and mechanical properties and provided with at least one contact portion for a corresponding plurality of contact pads of a device to be tested.

- 25 A testing head comprising vertical probes, which is usually called "vertical probe head", essentially comprises a plurality of contact probes retained by at least one pair of plates or guides, which are substantially plate-shaped and parallel to each other. Those guides are provided with suitable holes and are arranged at a certain distance from each other so as to leave  
30 a free space or air gap for the movement and the possible deformation of

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the contact probes. The pair of guides comprises in particular an upper guide and a lower guide, both provided with respective guide holes where the contact probes axially slide, the probes being usually made of wires of special alloys having good electrical and mechanical properties.

- 5 The good connection between the contact probes and the contact pads of the device to be tested is guaranteed by pressing the testing head on the device itself, the contact probes, which are movable within the guide holes made in the upper and lower guides, undergoing a bending inside the air gap between the two guides and sliding within such guide holes during  
10 that pressing contact.

Furthermore, the bending of the contact probes in the air gap can be assisted by means of a suitable configuration of the probes themselves or of their guides, as schematically shown in Figure 1, where for sake of illustration simplicity only one contact probe of the plurality of probes  
15 usually included in a testing head has been shown, the shown testing head being of the so-called shifted plates type.

In particular, Figure 1 schematically shows a testing head 1 comprising at least one upper plate or guide 2 and one lower plate or guide 3, having respective upper guide hole 2A and lower guide hole 3A where at least one  
20 contact probe 4 slides.

The contact probe 4 has at least one contact end or contact tip 4A. Here and in the following, the terms end or tip mean an end portion, not necessarily being sharp. In particular the contact tip 4A abuts on a contact pad 5A of a device to be tested 5, realizing the mechanical and  
25 electrical contact between that device and a testing apparatus (not shown) of which such testing head is a terminal element.

In some cases, the contact probes are fixedly fastened to the head itself at the upper guide: in such case, the testing heads are referred to as blocked probe testing heads.

- 30 Alternatively, testing heads having probes not fixedly fastened are used, those probes being interfaced to a board by means of a micro-contact board; those testing heads are referred to as non-blocked probe testing heads. The micro-contact board is usually called "space transformer"

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since, besides contacting the probes, it also allows to spatially redistribute the contact pads made on it with respect to the contact pads of the device to be tested, in particular relaxing the distance constraints between the centers of the pads themselves.

5 In this case, as illustrated in Figure 1, the contact probe 4 has a further contact tip 4B, which in this technical field is referred to as contact head, towards a plurality of contact pads 6A of such a space transformer 6. The good electrical contact between probes and space transformer is guaranteed in a similar manner to the contact with the device to be tested  
10 by pressing the contact heads 4B of the contact probes 4 against the contact pads 6A of the space transformer 6.

As already explained, the upper 2 and lower 3 guides are suitably spaced by an air gap 7 which allows the deformation of the contact probes 4 and ensures the contact of the contact tip and of the contact head of the  
15 contact probes 4 with the contact pads of the device to be tested 5 and of the space transformer 6, respectively. Obviously, the upper 2A and lower 3A guide holes must be sized so as to allow a sliding movement of the contact probe 4 therein.

In fact, it should be remembered that the correct operation of a testing  
20 head is basically linked to two parameters: the vertical movement, or overtravel, of the contact probes and the horizontal movement, or scrub, of the contact tips of such probes.

These characteristics must therefore be evaluated and calibrated in the manufacturing step of a testing head, since the good electrical connection  
25 between the probes and the device to be tested must always be guaranteed.

It is also possible to realize a testing head having contact probes protruding from a support, usually made of a ceramic material, possibly suitably preformed so as to ensure a proper bending thereof during the  
30 contact with the pads of a device to be tested. Such probes are further deformed when contacting the pads of the device to be tested.

The increase of the packing density of the probes required by the most modern technologies of integration on wafers has caused the occurrence of

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problems of contact between adjacent probes, in particular during their deformation during the operation of the testing head.

In order to ensure a correct orientation of the probes, and in particular of their deformed sections, and therefore also of their deformation, it is  
5 known to realize contact probes having non-circular section, and in particular rectangular, and testing heads with guides having respective guide holes in turn having non-circular section, in particular rectangular, keeping in position the contact probes during the contact thereof with the contact pads of the device to be tested and their consequent further  
10 deformation.

It is convenient to emphasize that the end portions of contact probes 4, at the contact head and contact tip 4A and 4B and in particular comprising the portions of the probes that are apt to slide in the guide holes 2A and 3A, are normally made so as to be tilted with respect to the axes of these  
15 holes (usually orthogonal to a plane defined by the device to be tested), in order to ensure the desired scrub on the contact pads.

The inclination of the end portions of the contact probes with respect to the axes of the guide holes then creates one or more points of contact between probes and holes, so as to realize an at least partial retention of  
20 the probes inside the holes.

It happens, however, that the retention of the probes, and in particular of their end portions, inside the guide holes is sometimes excessive, which limits the freedom of sliding of the probes themselves and affecting the proper operation of the testing head as a whole. In extreme conditions, the  
25 contact probes can "get stuck" inside the guide holes, completely stopping any operation of the testing head and leading to the need to replace it.

To ensure a correct sliding of the probe inside a relative guide hole as well as a proper hold in position of the probes inside the guides, while minimizing the risk that the probes get stuck and thus the need to replace  
30 the head, it is known to coat the end portions of the contact probes 4 with layers of a conductive material having a greater hardness than that of the conductive material forming the rest of the contact probe.

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In particular, the coating layers extend in correspondence of a terminal portion of the respective end portion, from a tip up to the full height of the respective guide hole.

5 However, conductive materials with high hardness have also a marked fragility and can be made only in the form of films of reduced thickness, for example between 0.01 microns and 5 microns.

As it is known for example from US patent application No. US 2012/0286816, it is also possible to use such conductive materials with high hardness for producing thin plates protruding from the body of the  
10 contact probes at their end portions. These plates, which are very resistant and able to penetrate a possible oxide layer which covers the contact pads, also allow in particular to make contact with the so-called bump, i.e. of conductive elements protruding from a device to be tested as contact portions, as it happens in other embodiments for the contact  
15 pads.

In some cases, a central portion of the contact probe is also coated with a layer of insulating material, such as arylene, apt to improve the electrical insulation of the probes, in particular avoiding short circuits in the event of accidental contacts between adjacent contact probes.

20 Coatings of the end portions of the contact probes by means of noble metals, in particular palladium-based noble metals, are also used to improve the contact of such end portions with respective contact pads, the materials forming the contact probes having in fact contact problems, in particular by varying the operating temperatures of the testing head  
25 including the contact probes.

The technical problem of the present invention is to provide a contact probe having at least one end portion made of at least one conductive material having a greater hardness value than a conductive material that forms a body of the contact probe and being able to improve the contact of  
30 the end portions with respective contact pads, and at the same time avoiding the breakage of the end portion, so as to overcome the limitations and drawbacks currently affecting the testing heads made according to the prior art.

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### Summary of the invention

The solution idea at the basis of the present invention is to realize a contact probe having at least one end portion provided with an insert made of a conductive material with a greater hardness value than a  
5 conductive material forming the contact probe, such an insert being supported by at least one section of the end portion made of the same material forming the contact probe.

Based on that solution idea, the technical problem is solved by a contact probe for a testing head of a testing apparatus of electronic devices  
10 comprising a body essentially extended in a longitudinal direction between respective end portions adapted to contact respective contact pads, characterized in that at least one end portion comprises an insert made of a first conductive material having a hardness greater than a second conductive material which forms the contact probe, the insert being  
15 supported by a section of the end portion, the section being made of the second conductive material and being shaped so as to have a shape that is complementary to the insert and to have respective abutting surfaces facing and adhering to respective abutting surfaces of the insert.

More in particular, the invention comprises the following additional and  
20 optional characteristics, taken alone or in combination if needed.

According to another aspect of the invention, the insert can be made of a first conductive material having a hardness greater than a second conductive material which forms the contact probe, and in particular the end portion and the section.

25 The first conductive material may be a metal or a metal alloy selected from rhodium, platinum, iridium or a metal alloy thereof, or a palladium-cobalt alloy, a palladium-nickel alloy or a nickel-phosphorous alloy, preferably rhodium.

The second conductive material may be a metal or a metal alloy selected  
30 from nickel or a metal alloy thereof, such as nickel-manganese, nickel-cobalt or nickel-tungsten alloys, copper or an alloy thereof, palladium or an alloy thereof, preferably nickel-tungsten.

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According to another aspect of the invention, the insert and the section can have respective free end surfaces, forming a contact area of the contact probe.

5 In particular, the insert may comprise at least one first abutting surface arranged at the bottom of the insert along a longitudinal direction of the contact probe, at an opposite position with respect to the contact area and at least one second lateral abutting surface along a transversal direction perpendicular to the longitudinal direction, such first and second abutting surfaces of the insert facing and contacting respectively first and second  
10 abutting surfaces of the section.

According to another aspect of the invention, the section can comprise a substantially laminar or thin plate portion for abutting the insert.

Moreover, the insert can have a height substantially corresponding to a height of the contact probe and in particular of the section. Alternatively,  
15 the insert can have a height lower than a height of the contact probe and in particular of the section.

In such case, the insert can have a height equal to 20%-80% of the height of the contact probe and in particular of the section, preferably equal to 50%.

20 According to this aspect of the invention, the insert can be arranged in correspondence of one corner of the contact probe, or in correspondence of only one side of the contact probe or can be positioned so as to be fully embedded in the contact probe.

25 According to another aspect of the invention, the insert and the section can have a lowered portion. In particular, the lowered portion can reduce a height of the contact area to a value equal to 20%-80% of the height of the contact probe.

Furthermore, according to another aspect of the invention, the contact probe can comprise at least one coating layer, extending in  
30 correspondence of the end portion, in order to cover at least the section and insert.

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In particular, the coating layer can be made of a conductive alloy having a low internal stress, preferably a nickel alloy or a conductive alloy having a high wear resistance, preferably rhodium or an alloy thereof.

5 According to another aspect of the invention, the contact probe can further comprise at least one adhesion film disposed at the abutting surfaces between the insert and section.

In particular, the adhesion film can be a metal or a metal alloy selected from nickel or a nickel alloy or gold, silver, platinum alloy, or a metal alloy thereof, preferably gold.

10 According to yet another aspect of the invention, the insert and the section can have curvilinear free end surfaces, the free end surfaces forming a contact area of the contact probe.

In particular, the contact area can be formed by the free end surface of the insert only.

15 Furthermore, according to another aspect of the invention, the end portion can comprise at least one first and one second insert, symmetrically arranged on the sides of a thin plate portion of the section realizing a support for both inserts.

20 In particular, the thin plate portion can have a height lower than a height of the contact probe. Additionally, the thin plate portion can be centrally arranged and can be completely surrounded by the insert, which is substantially crown-shaped, or it can be arranged having a surface emerging from one surface of the contact probe, the insert being essentially U-shaped, or it can be arranged at one corner of the contact  
25 probe, surrounded by the insert, which is substantially L-shaped.

Furthermore, according to yet another aspect of the invention, the contact probe may comprise at least one material bridge arranged between the insert and the section. Such material bridge can be made of the first conductive material.

30 Finally, the insert can have a length along a longitudinal direction with a value between 10  $\mu\text{m}$  and 1000  $\mu\text{m}$ .

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The technical problem is also solved by a testing head for a testing apparatus of electronic devices comprising a plurality of contact probes, the contact probes being realized as indicated above.

5 The characteristics and the advantages of the contact probe according to the invention will result from the following description of one embodiment thereof, given by way of an indicative and non-limiting example with reference to the annexed drawings.

#### Brief Description of the Drawings

In such drawings:

- 10 - Figure 1 schematically shows a contact probe for a testing head having vertical probes according to the prior art;
- Figures 2A and 2B schematically show an embodiment of a contact probe according to the present invention, in a perspective and exploded view, respectively; and
- 15 - Figures 3, 4A-4C, 5, 6A-6D, 7A-7B, 8 and 9 schematically show a perspective view of alternative embodiments of a contact probe according to the present invention.

#### Detailed description

20 With reference to those Figures, and in particular to Figure 2A, a contact probe for a testing head of a testing apparatus of electronic devices integrated on wafers is described, the contact probe being globally indicated with 10.

It should be noted that the Figures represent schematic views of the contact probe according to the invention and are not drawn to scale, but  
25 instead are drawn so as to emphasize the important features of the invention. In the Figures, the different pieces are shown schematically, as their shape can vary depending on the desired application.

In particular, Figure 2A essentially shows an end portion 10A of the contact probe 10, the end portion 10A comprising for example at least one  
30 contact tip apt to abut on a contact pad of a device to be tested, which is

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not shown as it is of conventional type. The contact probe 10 may have a configuration that can be used in a so called vertical probe testing head, such as the one illustrated in Figure 1 in relation to the prior art, or may have any other form used in the technical field, ending with an end  
5 portion 10A apt to make contact with a contact pad, which can be a contact pad of a device to be tested, as in the case of a contact tip, or can be a contact pad of a space transformer, as in the case of a contact head.

Considering the end portion 10A as a contact tip, the contact probe 10 illustrated in known example of Figure 1 may also comprise a further end  
10 portion, in particular a contact head (not shown), having the same or a different shape compared to the contact tip, the contact head being intended to abut onto a contact pad of a space transformer, as in the case of non-blocked probes. Alternatively, the contact head can be fixedly associated to a ceramic support, for example by welding, as in the case of  
15 blocked probes protruding from that support.

The contact probe 10 also comprises a body 10C essentially extended in a longitudinal direction between the end portions, in particular between the contact tip and the contact head, that direction being indicated with Y in Figure 2A.

20 According to an aspect of the invention, at least one end portion 10A of the contact probe 10, for example the contact tip, comprises an insert 20, which is supported by a section 21 of such end portion 10A.

More particularly, as shown in the exploded view of Figure 2B, the section 21 is shaped so as to have at least one first abutting surface 21A and one  
25 second abutting surface 21B abutting and contacting, respectively, a first abutting surface 20A and a second abutting surface 20B of the insert 20. The section 21 comprises a portion 21' substantially laminar (i.e. a thin plate portion) forming a support for abutting the insert 20.

The insert 20 and the section 21 have respective free end surfaces 22A  
30 and 22B, forming a contact area 22 of the contact probe 10, as globally indicated in Figure 2A.

In particular, the first abutting surface 20A of the insert 20 is a surface arranged at the bottom of the insert 20 along the longitudinal direction Y,

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considering as starting point the contact area 22 of the contact probe 10, while the second abutting surface 20B of the insert 20 is a lateral surface along a transverse direction indicated always with X in Figure 2A, in particular it is a right lateral surface according to the local reference  
5 system of the Figure.

The insert 20 has a length L according to the longitudinal direction Y with a value between 10  $\mu\text{m}$  and 1000  $\mu\text{m}$  and a height H1 according to the orthogonal direction Z, always indicated in Figure 2A, equal to a height H of the contact probe 10 and with a value between 20  $\mu\text{m}$  and 100  $\mu\text{m}$ .

10 In the example of Figure 2A, the insert 20 is in particular positioned at one corner of the contact probe 10 and has further exposed surfaces, in particular an upper surface, a lower surface and a left lateral surface, always considering the local reference system of the Figure.

Suitably, the insert 20 is made of a first conductive material having a  
15 hardness greater than a second conductive material, which the contact probe 10 is made of, and in particular which the body 10C and the end portion 10A of the contact probe 10, more particularly the section 21, are made of.

The first conductive material is a metal or a metal alloy and can be  
20 rhodium, platinum, iridium or a metal alloy thereof, or a palladium-cobalt alloy, a palladium-nickel alloy or a nickel-phosphorous alloy. In a preferred embodiment of the invention, the first conductive material is rhodium.

Furthermore, the second conductive material is a metal or a metal alloy  
25 and can be for example nickel or an alloy thereof, such as a nickel-manganese alloy, a nickel-cobalt alloy or a nickel-tungsten alloy, copper or an alloy thereof, palladium or an alloy thereof. In a preferred embodiment of the invention, the second conductive material is nickel-tungsten.

It must be underlined in particular that, by virtue of its shape and of the  
30 materials used, the section 21 of the end portion 10A realizes a mechanical support for the insert 20, the second conductive material of the section 21 being less fragile than the first conductive material of the

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insert 20 and the section 21 being shaped so as to have a complementary shape to the insert 20.

In the exemplary embodiment illustrated in Figures, the contact probe 10 has a substantially rectangular section. Obviously the contact probe 10  
5 could have a section of any prismatic shape.

Suitably, as shown schematically in Figure 3, the contact probe 10 can further include at least one coating layer 23, which extends at the end portion 10A, in order to cover at least the section 21 and the insert 20. According to an embodiment, the coating layer 23 can be such that the  
10 contact area 22 of the contact probe 10 protrudes, i.e. the free end surfaces 22A and 22B of the insert 20 and of the section 21, respectively.

The coating layer 23 can be made of a conductive alloy having a low internal stress, such as a nickel alloy, able to improve the mechanical performances of the end portion 10A of the contact probe 10.

15 Suitably, the coating layer 23 is also adapted to maintain in position the insert 20 with the abutting surfaces 20A and 20B adhering to respective abutting surfaces 21A and 21B of the section 21. In practice, the coating layer 23 acts as a containment sock of the insert 20 and of the section 21.

Furthermore, by using a coating layer 23 having high hardness values, it  
20 is possible to increase the working life of the probe, thus guaranteeing its correct operation for a large number of testing operations where the end portion 10A of the contact probe 10 is in pressing contact on the contact pads of a device to be tested and even in the presence of a large number of cleaning and reshaping operations which usually involve abrasive cloths.

25 Additionally, the coating layer 23 can be made of a conductive alloy having a high wear resistance, in particular having high hardness values, so as to limit the wear of a lower guide of the testing head, in particular of respective guide holes where the contact probes axially slide. In this case, the coating layer 23 is formed so as to extend for the entire thickness of  
30 the lower guide, i.e. up to its surface within the testing head, in particular within its air gap.

Suitably, such cleaning operations performed on abrasive cloths also allow to eliminate the coating layer 23 in correspondence of the contact area 22,

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letting protrude the free end surfaces 22A and 22B of the insert 20 and the section 21, respectively.

According to an alternative embodiment, the contact probe 10 further comprises at least one adhesion film 24 arranged on the abutting surfaces 20A and 20B, and 21A and 21B, respectively, between the insert 20 and the section 21 of the end portion 10A of the contact probe 10.

In particular, the adhesion film 24 can be made of a metal or a metal alloy, such as nickel or a nickel alloy, so as to improve the adhesion of the insert 20 on the section 21. Alternatively, the adhesion film 24 can be made of gold, silver, platinum or a metal alloy thereof, preferably gold.

As it is known in the field, the term "film" means a layer having a thickness between 0.01 and 0.5  $\mu\text{m}$ .

In the embodiments illustrated in Figures 2A, 2B and 3, purely by way of example, the insert 20 has a height H1 substantially corresponding to the height H of the contact probe 10 and of the section 21 supporting that contact probe 10, in particular of its thin plate portion 21'.

Alternatively, as illustrated in Figures 4A-4C, the insert 20 can have a height H2 lower than the one of the contact probe 10.

Such height H2 of the insert 20 is for example equal to 20%-80% of the height H of the contact probe 10, preferably equal to 50%. More particularly, the height H2 can have a value from 3  $\mu\text{m}$  to 50  $\mu\text{m}$ .

It is possible to consider the insert 20 arranged at one corner of the contact probe 10; in such case, the insert 20 and the section 21 supporting that insert 20 have at least respective third abutting surfaces 20C and 21C adhering to each other, as shown schematically in Figure 4A. In particular, the third abutting surface 20C of the insert 20 is an upper surface, by considering the local reference system of the Figure.

Alternatively, the insert 20 can be arranged at only one side of the contact probe 10; in such case, the insert 20 and the section 21 supporting that insert 20 have at least respective fourth and fifth abutting surfaces, 20D, 21D and 20E, 21E, as shown schematically in Figure 4B. In particular, the fourth abutting surface 20D of the insert 20 is a lower surface and the

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fifth abutting surface 20E of the insert 20 is a left lateral surface, by considering the local reference system of the Figure.

Furthermore, the insert 20 can be positioned so as to be completely embedded in the contact probe 10; in such case, the insert 20 and the section 21 supporting the insert 20 have respective third, fourth and fifth  
5 abutting surfaces 20C, 20D and 20E, as shown schematically in Figure 4C.

In any case, the insert 20 has at least one free end surface 22A, protruding in correspondence of the contact area 22 of the contact probe  
10 10.

According to a further alternative embodiment illustrated in Figure 5, the insert 20 and the section 21 have a lowered portion 25, apt to reduce the area of contact area 22 of the contact probe 10. In such case, it is possible to use contact probes 10 with cross-section having an area greater than  
15 the contact area 22, the latter being for example bound, in particular limited, to the dimensions of the contact pads of the device to be tested or by the scrub which the first abutting surface 20A of the contact probe 10 must perform on such pads.

In the presence of the lowered portion 25, the contact area 22 has a height  
20 H3 less than the height of the contact probe 10. In particular, the height H3 of the contact area 22 is equal to 20%-80% of the height H of the contact probe 10, preferably equal to 50%. More particularly, the height H3 can have a value ranging from 3  $\mu\text{m}$  to 50  $\mu\text{m}$ .

It is also possible to subject the contact probe 10, in particular its end  
25 portion 10A, to a lapping operation, in order to sharpen or at least round the contact area 22, as schematically illustrated in Figures 6A and 6B in the case of a contact probe 10 including an insert 20 having a height H1 equal to the height H of the contact probe 10 (Figure 6A) and also having a lowered portion 25 (Figure 6B).

30 In such case, the free end surfaces 22A and 22B of the insert 20 and the section 21 forming the contact area 22 have a curvilinear shape, due to the lapping operation.

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It is emphasized that such a lapping operation can be carried out at the end of the manufacture of the contact probes and/or of their inclusion in the respective testing head; it is also possible to perform one or more lapping operations of the end portions of the contact probe 10 during the life of the testing head in which such probes are inserted, for example in order to "renew" the rounded or sharp shape of the end portion and also in order to remove possible impurities which may have accumulated at such portion.

According to a further alternative embodiment illustrated in Figure 6C, the lapping operation is able to make the section 21 thinner at the insert 20, in particular by canceling the area of the free end surface 22B of the section 21 at the contact area 22, which thus results to be formed only by the free end surface 22A of the insert 20. The end portion 10A can comprise also in this case a lowered portion 25, as schematically shown in Figure 6D.

Suitably, due to the support realized by the section 21, it is possible to realize the insert 20 with dimensions, in particular a length L, adapted to realize a "consumption" end portion 10A, the fragility of the material which such insert 20 is made of no longer constituting a problem, in particular a limit to the longitudinal dimensions of the insert 20 itself, so overcoming in this way the problems affecting the known probes.

It is also possible to realize the end portion 10A so as to comprise at least a first insert 20' and a second insert 20'', symmetrically arranged at the sides of a section 21 having a central thin plate portion 21' which realizes the support for both inserts, as schematically shown in Figure 7A. Even in such a case, the end portion 10A of the contact probe 10 can also comprise a lowered portion 25, as schematically shown in Figure 7B.

Furthermore, it is possible to realize a reduced thin plate portion 21'' of the section 21, in particular having a height H4 less than the height H of the probe.

The height H4 of the reduced thin plate portion 21'' is equal to 20%-80% of the height H of the contact probe 10, preferably equal to 50%. More particularly, the height H4 can have a value ranging from 3  $\mu\text{m}$  to 50  $\mu\text{m}$ .

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In the example illustrated in Figure 8, such reduced thin plate portion 21" is positioned centrally and completely surrounded by the insert 20, which in such case is substantially crown-shaped. It is also possible to realize the reduced thin plate portion 21" so that it has at least one protruding surface on a protruding face of the contact probe 10. In such case, the insert 20 is substantially U-shaped, so as to surround on three sides the thin plate portion 21". Furthermore, the reduced thin plate portion 21" can be realized at one corner of the contact probe 10, surrounded by an insert 20 substantially L-shaped.

Also the inserts of the embodiments illustrated in Figures 5, 6A-6D and 7A-7B can be positioned differently from those illustrated by way of example in the Figures, in particular according to the alternative embodiments illustrated in Figure 4A-4C.

Obviously, it is also possible to provide also the embodiments of Figures 4A-4C, 5, 6A-6D and 7A-7B with a coating layer which extends at the end portion 10A, in order to coat at least the section 21 and the insert 20, as well as an adhesion film arranged between the insert 20 and the section 21.

Finally, according to a further alternative embodiment schematically illustrated in Figure 9, the contact probe 10 can comprise, between the insert 20 and the section 21, at least one material bridge 30, suitably a plurality of material bridges 30 extending from the insert 20 to the section 21.

More in particular, the material bridges 30 can be realized by means of the first conductive material, which the insert 20 is made of, and are apt to improve the hold of the insert itself on the section 21.

It is possible to make such material bridges by means of blind holes suitably filled with the first conductive material.

Finally, it is possible to coat the whole contact 10 with an outer layer apt to protect the contact probe 10 from corrosive agents, in particular at the end portion 10A.

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A testing head includes a plurality of probes of the type of the contact probe 10 according to the invention. In particular, such a testing head could comprise an upper guide and a lower guide in spaced relation to each other to define an air gap and provided with respective upper and lower guide holes where the contact probes slide.

Alternatively, the testing head could comprise a plate-shaped support, in particular a ceramic one, to which the plurality of contact probes is fixedly fastened at the head of the probes, while the tips of the probes freely protrude from the plate-shaped support so as to abut onto a corresponding plurality of contact pads of a device to be tested.

In practice, the contact probe 10, which is provided with an insert 20 made of a material having a greater hardness than the material forming the rest of the contact probe 10, has an improved contact with the pads of a device to be tested or of a space transformer and also allows to realize an end portion 10A having dimensions adapted to realize a "consumption" tip, the structure of the section 21 providing the proper support of the insert 20 due to its anchoring in correspondence of at least two abutting surfaces of the insert 20 and of the section 21, facing and in contact with each other.

It is noted that the insert 20, which is made of the first conductive material, also allows to penetrate possible oxide layers on the pads of the device to be tested, the section 21 that is made of the second conductive material providing for the actual contact.

Obviously, to the contact probe described above a person skilled in the art, in order to meet particular needs and specifications, can carry out several changes and modifications, all included in the protection scope of the invention as defined by the following claims.

## CLAIMS

1. A contact probe (10) for a testing head of a testing apparatus of electronic devices comprising a body essentially extended in a longitudinal direction (Y) between respective end portions adapted to contact respective  
5 contact pads and having a height (H) in a direction (Z) orthogonal to said longitudinal direction (Y), at least one end portion (10A), which is adapted to contact a contact pad of a testing device through a contact area (22), comprising an insert (20) made of a first conductive material having a hardness being greater than a second conductive material, which said  
10 contact probe (10) is made of, said contact probe (10), said insert (20) being supported by a section (21) of said end portion (10A), said section (21) being made of said second conductive material and being shaped so as to have a shape that is complementary to said insert (20) and to have respective abutting surfaces (21A, 21B) facing and adhering to respective  
15 abutting surfaces (20A, 20B) of said insert (20), said insert (20) and said section (21) having respective free end surfaces (22A, 22B) forming said contact area (22) of said contact probe (10), characterized in that said insert (20) is positioned at one corner of said contact probe (10) and has at least two exposed surfaces other than the free end surface (22A) forming  
20 said contact area (22) and in that said insert (20) does not protrude with respect to said section (21).
2. The contact probe according to claim 1, characterized in that said first conductive material is a metal or metal alloy chosen from rhodium, platinum, iridium or a metal alloy thereof or a palladium-cobalt alloy, a  
25 palladium-nickel alloy or a nickel-phosphorus alloy.
3. The contact probe according to claim 1, characterized in that said first conductive material is rhodium.
4. The contact probe according to claim 1, characterized in that said second conductive material is a metal or metal alloy chosen from nickel or  
30 a metal alloy thereof, such as nickel-manganese, nickel-cobalt or nickel-tungsten alloys, copper or an alloy thereof, palladium or an alloy thereof.
5. The contact probe according to claim 1, characterized in that said second conductive material is nickel-tungsten.

6. The contact probe according to claim 1, characterized in that said insert (20) comprises at least one first abutting surface (20A) arranged at the bottom of said insert (20) along said longitudinal direction (Y) of said contact probe (10), at an opposite position with respect to said contact area (22), and at least one second lateral abutting surface (20B) along a transversal direction (X) perpendicular to said longitudinal direction (Y), said first and second abutting surfaces (20A, 20B) of said insert (20) being facing and contacting respectively first and second abutting surfaces (21A, 21B) of said section (21).
7. The contact probe according to any preceding claim, characterized in that said section (21) comprises a thin plate portion (21', 21'') for abutting said insert (20, 20', 20'').
8. The contact probe according to any preceding claim, characterized in that said insert (20) has a height (H1) corresponding to said height (H) of said contact probe (10) and of said section (21).
9. The contact probe according to any claim 1 to 7, characterized in that said insert (20) has a height (H2, H4) less than said height (H) of said contact probe (10) and of said section (21).
10. The contact probe according to claim 9, characterized in that said insert (20) has a height (H2, H4) equal to 20%-80% of said height (H) of said contact probe (10) and of said section (21).
11. The contact probe according to claim 9, characterized in that said insert (20) has a height (H2, H4) equal to 50% of said height (H) of said contact probe (10) and of said section (21).
12. The contact probe according to any preceding claim, characterized in that said insert (20) and said section (21) have a lowered portion (25) that decreases a height (H3) of said contact area (22) to 20%-80% of said height (H) of said contact probe (10).
13. The contact probe according to any preceding claim, characterized by further comprising at least one coating layer (23), extending at said end portion (10A), in order to cover at least said section (21) and said insert (20).

14. The contact probe according to claim 13, characterized in that said coating layer (23) is made of a conductive alloy having a low internal stress or a conductive alloy having a substantial wear resistance.
- 5 15. The contact probe according to claim 13, characterized in that said coating layer (23) is made of a nickel alloy.
16. The contact probe according to claim 13, characterized in that said coating layer (23) is made of rhodium or an alloy thereof.
- 10 17. The contact probe according to any preceding claim, characterized by further comprising at least one adhesion film (24) arranged on said abutting surfaces between said insert (20) and said section (21).
18. The contact probe according to claim 17, characterized in that said adhesion film (24) is a metal or a metal alloy chosen from nickel or a nickel alloy or gold, silver, platinum or a metal alloy thereof.
- 15 19. The contact probe according to claim 17, characterized in that said adhesion film (24) is gold.
20. The contact probe according to any preceding claim, characterized in that said free end surfaces (22A, 22B) are curvilinear.
- 20 21. The contact probe according to any preceding claim, characterized in that said end portion (10A) comprises at least one first insert (20') and one second insert (20''), arranged symmetrically on the sides of a thin plate portion (21') of said section (21) realizing a support for both said inserts (20', 20'').
- 25 22. The contact probe according to claim 21, characterized in that said thin plate portion (21'') has a height (H4) less than said height (H) of said contact probe (10).
- 30 23. The contact probe according to claim 7, characterized in that said thin plate portion (21'') is arranged centrally and it is fully surrounded by said insert (20), which is crown-shaped, or it is arranged having a surface emerging from one surface of said contact probe (10), said insert (20) being U-shaped, or it is arranged at one corner of said contact probe (10), surrounded by said insert (20), which is L-shaped.

24. The contact probe according to any preceding claim, characterized by comprising at least one material bridge (30) that is arranged between said insert (20) and said section (21).

5 25. The contact probe according to claim 24, characterized in that said material bridge (30) is made of said first conductive material.

26. The contact probe according to any preceding claim, characterized in that said insert (20) has a length (L) along said longitudinal direction (Y) between 10 $\mu$ m and 1000 $\mu$ m.

10 27. A testing head for a testing apparatus of electronic devices characterized by comprising a plurality of contact probes (10), said contact probes (10) being realized according to any preceding claim.