

METHOD FOR PRODUCING CONTACT STRUCTURES

Field of the Invention

This invention relates to a method for producing contact structures, and more particularly, to a method for producing a large number of contact structures on a semiconductor wafer in a horizontal direction and removing the contact structures from the wafer to be mounted on a probe card, IC chip, or other contact mechanism in a vertical direction.

Background of the Invention

In testing high density and high speed electrical devices such as LSI and VLSI circuits, a high performance probe card having a large number of contact structures must be used. In other applications, contact structures may be used for IC packages as IC leads. The present invention is directed to a production process of such contact structures to be used in testing LSI and VLSI chips, semiconductor wafers, burn-in of semiconductor wafers and die, testing and burn-in of packaged semiconductor devices, printed circuit boards and the like, as well as used in forming leads of IC chips or IC packages.

The inventors of this application have proposed a new type of contact structure to be used in such applications in U.S. Patent Application No. 09/099,614 filed June 19, 1998, entitled "Probe Contactor Formed by Photolithography Process", U.S. Patent Application No. 09/140,961 filed August 27, 1998, entitled "High Performance Integrated Circuit Chip Package", and U.S. Patent Application No. 09/157,842 filed September 21, 1998, entitled "Packaging and Interconnection of Contact Structure". This invention is directed to a method of producing contact structures shown in such patent applications.

In the above noted patent applications, the inventors have proposed a unique type of contact structures as shown in Figure 1. The example of Figure 1 shows the application in

which contact structures 30 are mounted on a probe card to electrically contact the targets such as contact pads 320 on a printed circuit board 300. The contact structures 30 are formed through a photolithography process on a semiconductor substrate 20, which is fully described in the above patent applications.

Although the production methods introduced in the above noted patent applications appear to be successful, the methods require relatively many lithography steps to form the structure in a vertical direction on the substrate. The inventors have attained a more simplified and low cost production process which is also able to achieve contact structures of higher reliability because of the simplified production process.

Summary of the Invention

Therefore, it is an object of the present invention to provide a method for producing a large number of contact structures by using relatively simple technique.

It is another object of the present invention to provide a method for producing a large number of contact structures in a two dimensional manner rather than a three dimensional manner on a planar surface of a silicon substrate.

It is a further object of the present invention to provide a method for producing a large number of contact structures in a two dimensional manner on a silicon substrate, removing the contact structures from the substrate to be mounted on a probe card or other contact mechanism.

It is a further object of the present invention to provide a method for producing a large number of contact structures in a two dimensional manner on a silicon substrate, transferring the contact structure from the silicon substrate to an adhesive tape or plate, and removing the contact structures from the adhesive tape or plate to be mounted on a probe card or other contact mechanism.

It is a further object of the present invention to

provide a method for producing a large number of contact structures with low cost and high efficiency.

It is a further object of the present invention to provide a method for producing a large number of contact structures of high mechanical strength and reliability.

It is a further object of the present invention to provide a method of producing contact structures to be used in testing and burn-in semiconductor wafers, packaged LSIs and the like.

In the present invention, contact structures for testing (including burn-in) a semiconductor wafers, packaged LSIs or printed circuit boards (devices under test) are formed on a planar surface of a silicon substrate by a photolithography technology established in the semiconductor production process. The contact structure of the present invention can also be applied to leads of electronics devices such as IC leads and pins.

In the first invention, the production method is comprised of the steps of:

- (a) forming a sacrificial layer on a surface of a silicon substrate;

- (b) forming an conductive layer made of electric conductive material on the sacrificial layer;

- (c) forming a photoresist layer on the conductive layer;

- (d) aligning a photo mask over the photoresist layer and exposing the photoresist layer with ultraviolet light through the photo mask, the photo mask including an image of the contact structures;

- (e) developing the image on the photoresist layer which has openings on the surface of the photoresist layer;

- (f) forming the contact structures made of electric conductive material in the openings by an electroplating process;

- (g) stripping the photoresist layer;

- (h) removing the sacrificial layer by a first etching

process so that the contact structures are separated from the silicon substrate; and

(i) removing the conductive layer from the contact structure by a second etching process.

Another aspect in the first invention is a process of producing a contact mechanism having the contact structures each being able to exhibit a spring force for establishing electrical contact with a contact target. The production process is comprised of the following steps of:

(a) forming a sacrificial layer on a surface of a silicon substrate;

(b) forming an conductive layer made of electric conductive material on the sacrificial layer;

(c) forming the contact structures through a photolithography process, the contact structures being in a horizontal directions on the silicon substrate;

(d) removing the contact structures from the silicon substrate and from the conductive layer;

(e) aligning and orienting the contact structures in a predetermined direction;

(f) positioning the contact mechanism having bonding locations for mounting the contact structures thereon; and

(g) picking at least one of the contact structures and placing the same on a predetermined position on the bonding pad of the contact mechanism and bonding the contact structure to the bonding pad.

The second invention is a production method in which the contact structures produced in the horizontal direction are transferred to an adhesive tape for the convenience of the later process of forming a contact mechanism. In the second invention the production method is comprised of the steps of:

(a) forming a sacrificial layer on a surface of a silicon substrate;

(b) forming an conductive layer made of electric conductive material on the sacrificial layer;

(c) forming a photoresist layer on the conductive layer;
(d) aligning a photo mask over the photoresist layer and exposing the photoresist layer with ultraviolet light through the photo mask, the photo mask including an image of the contact structures;

(e) developing the image on the photoresist layer which has openings on the surface of the photoresist layer;

(f) forming the contact structures made of electric conductive material in the openings by an electroplating process;

(g) stripping the photoresist layer;

(h) placing an adhesive tape on the contact structure so that upper surfaces of the contact structures adhere to the adhesive tape; and

(i) removing the sacrificial layer and conductive layer by an etching process so that the contact structures on the adhesive tape are separated from the silicon substrate.

Another aspect of the second present invention is a process of producing a contact mechanism having the above noted contact structures with use of a pick and place mechanism. The production process is comprised of the following steps of:

(a) forming a sacrificial layer on a surface of a silicon substrate;

(b) forming an conductive layer made of electric conductive material on the sacrificial layer;

(c) forming the contact structures through a photolithography process, the contact structures being in a horizontal directions on the silicon substrate;

(d) transferring the contact structures from the silicon substrate to an adhesive tape;

(e) positioning the adhesive tape having the contact structures and removing the contact structures therefrom;

(f) orienting the contact structures in a predetermined direction;

(g) positioning a contact mechanism having bonding locations for mounting the contact structures thereon; and

(h) placing the contact structure on a predetermined position on the bonding location of the contact mechanism and bonding the contact structure to the bonding location.

According to the present invention, the production process is able to produce a large number of contact structures in a horizontal direction on the silicon substrate by using relatively simple technique. Such contact structures produced are removed from the substrate and mounted on a contact mechanism such as a probe card in a vertical direction. The contact structures produced by the present invention are low cost and high efficiency and have high mechanical strength and reliability. The contact structures produced by the method of the present invention are advantageously applied in testing a semiconductor wafer, packaged LSI and the like including burn-in testing.

Brief Description of the Drawings

Figure 1 is a schematic diagram showing a structural relationship between a probe card mounting contact structures and contact targets such as a semiconductor wafer.

Figures 2A-2D are schematic diagrams showing basic concepts of production method of the present invention in which a large number of contact structures are formed on a planar surface of a silicon substrate and removed therefrom for later processes.

Figures 3A-3L are schematic diagrams showing an example of production process in the first embodiment of the present invention for producing the contact structures.

Figures 4A-4D are schematic diagrams showing an example of production process in the second embodiment of the present invention for producing the contact structures.

Figure 5 is a schematic diagram showing a process of picking the contact structures and placing the same on a substrate such as a probe card.

Figures 6A and 6B are schematic diagrams showing an example of pick and place mechanism and its process for picking the contact structures and placing the same on a substrate such as a probe card to mount the contact structures on the substrate.

Figures 7A and 7B are schematic diagrams showing another example of pick and place mechanism and its process for picking the contact structures and placing the same on a substrate such as a probe card to mount the contact structures on the substrate.

Figure 8 is a perspective view showing an example of contact mechanism such as a contact probe having the contact structures produced by the process of the present invention.

Figures 9A-9F are schematic diagrams showing examples of shape of contact structures to be produced through the production process of the present invention.

Detailed Description of the Preferred Embodiment

Each of the contact structures 30 of Figure 1 produces contact pressure by a spring force derived mainly from a horizontal beam thereof when the contact structure is pressed against contact pad 320 on the printed circuit board 300. The contact pressure also creates a scrubbing effect at the tip of the contact structure against the surface of contact pad 320. The contact structures may take various shapes such as shown in Figures 9A-9F.

Figure 2 shows a basic idea of the present invention for producing such contact structures. In the present invention, as shown in Figure 2A, contact structures are produced on a planar surface of a silicon substrate in a horizontal direction, i.e., in a two dimensional manner. Then, in the first embodiment, as shown in Figure 2B, the contact structures are removed from the substrate to be mounted on a printed circuit board, IC chip, or other contact mechanism in a vertical direction, i.e., in a three dimensional manner such as shown in Figure 8.

In the second embodiment, as shown in Figure 2C which is the same as Figure 2A, contact structures are produced on a planar surface of a silicon substrate in a horizontal direction, i.e., in a two dimensional manner. Then, as shown in Figure 2D, the contact structures are transferred from the substrate to an adhesive member, such as an adhesive tape, adhesive film and adhesive plate (collectively "adhesive tape"). The contact structures on the adhesive tape are removed therefrom to be mounted on a printed circuit board, IC chip, or other contact mechanism in a vertical direction, i.e., in a three dimensional manner such as shown in Figure 8 with use of a pick and place mechanism.

Figures 3A-3L are schematic diagrams showing an example of production process for producing the contact structure in the first embodiment of the present invention. In Figure 3A, a sacrificial layer 42 is formed on a silicon substrate 40. The sacrificial layer 42 is made, for example, of silicon dioxide (SiO_2) through a deposition process such as a chemical vapor deposition (CVD). The sacrificial layer 42 is to separate the contact structure from the silicon substrate in the later stage of the production process.

An adhesion promoter layer 44 is formed on the sacrificial layer 42 as shown in Figure 3B through, for example, an evaporation process. An example of material for the adhesion promoter layer 44 includes chromium (Cr) and titanium (Ti) with a thickness of 200-1,000 angstrom. The adhesion promoter layer 44 is to facilitate the adhesion of conductive layer 46 of Figure 3C on the silicon substrate 40. The conductive layer 46 is made, for example, of copper (Cu) or nickel (Ni), with a thickness of 1,000-5,000 angstrom. The conductive layer 46 is to establish electrical conductivity for an electroplating process in the later stage.

In the next process, a photoresist layer 48 is formed on the conductive layer 46 over which a photo mask 50 is

precisely aligned to be exposed with ultraviolet (UV) light as shown in Figure 3D. The photo mask 50 shows a two dimensional image of the contact structure 30 which will be developed on the photoresist layer 48. As is well known in the art, positive as well as negative photoresist can be used for this purpose. If a positive acting resist is used, the photoresist covered by the opaque portions of the mask 50 harden (cure) after the exposure. Examples of photoresist material include Novolak (M-Cresol-formaldehyde), PMMA (Poly Methyl Methacrylate), SU-8 and photo sensitive polyimide. The exposed part of the resist can be dissolved and washed away, leaving a photoresist layer 48 of Figure 3E having an opening A (development process). Figure 3E is a top view showing the photoresist layer 48 of Figure 3F wherein the opening A having the shape of the contact structure 30 is shown.

In the photolithography process in the foregoing, instead of the UV light, it is also possible to expose the photoresist layer 48 with an electron beam or X-rays as is known in the art. Further, it is also possible to directly write the image of the contact structure on the photoresist layer 48 by exposing the photoresist 48 with a direct write electron beam, X-ray or light source (laser).

The contactor material such as copper (Cu), nickel (Ni), aluminum (Al), rhodium (Rh), palladium (Pd), tungsten (W) or other metal is deposited (electroplated) in the opening A of the photoresist layer 48 to form the contact structure 30 as shown in Figure 3G. It can be beneficial for the contact material to be different from that of the conductive layer 46 to differentiate etching characteristics from one another as will be described later. The over plated portion of the contact structure 30 in Figure 3G can be taken out in the grinding (planarizing) process of Figure 3H.

In the next process, the photoresist layer 48 is removed in a resist stripping process as shown in Figure 3I.

Typically, the resist layer 48 is removed by wet chemical processing. Other examples are acetone-based stripping and plasma O_2 stripping. In Figure 3J, the sacrificial layer 42 is etched away so that the contact structure 30 is separated from the silicon substrate 40. Another etching process is conducted so that the adhesion promoter layer 44 and the conductive layer 46 are removed from the contact structure 30 as shown in Figure 3K.

The etching condition can be selected to etch the layers 44 and 46 but not to etch the contact structure 30. In other words, to etch the conductive layer 46 without etching the contact structure 30, as noted above, the conductive material used for the contact structure 30 must be different from the material of the conductive layer. Finally, the contact structure 30 is separated from any other materials as shown in the perspective view of Figure 3L. Although the production process in Figures 3A-3L shows only one contact structure, in an actual production process, as shown in Figures 2A-2D, a large number of contact structures are produced at the same time.

Figures 4A-4D are schematic diagrams showing an example of production process for producing the contact structures in the second embodiment of the present invention. In the second embodiment, an adhesive tape is incorporated in the production process to transfer the contact structures from the silicon substrate to the adhesive tape. Figures 4A-4D only show a latter part of the production process in which the adhesive tape is involved.

Figure 4A shows a process which is equivalent to the process shown in Figure 3I where the photoresist layer 48 is removed in the resist stripping process. Then, also in Figure 4A, an adhesive tape 90 is placed on an upper surface of the contact structure 30 so that the contact structure 30 adhere to the adhesive tape 90. As noted above with reference to Figure 2D, within the context of the present

invention, the adhesive tape 90 includes other types of adhesive member, such as an adhesive film and adhesive plate, and the like.

In the process shown in Figure 4B, the sacrificial layer 42 is etched away so that the contact structure 30 on the adhesive tape 90 is separated from the silicon substrate 40. Another etching process is conducted so that the adhesion promoter layer 44 and the conductive layer 46 are removed from the contact structure 30 as shown in Figure 4C.

As noted above, in order to etch the conductive layer 46 without etching the contact structure 30, the conductive material used for the contact structure 30 must be different from the material of the conductive layer. Although the production process in Figures 4A-4C shows only one contact structure, in an actual production process, a large number of contact structures are produced at the same time. Thus, a large number of contact structures 30 are transferred to the adhesive tape 90 and separated from the silicon substrate and other materials as shown in the top view of Figure 4D.

Figure 5 is a schematic diagram showing a process of picking the contact structures produced by the first embodiment of the present invention and placing the same on a substrate such as a probe card. A container 52 stores the contact structures 30 which have been produced by the process of Figures 3A-3L and provides the contact structures to a pick and place mechanism 55. Either the container 52 or the pick and place mechanism 55 may include an alignment capability so that the pick and place mechanism 55 grabs the contact structure in the same position and orientation. A probe card 20 having bonding pads 32 is placed on an X-Y table 57. The X-Y table 57 is able to fine adjust the position of the probe card 20 in X and Y directions as well as a vertical direction so that the pick and place mechanism 55 can place the contact structures 30 accurately on the corresponding bonding pads 32.

Figures 6A and 6B are schematic diagrams showing an example of pick and place mechanism and its process for picking the contact structures 30 from the adhesive tape 90 and placing the same on a substrate 20 such as a probe card. The pick and place mechanism of Figure 6 is advantageously applied to the contact structures produced by the second embodiment of the present invention. Figure 6A is a top view of the pick and place mechanism 60 and Figure 6B is a front view of the pick and place mechanism for picking the contact structure 30 on the adhesive tape 90 and placing the contact structure on bonding locations 32 of the substrate 20 so that the contact structures 30 be bonded to the bonding locations 32 by a bonding machine (not shown).

In this example, the pick and place mechanism 60 is comprised of a first transfer mechanism 71 to pick, transfer and place the contact structures 30, a mobile arm 65 to allow movements of the transfer mechanism 71 in a Y direction, a second transfer mechanism 72 to pick, transfer and place the contact structures 30, a mobile arm 66 to allow movements of the transfer mechanism 72 in the Y direction, and rails 62 and 63 to allow movements of the mobile arms 65 and 66 in an X direction. Thus, the transfer mechanisms 71 and 72 are freely moveable in the X and Y directions on the pick and place mechanism 60. In Figures 6A and 6B, the pick and place mechanism 60 further includes a horizontal/vertical converter 68 for receiving contact structures 30 and converting the direction of the same.

The transfer mechanism 71 includes a suction arm 73 that performs suction (pick operation) and suction release (place operating) operations for the contact structures 30. The suction force is created, for example, by a negative pressure such as vacuum. The suction arm 73 moves in a Z direction (up-down direction). Similarly, the transfer mechanism 72 includes a suction arm 76 that performs suction (pick operation) and suction release (place operating) operations

for the contact structures 30. The suction arm 76 moves in the Z direction. As shown in Figures 6A and 6B, cameras 74 and 75, having, for example CCD image sensors, are respectively attached to the transfer mechanism 71 and 73 to acquire image data to accurately control the movements of the transfer mechanism 71 and 72.

In operation, the adhesive tape 90 having the contact structures 30 and the substrate 20 having the bonding locations 32 are respectively positioned on the pick and place mechanism 60. Preferably, the adhesive tape 90 and the substrate are placed on XYZ stages (not shown), respectively, to be able to adjust the positions in X, Y and Z directions. As shown in Figure 6A, the transfer mechanism 71 picks the contact structure 30 from the adhesive tape 90 by the suction force of the suction arm 76 and places the same on the converter 68. After placing the predetermined number of contact structures 30 on the converter 68, the contact structures 30 in the horizontal direction are converted their orientation to the vertical direction.

The transfer mechanism 72 then picks the contact structure in the converter 68 by the suction force of the suction arm 76. By the operation of the converter 68, the contact structure 30 is in the vertical direction as shown in Figure 6B. The transfer mechanism 72 places the contact structure 30 on the bonding position 32 on the substrate 20. The contact structure 30 is bonded to the bonding location 32 through a bonding process in a known manner.

Figures 7A and 7B are schematic diagrams showing another example of process for picking the contact structures from the adhesive tape 90 and placing the same on the substrate. The pick and place mechanism of Figure 7 is advantageously applied to the contact structures produced by the second embodiment of the present invention. Figure 7A is a front view of the pick and place mechanism 80 showing the first half process of the pick and place operation. Figure 7B is

a front view of the pick and place mechanism 80 showing the second half process of the pick and place operation.

In this example, the pick and place mechanism 80 is comprised of a transfer mechanism 84 to pick and place the contact structures 30, mobile arms 86 and 87 to allow movements of the transfer mechanism 84 in X, Y and Z directions, tables 81 and 82 whose positions are adjustable in X, Y and Z directions, and a monitor camera 78 having, for example, a CCD image sensor therein. The transfer mechanism 84 includes a suction arm 85 that performs suction (pick operation) and suction release (place operating) operations for the contact structures 30. The suction force is created, for example, by a negative pressure such as vacuum. The suction arm 85 rotates in a predetermined angle such as 90 degrees.

In operation, the adhesive tape 90 having the contact structures 30 and the substrate 20 having the bonding locations 32 are positioned on the respective tables 81 and 82 on the pick and place mechanism 80. As shown in Figure 7A, the transfer mechanism 80 picks the contact structure 30 from the adhesive tape 90 by suction force of the suction arm 85. After picking the contact structure 30, the suction arm 85 rotates by 90 degrees, for example, as shown in Figure 7B. Thus, the orientation of the contact structure 30 is changed from the horizontal direction to the vertical direction. The transfer mechanism 80 then places the contact structure 30 on the bonding location 32 on the substrate 20. The contact structure 30 is bonded to the bonding location 32 through a bonding process in a known manner.

Figure 8 is a perspective view showing an example of contact mechanism such as a contact probe having the contact structures produced in the present invention. Each of the contact structures 30 is attached to the surface of the bonding pad by bonding. Examples of bonding technology include brazing, ultrasonic welding, conductive adhesive,

soldering, and micro welding.

Figures 9A-9F are schematic diagrams showing examples of shape of contact structures to be produced through the production process of the present invention. Figures 9A-9F merely show examples and are not exhaustive, and thus, other shapes of contact structures are also feasible. When mounted on a contact mechanism such as a probe card made of printed circuit board, and pressed against the contact targets such as contact pads on a semiconductor wafer to be tested, the contact structures in Figures 9A-9F exhibit contact force by spring effects and can produce scrubbing effects against the surface of the contact targets, depending on the target metallurgy of contact.

According to the present invention, the production process is able to produce a large number of contact structures in a horizontal direction on the silicon substrate by using relatively simple technique. Such contact structures produced are removed from the substrate and mounted on a contact mechanism such as a probe card in a vertical direction. The contact structures produced by the present invention are low cost and high efficiency and have high mechanical strength and reliability. The contact structures produced by the method of the present invention are advantageously applied in testing a semiconductor wafer, packaged LSI and the like including burn-in testing.

Although only a preferred embodiment is specifically illustrated and described herein, it will be appreciated that many modifications and variations of the present invention are possible in light of the above teachings and within the purview of the appended claims without departing the spirit and intended scope of the invention.



WHAT IS CLAIMED IS:

1. A method for producing contact structures, comprising the following steps of:

forming a sacrificial layer on a surface of a silicon substrate;

forming an conductive layer made of electric conductive material on the sacrificial layer;

forming a photoresist layer on the conductive layer;

aligning a photo mask over the photoresist layer and exposing the photoresist layer with ultraviolet light through the photo mask, the photo mask including an image of the contact structures;

developing the image on the photoresist layer which has openings on the surface of the photoresist layer;

forming the contact structures made of electric conductive material in the openings by a deposition process;

stripping the photoresist layer;

removing the sacrificial layer by a first etching process so that the contact structures are separated from the silicon substrate; and

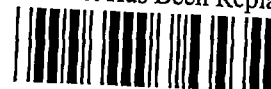
removing the conductive layer from the contact structure by a second etching process.

2. A method for producing contact structures as defined in Claim 1, in the aligning and exposing step, the photoresist layer is exposed by an electron beam or X-rays through the photo mask.

3. A method for producing contact structures as defined in Claim 1, in the aligning and exposing step, the photoresist layer is directly exposed by an electron beam, X-ray or laser light to define the image of the contact structure thereon.

4. A method for producing contact structures as defined in Claim 1, further including a step of forming an

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adhesion promoter layer between the sacrificial layer and the conductive layer.

5. A method for producing contact structures as defined in Claim 1, wherein the electric conductive material for the conductive layer is different from the electric conductive material for the contact structures.

6. A method for producing contact structures as defined in Claim 4, wherein the adhesion promoter layer is made of chromium (Cr) or titanium (Ti).

7. A method for producing a contact mechanism having contact structures each of which is able to exhibit a spring force for establishing electrical contact with a contact target, comprising the following steps of:

forming a sacrificial layer on a surface of a silicon substrate;

forming a conductive layer made of electric conductive material on the sacrificial layer;

forming the contact structures through a photolithography process, the contact structures being in a horizontal direction on the silicon substrate;

removing the contact structures from the silicon substrate and from the conductive layer;

aligning and orienting the contact structures in a predetermined direction;

positioning either the contact mechanism having bonding locations or the contact structure for mounting the contact structure on the bonding locations; and

picking at least one of the contact structures and placing the same on a predetermined position on the bonding pad of the contact mechanism.

8. A method for producing a contact mechanism as defined in Claim 7, wherein the photolithography process includes steps of photoresist coating, masking, exposure, photoresist stripping and conductive material deposition.

9. A method for producing a contact mechanism as

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defined in Claim 7, further including a step of forming an adhesion promoter layer between the sacrificial layer and the conductive layer, the adhesion promoter layer being made of chromium (Cr) or titanium (Ti).

10. A method for producing a contact mechanism as defined in Claim 7, wherein conductive material deposition step in the photolithography process is an electroplating process utilizing the conductive layer.

11. A method for producing contact structures, comprising the following steps of:

- forming a sacrificial layer on a surface of a silicon substrate;

- forming an conductive layer made of electric conductive material on the sacrificial layer;

- forming a photoresist layer on the conductive layer;

- aligning a photo mask over the photoresist layer and exposing the photoresist layer with ultraviolet light through the photo mask, the photo mask including an image of the contact structures;

- developing the image on the photoresist layer which has openings on the surface of the photoresist layer;

- forming the contact structures made of electric conductive material in the openings by a deposition process;

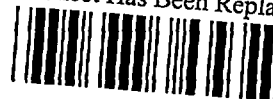
- stripping the photoresist layer;

- placing an adhesive tape on the contact structure so that upper surfaces of the contact structures adhere to the adhesive tape; and

- removing the sacrificial layer and the conductive layer by an etching process so that the contact structures are separated from the silicon substrate.

12. A method for producing contact structures as defined in Claim 11, in the aligning and exposing step, the photoresist layer is exposed by an electron beam or X-rays

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through the photo mask.

13. A method for producing contact structures as defined in Claim 11, in the aligning and exposing step, the photoresist layer is directly exposed by an electron beam, X-ray or laser light to define the image of the contact structure thereon.

14. A method for producing contact structures as defined in Claim 11, further including a step of forming an adhesion promoter layer between the sacrificial layer and the conductive layer.

15. A method for producing contact structures as defined in Claim 11, wherein the sacrificial layer is made of silicon dioxide.

16. A method for producing contact structures as defined in Claim 11, wherein the electric conductive material for the conductive layer is different from the electric conductive material for the contact structures.

17. A method for producing contact structures as defined in Claim 14, wherein the adhesion promoter layer is made of chromium (Cr) or titanium (Ti).

18. A method for producing a contact mechanism having contact structures each of which is able to exhibit a spring force for establishing electrical contact with a contact target, comprising the following steps of:

forming a sacrificial layer on a surface of a silicon substrate;

forming a conductive layer made of electric conductive material on the sacrificial layer;

forming the contact structures through a photolithography process, the contact structures being in a horizontal direction on the silicon substrate;

transferring the contact structures from the silicon substrate to an adhesive tape;

positioning the adhesive tape having the contact structures and removing the contact structures

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therefrom;

orienting the contact structures in a predetermined direction;

positioning a contact mechanism having bonding locations for mounting the contact structures thereon; and

placing the contact structure on a predetermined position on the bonding location of the contact mechanism and bonding the contact structure to the bonding location.

19. A method for producing a contact mechanism as defined in Claim 18, further including a step of forming an adhesion promoter layer between the sacrificial layer and the conductive layer, the adhesion promoter layer being made of chromium (Cr) or titanium (Ti).

20. A method for producing a contact mechanism as defined in Claim 18, wherein the contact structures are made of copper (Cu), nickel (Ni), aluminum (Al), palladium (Pd) or tungsten (W).

21. A method for producing a contact mechanism as defined in Claim 18, wherein the electric conductive material for the conductive layer is different from the electric conductive material for the contact structures.

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