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PACKAGING AND INTERCONNECTION OF CONTACT STRUCTURE

Field of the Invention

This invention relates to an electronic packaging and interconnection of a contact structure, and more particularly, to an electronic packaging and interconnection for mounting a contact structure on a probe card or equivalent thereof which is used to test semiconductor wafers, semiconductor chips, packaged semiconductor devices or printed circuit boards and the like with increased accuracy, density and speed.

Background of the Invention

In testing high density and high speed electrical devices such as LSI and VLSI circuits, high performance probe contactors or test contactors must be used. The electronic packaging and interconnection of a contact structure of the present invention is not limited to the application of testing and burn-in of semiconductor wafers and die, but is inclusive of testing and burn-in of packaged semiconductor devices, printed circuit boards and the like. However, for the convenience of explanation, the present invention is described mainly with reference to a probe card to be used in semiconductor wafer testing.

In the case where semiconductor devices to be tested are in the form of a semiconductor wafer, a semiconductor test system such as an IC tester is usually connected to a substrate handler, such as an automatic wafer prober, to automatically test the semiconductor wafer. Such an example is shown in Figure 1 in which a semiconductor test system has a test head 100 which is ordinarily in a separate housing and electrically connected to the test system through a bundle of cables. The test head 100 and a substrate handler 400 are mechanically connected with one another by means of a manipulator 500 and a drive motor 510 and the semiconductor wafers to be tested are automatically provided to a test

position of the test head by the substrate handler.

On the test head, the semiconductor wafer to be tested is provided with test signals generated by the semiconductor test system. The resultant output signals from the semiconductor wafer under test are transmitted to the semiconductor test system wherein they are compared with expected data to determine whether IC circuits on the semiconductor wafer function correctly or not.

As shown in Figure 2, the test head and the substrate handler are connected with an interface component 140 consisting of a performance board 120 which is typically a printed circuit board having electric circuit connections unique to a test head's electrical footprint, such as coaxial cables, pogo-pins and connectors. The test head 100 includes a large number of printed circuit boards 150 which correspond to the number of test channels (tester pins). Each of the printed circuit boards 150 has a connector 160 to receive a corresponding contact terminal 121 of the performance board 120. In the example of Figure 2, a "frog" ring 130 is mounted on the performance board 120 to accurately determine the contact position relative to the substrate handler 400. The frog ring 130 has a large number of contact pins 141, such as ZIF connectors or pogo-pins, connected to contact terminals 121, through coaxial cables 124.

Figure 2 further shows a structure of the substrate handler 400, the test head 100 and the interface component 140 when testing a semiconductor wafer. As shown in Figure 2, the test head 100 is placed over the substrate handler 400 and mechanically and electrically connected to the substrate handler through the interface component 140. In the substrate handler 400, a semiconductor wafer 300 to be tested is mounted on a chuck 180. A probe card 170 is provided above the semiconductor wafer 300 to be tested. The probe card 170 has a large number of probe contactors (contact structures) 190, such as cantilevers or needles, to contact

with circuit terminals or contact targets in the IC circuit of the semiconductor wafer 300 under test.

Electrical terminals or contact receptacles of the probe card 170 are electrically connected to the contact pins 141 provided on the frog ring 130. The contact pins 141 are also connected to the contact terminals 121 of the performance board 120 via the coaxial cables 124 where each contact terminal 121 is connected to the printed circuit board 150 of the test head 100. Further, the printed circuit boards 150 are connected to the semiconductor test system main frame through the cable bundle 110 having several hundreds of cables therein.

Under this arrangement, the probe contactors 190 contact the surface of the semiconductor wafer 300 on the chuck 180 to apply test signals to the IC chips in the semiconductor wafer 300 and receive the resultant signals of the IC chips from the wafer 300. The resultant output signals from the semiconductor wafer 300 under test are compared with the expected data generated by the semiconductor test system to determine whether the IC chips in the semiconductor wafer 300 properly perform the intended functions.

Figure 3 is a bottom view of the probe card 170 of Figure 2. In this example, the probe card 170 has an epoxy ring on which a plurality of probe contactors 190 called needles or cantilevers are mounted. When the chuck 180 mounting the semiconductor wafer 300 moves upward in Figure 2, the tips of the cantilevers 190 contact the pads or bumps on the wafer 300. The ends of the cantilevers 190 are connected to wires 194 which are further connected to transmission lines (not shown) formed in the probe card 170. The transmission lines in the probe card 170 are connected to a plurality of electrodes 197 which contact the pogo pins 141 of Figure 2.

Typically, the probe card 170 is structured by a multi-layer of polyimide substrates having ground planes, power

planes, signal transmission lines on many layers. As is well known in the art, each of the signal transmission lines is designed to have a characteristic impedance such as 50 ohms by balancing the distributed parameters, i.e., dielectric constant of the polyimide, inductances, and capacitances of the signal within the probe card 170. Thus, the signal transmission lines are impedance matched to achieve a high frequency transmission bandwidth to the wafer 300. The signal transmission lines transmit small current during a steady state of a pulse signal and large peak current during a transition state of the device's outputs switching. For removing noise, capacitors 193 and 195 are provided on the probe card 170 between the power and ground planes.

An equivalent circuit of the probe card 170 is shown in Figures 4A-AE to explain the limitations of bandwidth in the conventional probe card technology. As shown in Figures 4A and 4B, the signal transmission line on the probe card 170 extends from the electrode 197, the strip line (impedance matched line) 196, the wire 194 and the needle (cantilever) 190. Since the wire 194 and needle 190 are not impedance matched, these portions function as an inductor L in the high frequency band as shown in Figure 4C. Because of the overall length of the wire 194 and needle 190 is around 20-30mm, the significant frequency limitation is resulted in testing a high frequency performance of a device under test.

Other factors which limit the frequency bandwidth in the probe card 170 reside in power and ground needles shown in Figures 4D and 4E. If a power line can provide large enough currents to the device under test, it will not seriously limit the operational bandwidth in testing the device. However, because the series connected wire 194 and needle 190 for supplying the power to the device under test are equivalent to the inductors as shown in Figure 4D, which impede the high speed current flow in the power line. Similarly, because the series connected wire 194 and needle

190 for grounding the power and signals are equivalent to the inductors as shown in Figure 4E, the high speed current flow is impeded by the wire 194 and needle 190.

Moreover, the capacitors 193 and 195 are provided between the power line and the ground line to secure a proper performance of the device under test by filtering out the noise or surge pulses on the power lines. The capacitors 193 have a relatively large value such as 10μF and can be disconnected from the power lines by switches if necessary. The capacitors 195 have a relatively small capacitance value such as 0.01μF and fixedly connected close to the DUT. These capacitors serve the function as high frequency decoupling on the power lines, which also impede the high speed current flow in the signal and power lines.

Accordingly, the most widely used probe contactors as noted above are limited to the frequency bandwidth of approximately 200MHz which is insufficient to test recent semiconductor devices. It is considered, in the industry, that the frequency bandwidth be of at least that equal to the tester's capability which is currently on the order of 1GHz or higher, will be necessary in the near future. Further, it is desired in the industry that a probe card is capable of handling a large number of semiconductor devices, especially memories, such as 32 or more, in parallel (parallel test) to increase test throughput.

To meet the next generation test requirements noted above, the inventors of this application has provided a new concept of contact structure in the U.S. Application No. 09/099,614 "Probe Contactor Formed by Photolithography Process" filed June 19, 1998. The contact structure is formed on a silicon or dielectric substrate through a photolithography process. Figures 5 and 6A-6C show the contact structure in the above noted application. In Figure 5, all of the contact structures 30 are formed on a silicon substrate 20 through the same photolithography process. The

silicon substrate 20 having the contact structures 30 may be mounted on a probe card such as shown in Figures 2 and 3. When the semiconductor wafer 300 under test moves upward, the contact structures 30 contact corresponding contact targets (electrodes or pads) 320 on the wafer 300.

The contact structure 30 on the silicon substrate 20 can be directly mounted on a probe card such as shown in Figure 3, or molded in a package, such as a traditional IC package having leads, so that the package is mounted on a probe card. In the above noted patent application by the inventors, such technologies of packaging and interconnection of the contact structure 30 with respect to the probe card or equivalent thereof is not described.

Summary of the Invention

Therefore, it is an object of the present invention to provide a packaging and interconnection of a contact structure with respect to a probe card or equivalent thereof to be used in testing a semiconductor wafer, packaged LSI and the like.

It is another object of the present invention to provide a packaging and interconnection of a contact structure with respect to a probe card or equivalent thereof to achieve a high speed and frequency operation in testing a semiconductor wafer, packaged LSI and the like.

It is a further object of the present invention to provide a packaging and interconnection of a contact structure with respect to a probe card or equivalent thereof wherein the packaging and interconnection is formed at an upper surface (top) of the contact structure.

It is a further object of the present invention to provide a packaging and interconnection of a contact structure which is established through a bonding wire, a tape automated bonding (TAB), and a multi-layer TAB.

It is a further object of the present invention to provide a packaging and interconnection of a contact

structure which is formed between a contact trace provided at the upper surface of the contact structure and a connector.

It is a further object of the present invention to provide a packaging and interconnection of a contact structure which is formed between a contact trace provided at the upper surface of the contact structure and an interconnect pad of a printed circuit board through a solder bump.

It is a further object of the present invention to provide a packaging and interconnection of a contact structure which is formed between a contact trace provided at the upper surface of the contact structure and an interconnect pad of a printed circuit board through a conductive polymer.

In the present invention, an electronic packaging and interconnection of a contact structure to be used in a probe card or equivalent thereof to test semiconductor wafers, semiconductor chips, packaged semiconductor devices or printed circuit boards and the like is established between a contact trace formed at an upper surface of the contact structure and various types of connection means on the probe card.

In one aspect of the present invention, a packaging and interconnection of a contact structure is comprised of: a contact structure made of conductive material and formed on a contact substrate through a photolithography process wherein the contact structure has a base portion vertically formed on the contact substrate, a horizontal portion, one end of which being formed on the base portion, and a contact portion vertically formed on another end of the horizontal portion; a contact trace formed on the contact substrate and electrically connected to the contact structure at one end, and an upper surface of the other end of the contact trace is formed as a contact pad; a contact target provided on a printed circuit board (PCB) substrate or lead frame to be

electrically connected with the contact pad of the contact trace through a conductive lead or wire; an elastomer provided under the contact substrate for allowing flexibility in the interconnection and packaging of the contact structure; and a support structure for supporting the contact structure, the contact substrate and the elastomer.

In another aspect of the present invention, a connector is provided to receive the other end of the contact trace to establish electrical connection therebetween. In a further aspect of the present invention, a conductive bump is provided between the other end of the contact trace and the PCB pad to establish electrical connection thereamong. In a further aspect of the present invention, a conductive polymer is provided between the other end of the contact trace and the PCB pad to establish electrical connection thereamong.

In a further aspect of the present invention, the interconnection and packaging of the contact structure is established through a bonding wire between the contact pad of the contact trace and a contact target. In a further aspect of the present invention, the interconnection and packaging of the contact structure is established through a single layer lead of tape automated bonding (TAB) structure extending between the contact pad of the contact trace and a contact target. In a further aspect of the present invention, the interconnection and packaging of the contact structure is established through double layer leads of tape automated bonding (TAB) structure extending between the contact pad of the contact trace and a contact target. In a further aspect of the present invention, the interconnection and packaging of the contact structure is established through triple layer leads of tape automated bonding (TAB) structure extending between the contact pad of the contact trace and a contact target.

According to the present invention, the packaging and interconnection has a very high frequency bandwidth to meet

the test requirements in the next generation semiconductor technology. The packaging and interconnection is able to mount the contact structure on a probe card or equivalent thereof by electrically connecting therewith through the upper surface of the contact structure. Moreover, because of the relatively small number of overall components to be assembled, the interconnection and packaging of the present invention can be fabricated with low cost and high reliability as well as high productivity.

Brief Description of the Drawings

Figure 1 is a schematic diagram showing a structural relationship between a substrate handler and a semiconductor test system having a test head.

Figure 2 is a schematic diagram showing an example of detailed structure for connecting the test head of the semiconductor test system to the substrate handler.

Figure 3 is a bottom view showing an example of the probe card having an epoxy ring for mounting a plurality of cantilevers as probe contactors.

Figures 4A-4E are circuit diagrams showing equivalent circuits of the probe card of Figure 3.

Figure 5 is a schematic diagram showing contact structures associated with the present invention produced through a photolithography process.

Figures 6A-6C are schematic diagrams showing examples of contact structure associated with the present invention formed on a silicon substrate.

Figure 7 is a schematic diagram showing a first embodiment of the present invention in which the packaging and interconnection is established by a bonding wire between a contact pad provided at an upper surface of the contact structure and a lead frame.

Figure 8 is a schematic diagram showing a modified structure of the first embodiment of the present invention.

Figure 9 is a schematic diagram showing a second

embodiment of the present invention in which the packaging and interconnection is established by a single layer TAB (tape automated bonding) between a contact pad provided at an upper surface of the contact structure and a contact target on a probe card or package.

Figure 10 is a schematic diagram showing a modified structure of the second embodiment of the present invention in which a straight TAB is incorporated as an interconnection and packaging member.

Figure 11 is a schematic diagram showing a further modified structure of the second embodiment of the present invention in which a contact target is a connector.

Figure 12 is a schematic diagram showing a further modified structure of the second embodiment of the present invention in which a conductive bump is incorporated between the TAB and the contact target as an interconnection and packaging member.

Figure 13 is a schematic diagram showing a further modified structure of the second embodiment of the present invention in which a conductive polymer is incorporated between the TAB and the contact target as an interconnection and packaging member.

Figure 14 is a schematic diagram showing a third embodiment of the present invention in which the packaging and interconnection is established by a double layer TAB (tape automated bonding) between a contact pad provided at an upper surface of the contact structure and a contact target on a probe card or package.

Figure 15 is a schematic diagram showing a modified structure of the third embodiment of the present invention in which a straight double layer TAB is incorporated as an interconnection and packaging member to be connected to a pair of contact targets.

Figure 16 is a schematic diagram showing a further modified structure of the third embodiment of the present

invention in which a contact target is a connector to be connected with the double layer TAB.

Figure 17 is a schematic diagram showing a further modified structure of the third embodiment of the present invention in which a contact target is a connector to be connected with the straight double layer TAB.

Figure 18 is a schematic diagram showing a further modified structure of the third embodiment of the present invention in which a conductive bump is incorporated between the TAB and the contact target as an interconnection and packaging member.

Figure 19 is a schematic diagram showing a further modified structure of the third embodiment of the present invention in which a pair of conductive bumps are incorporated between the double layer TAB and the contact targets as interconnection and packaging members.

Figure 20 is a schematic diagram showing a further modified structure of the third embodiment of the present invention in which a conductive polymer is incorporated between the double layer TAB and the contact target as an interconnection and packaging member.

Figure 21 is a schematic diagram showing a further modified structure of the third embodiment of the present invention in which a pair of conductive polymer are incorporated between the double layer TAB and the contact targets as interconnection and packaging members.

Figure 22 is a schematic diagram showing a fourth embodiment of the present invention in which the packaging and interconnection is established by a triple layer TAB (tape automated bonding) between a contact pad provided at an upper surface of the contact structure and a contact target on a probe card or package.

Figure 23 is a schematic diagram showing a modified structure of the fourth embodiment of the present invention in which a straight triple layer TAB is incorporated as an

interconnection and packaging member to be connected to three contact targets.

Figure 24 is a schematic diagram showing a further modified structure of the fourth embodiment of the present invention in which a contact target is a connector to be connected with the triple layer TAB.

Figure 25 is a schematic diagram showing a further modified structure of the fourth embodiment of the present invention in which a contact target is a connector to be connected with the straight triple layer TAB.

Figure 26 is a schematic diagram showing a further modified structure of the fourth embodiment of the present invention in which a conductive bump is incorporated between the TAB and the contact target as an interconnection and packaging member.

Figure 27 is a schematic diagram showing a further modified structure of the fourth embodiment of the present invention in which three conductive bumps are incorporated between the triple layer TAB and the contact targets as interconnection and packaging members.

Figure 28 is a schematic diagram showing a further modified structure of the fourth embodiment of the present invention in which a conductive polymer is incorporated between the triple layer TAB and the contact target as an interconnection and packaging member.

Figure 29 is a schematic diagram showing a further modified structure of the fourth embodiment of the present invention in which three conductive polymer are incorporated between the triple layer TAB and the contact targets as interconnection and packaging members.

Detailed Description of the Preferred Embodiment

To establish a packaging and interconnection of a contact structure directly with a probe card or indirectly with a probe card through an IC package, examples of Figures 6A-6C show basic three types of electrical path extended from

the contact structure to form such interconnections. Figure 6A shows an example in which such an electrical connection is established at the top of the substrate. Figure 6B shows an example in which an electrical connection is established at the bottom of the substrate while Figure 6C shows an example in which an electrical connection is formed at the edge of the substrate. Almost any types of existing IC package design or probe card design can accommodate at least one of the interconnect types of Figures 6A-6C.

Each of Figures 6A-6C include a contact interconnect trace 32 also designated by **a** which is to establish electrical connection with a probe card or any intermediate member to a probe card. The contact structure 30 has vertical portions **b** and **d** and a horizontal beam **c** and a tip portion **e**. The tip portion **e** of the contact structure 30 is preferably sharpened to achieve a scrubbing effect when pressed against contact targets 320 such as shown in Figure 3. The spring force of the horizontal beam **c** provides an appropriate contact force against the contact target 320. An example of material of the contact structure 30 and the contact trace 32 includes nickel, aluminum, copper and other conductive materials. The inventors of this application have provided a detailed description of production process of the contact structure 30 and the contact interconnect trace 32 on the silicon substrate 20 in the above noted U.S. Application No. 09/099,614.

In the present invention, the packaging and interconnection of a contact structure is directed to the type of structure having a contact trace at an upper surface thereof (top type contact trace) as shown in Figure 6A. Various embodiments of the present invention on the top type packaging and interconnection will be described with reference to the drawings.

Figures 7 and 8 show a first embodiment of the present invention wherein the top type contact trace is coupled to a

lead frame provided, for example, of a probe card (not shown) or an IC package (not shown) through a bonding wire. In the first example of Figure 7, a contact structure 30 formed on a contact substrate 20 is electrically connected to a contact trace 32 which is the top type contact trace noted above. The contact trace 32 has, at its end, a contact pad 33, an upper surface of which is designed to establish an electrical connection with contact targets through various contact means such as a bonding wire 72. The wire 72 is a thin (15-25μm) wire made, for example, of gold or aluminum.

Typically, the contact substrate 20 is a silicon substrate although other types of dielectric substrate, such as glass epoxy, polyimide, ceramic, and alumina substrates are also feasible. In the example of Figure 7, the bonding wire 72 connects the contact pad 33 and a lead frame 45 of, for example, a probe card. The contact substrate 20 and the lead frame 45 are mounted on a support structure 52 through, for example, an adhesive (not shown).

Any wire bonding procedure can be used to establish the connecting by the bonding wire 72. The wire 72 is first bonded to the contact pad 33 of the contact trace and spanned to the lead frame 45. The wire 72 is bonded to the lead frame 45 and is clipped and the entire process is repeated at the next bonding pad. The wire bonding is done with either gold or aluminum wires. Both materials are highly conductive and ductile enough to withstand deformation during the bonding steps and still remaining strong and reliable. In the gold wire bonding, thermo-compression (TC) and thermosonic methods are typically used. In the aluminum wire bonding, ultrasonic and wedge bonding methods are typically used.

In the example of Figure 8, the contact trace 32 is connected at its upper surface with a printed circuit board (PCB) interconnect pad 38 provided on a PCB substrate 62. The PCB substrate 62 can be a probe card such as shown in

Figure 3 or an intermediate circuit component between the contact structure and the probe card. The PCB substrate is mounted on a support structure 52. The contact substrate 20 and the support structure 52 are fixed with one another by, for example, an adhesive (not shown). Similarly, the PCB substrate and the support structure 52 are fixed with one another by an adhesive (not shown).

Figures 9-13 show a second embodiment of the present invention wherein the top type contact trace is coupled to a contact target through a single layer lead formed by a tape automated bonding (TAB) process. In the first example of Figure 9, the contact structure 30 formed on a contact substrate 20 is electrically connected to the contact pad 33 via the contact trace 32. The contact pad 33 is connected at its upper surface with a TAB lead 74 which is also connected to a printed circuit board (PCB) interconnect pad 38 provided on a PCB substrate 62_2.

The contact substrate 20 is mounted on the PCB substrate 62_2 through an elastomer 42 and a support structure 52_2. The contact substrate 20, the elastomer 42, the support structure 52_2 and the PCB substrate 62_2 are fixed with one another by, for example, an adhesive (not shown). In this example, the TAB lead 74 for connecting the contact pad 33 and the PCB pad 38 has a gull-wing shape where a gull-wing portion A is bonded to the PCB pad 38. A support member 54 is provided on the support structure 52_2 to support the TAB lead 74.

The TAB lead 74 has a gull-wing shape which is similar to the standard "gull-wing lead" used in a surface mount technology. Because of the down-ward bent of the gull-wing type TAB lead 74, a sufficient vertical clearance is achieved at the left end of Figure 9 over the contact portion between the PCB pad 38 and the lead 74. The lead form of the TAB lead 74 (downward bent, gull-wing lead) may require special tooling to produce the same. Since a large number of interconnection between the contact trace and the PCB pad

will be used in the application such as semiconductor testing, several hundred connections, such tooling may be standardized for a multiple of contact traces with given pitch.

The electrical connections between the contact pad 33 and the TAB lead 74 and between the TAB lead 74 and the PCB pad 38 will be established by various bonding technologies including thermosonic bonding, thermocompression bonding, and ultrasonic bonding technique. In another aspect, such electrical connections will be established through a surface mount technology (SMT) such as using a screen printable solder paste. A soldering process is carried out based on the reflow characteristics of the solder paste and other solder materials well known in the art.

The PCB substrate 62_2 itself may be a probe card such as shown in Figure 3 or provided separately and mounted directly or indirectly on the probe card. In the former case, the PCB 62_2 may make direct contact with an interface of a test system such as an IC tester in a manner shown in Figure 2. In the latter case, the PCB substrate 62_2 is pinned or in use of a conductive polymer for establishing an electrical contact to the next level of a contact mechanism on the probe card. Such types of electrical connection between the PCB substrate 62_2 and the probe card through pins or conductive polymer would allow for field repairability.

The PCB substrate 62_2 may be a multiple layer structure which is capable of providing high bandwidth signals, distributed high frequency capacitance and integrated high frequency chip capacitors for power supply decoupling as well as high pin counts (number of I/O pins and associated signal paths). An example of material of the PCB 62_2 is standard high performance glass epoxy resin. Another example of material is ceramics which is expected to minimize mismatch in coefficient of temperature expansion (CTE) rates during high temperature application such as a burn-in test of

semiconductor wafers and packaged IC devices.

The support structure 52_2 is to establish a physical strength of the packaging and interconnection of the contact structure. The support structure 52_2 is made of, for example, ceramic, molded plastic or metal. The elastomer 42 is to establish flexibility in the packaging and interconnection of the present invention to overcome a potential planarization mechanism. The elastomer 42 also functions to absorb a mismatch in temperature expansion rates between the contact substrate 20 and the PCB substrate 62_2.

An example of overall length of the contact trace 32 and the TAB lead 74 is in the range from several ten micrometers to several hundred micrometers. Because of the short path length, the packaging interconnection of the present invention can be easily operable in a high frequency band such as several GHz or even higher. Moreover, because of a relatively small number of overall components to be assembled, the packaging and interconnection of the present invention can be fabricated with low cost and high reliability as well as high productivity.

Figure 10 shows another example of the second embodiment of the present invention. A TAB lead 74_2 is straight and connects the contact pad 33 to the PCB pad 38 provided on a printed circuit board (PCB) substrate 62_3. To match the vertical position of the PCB pad 38, the PCB substrate 62_3 has a raised portion at the left end thereof.

The electrical connection between the TAB lead 74_2 and the PCB pad 38 will be established by a surface mount technology (SMT) such as using a screen printable solder paste as well as various other bonding technologies including thermosonic bonding, thermocompression bonding, and ultrasonic bonding technique. Because of the significantly small sizes of the components and signal path lengths involved in the contact structure 30, contact trace 32, and the TAB lead 74_2, the example of Figure 10 can operate at a

very high frequency band, such as several GHz. Moreover, because of the small number and simple structure of components to be assembled, the interconnection and packaging of the present invention can be fabricated with low cost and high reliability as well as high productivity.

Figure 11 shows a further modification of the second embodiment of the present invention wherein the top type contact trace 32 is coupled to a connector provided on a printed circuit board or other structure. In the example of Figure 11, a contact pad 33 connected to the contact trace 32 is connected to a connector 46 via a single layer TAB lead 74_3. The connector 46 is provided on a support structure 52_3. Typically, the contact structure 30, contact trace 32 and the contact pad 33 are formed on the contact substrate 20 through photolithography processes. The contact substrate 20 is a silicon substrate although other types of dielectric substrate, such as glass epoxy, polyimide, ceramic, and alumina substrates are also feasible.

In this example, the TAB lead 74_3 has a shape similar to the gull-wing widely used in the surface mount technology and incorporated in the example of Figure 9. At about the center of Figure 11, the contact substrate 20 is mounted on the support structure 52_3 through an elastomer 42. The contact substrate 20, the elastomer 42 and the support structure 52_3 are attached with one another by, for example, an adhesive (not shown).

The connector 46 may be mechanically fixed to the support structure 52_3 through an attachment mechanism (not shown). The end of the TAB lead 74_3 is inserted in a receptacle (not shown) of the connector 46. As is well known in the art, such a receptacle has a spring mechanism to provide a sufficient contact force when receiving the end of the TAB lead 74_3 therein. Between the TAB lead 74_3 and the support structure 52_3, there is provided a support member 54 to support the TAB lead 74_3 extending between the contact pad

33 and the connector 46. Also well known in the art, an inner surface of such a receptacle is provided with conductive metal such as gold, silver, palladium or nickel.

The connector 46 may be integrated with straight or right angle pins, which may be connected to the receptacle noted above, for direct connection to a printed circuit board (PCB). A PCB to mount the connector 46 thereon can be either solid or flexible. As is known in the art, a flexible PCB is formed on a flexible base material and has flat cables therein. Alternatively, the connector 46 may be integrated with a coaxial cable assembly in which a receptacle is attached to an inner conductor of the coaxial cable for receiving the end of the TAB lead 74_3 therein. The connection between the connector 46 and the TAB lead 74_3 or the support structure 52_3 is not a permanent attachment method, allowing for field replacement and repairability of the contact portion.

Typically, the contact substrate 20 is a silicon substrate although other types of substrate, such as glass epoxy, polyimide, ceramic, and alumina substrates are also feasible. The support structure 52_3 is to establish a physical strength of the packaging and interconnection of the contact structure. The support structure 52_3 is made of, for example, ceramic, molded plastic or metal. The elastomer 42 is to establish flexibility in the interconnection and packaging of the present invention to overcome a potential planarization mechanism. The elastomer 42 also functions to absorb a mismatch in temperature expansion rates between the contact substrate 20 and a PCB substrate to mount the connector 46 thereon.

An example of overall length of the contact trace 32 and the TAB lead 74_3 is in the range from several ten micrometers to several hundred micrometers. Because of the short path length, the interconnection and packaging of the present invention can be easily operable in a high frequency band

such as several GHz or even higher. Moreover, because of the lower total number of components to be assembled, the packaging and interconnection of the present invention can be fabricated with low cost and high reliability as well as high productivity. The gull-wing shaped TAB lead 74_3 may require special tooling in the production process, which may be standardized for a multiple of contact traces with a given pitch.

Figures 12 shows a further example of the second embodiment of the present invention wherein the top type contact trace is coupled to a pad provided on a printed circuit board through a conductive bump. In the example of Figure 12, a contact structure 30, a contact trace 32 and a contact tab 33 are formed on a contact substrate 20. Typically, the contact substrate 20 is a silicon substrate although other types of dielectric substrate, such as glass epoxy, polyimide, ceramic, and alumina substrates are also feasible. The contact trace 32 is connected to a PCB (print circuit board) pad 38 provided on a PCB substrate 62_2 through a conductive bump 56 via a TAB lead 74_4.

In this example, the TAB lead 74_4 has a shape similar to that shown in the example of Figure 11. The contact substrate 20 is mounted on the PCB substrate 62_2 through a support structure 52_2 and an elastomer 42. The contact substrate 20, the elastomer 42, the support structure 52_2, and the PCB substrate 62_2 are attached with one another by, for example, an adhesive (not shown). Between the TAB lead 74_4 and the support structure 52_2, there is provided a support member 54 to support the TAB lead 74_4 extending between the contact pad 33 and the PVB pad 38.

By the application of the heat, the conductive bump 56 is reflowed onto the PCB pad 38 for attachment between the TAB lead 74_4 and the PCB pad 38. An example of the conductive bump 56 is a solder bump used in a standard solder ball technology. Another example of the conductive bump 56

is a fluxless solder ball used in a plasma-assisted dry soldering technology.

Further examples of the conductive bump 56 are a conductive polymer bump and a compliant bump which involve the use of polymer in the bump. This helps in minimizing planarization problems or CTE (coefficient of temperature expansion) mismatches in the packaging and interconnection. There is no reflowing of metal, which prevents bridging between contact points. The conductive polymer bump is made of a screen printable conductive adhesive. The compliant bump is a polymer core bump with a metal coating. The polymer is typically plated with gold and is elastically compressible. Still further example of the conductive bump 56 is a bump used in a controlled collapse chip connection technology in which solder balls are formed by an evaporation process.

The PCB substrate 62_2 itself may be a probe card such as shown in Figure 3 or provided separately and mounted directly or indirectly on the probe card. In the former case, the PCB substrate 62_2 may make direct contact with an interface of a test system such as an IC tester in the manner shown in Figure 2. In the latter case, the PCB substrate 62_2 is pinned or in use of a conductive polymer for establishing an electrical contact to the next level. Such types of electrical connection between the PCB substrate 62_2 and the probe card through pins or conductive polymer would allow for field repairability.

The PCB substrate 62_2 may be a multiple layer structure which is capable of providing high bandwidth signals, distributed high frequency capacitance and integrated high frequency chip capacitors for power supply decoupling as well as high pin counts (number of I/O pins and associated signal paths). An example of material of the PCB substrate 62_2 is standard high performance glass epoxy resin. Another example of the material is ceramics which is expected to minimize

mismatch in coefficient of temperature expansion (CTE) rates during high temperature application such as a burn-in test of semiconductor wafers and packaged IC devices.

The support structure 52_2 is to establish a physical strength of the packaging and interconnection of the contact structure. The support structure 52_2 is made of, for example, ceramic, molded plastic or metal. The elastomer 42 is to establish flexibility in the packaging and interconnection of the present invention to overcome a potential planarization mechanism. The elastomer 42 also functions to absorb a mismatch in temperature expansion rates between the contact substrate 20 and the PCB substrate 62_2.

An example of overall length of the contact trace 32 and the TAB lead 74_4 is in the range from several ten micrometers to several hundred micrometers. Because of the short path length, the interconnection and packaging of the present invention can be easily operable in a high frequency band such as several GHz or even higher. Moreover, because of the lower total number of components to be assembled, the packaging and interconnection of the present invention can be fabricated with low cost and high reliability as well as high productivity.

Figure 13 shows a further example of the second embodiment of the present invention wherein the top type contact trace is coupled to a pad provided on a printed circuit board through a conductive polymer. In the example of Figure 13, a contact structure 30, a contact trace 32, and a contact pad 33 are formed on a contact substrate 20. The contact pad 33 is connected to a PCB (print circuit board) pad 38 provided on a PCB substrate 62_2 through a TAB lead 74_4 and a conductive polymer 66. Typically, the contact substrate 20 is a silicon substrate although other types of dielectric substrate, such as glass epoxy, polyimide, ceramic, and alumina substrates are also feasible.

In this example, the TAB lead 74_4 has a shape similar to

that shown in the example of Figures 11 and 12. The contact substrate 20 is mounted on the PCB substrate 62_2 through a support structure 52_2 and an elastomer 42. The contact substrate 20, the elastomer 42, the support structure 52_2, and the PCB substrate 62_2 are attached with one another by, for example, an adhesive (not shown).

Most conductive polymers are designed to be conductive between the mating electrodes normally in vertical of angled directions and not conductive in the horizontal direction. An example of the conductive polymer 66 is a conductive elastomer which is filled with conductive wire that extends beyond the surface of the elastomer.

Various other examples of the conductive polymer 66 are possible such as an anisotropic conductive adhesive, anisotropic conductive film, anisotropic conductive paste, and anisotropic conductive particles. The anisotropic conductive adhesive is filled with conductive particles that do not touch each other. The conductive path is formed by pressing the adhesive between the two electrodes at a specific location. The anisotropic conductive film is a thin dielectric resin filled with conductive particles that do not touch each other. The conductive path is formed by pressing the film between the two electrodes at a specific location.

The anisotropic conductive paste is a screen printable paste which is filled with conductive particles that do not touch each other. The conductive path is formed by pressing the paste between the two electrodes at a specific location. The anisotropic conductive particle is a thin dielectric resin filled with conductive particles coated with a very thin layer of dielectric material to improve isolation. The conductive path is formed by pressing the particle with enough force to explode the dielectric coating on the particles, between the two electrodes at a specific location.

The PCB substrate 62_2 itself may be a probe card such as shown in Figure 3 or provided separately and mounted directly

or indirectly on the probe card. In the former case, the PCB substrate 62_2 may make direct contact with an interface of a test system such as an IC tester in the manner shown in Figure 2. In the latter case, the PCB substrate 62_2 is pinned or in use of a conductive polymer for establishing an electrical contact to the next level. Such types of electrical connection between the PCB substrate 62_2 and the probe card through pins or conductive polymer would allow for field repairability.

The PCB substrate 62_2 may be a multiple layer structure which is capable of providing high bandwidth signals, distributed high frequency capacitance and integrated high frequency chip capacitors for power supply decoupling as well as high pin counts (number of I/O pins and associated signal paths). An example of material of the PCB substrate 62_2 is standard high performance glass epoxy resin. Another example of material is ceramics which is expected to minimize mismatch in coefficient of temperature expansion (CTE) rates during high temperature application such as a burn-in test of semiconductor wafers and packaged IC devices.

The support structure 52_2 is to establish a physical strength of the packaging and interconnection of the contact structure. The support structure 52_2 is made of, for example, ceramic, molded plastic or metal. The elastomer 42 is to establish flexibility in the packaging and interconnection of the present invention to overcome a potential planarization mechanism. The elastomer 42 also functions to absorb a mismatch in temperature expansion rates between the contact substrate 20 and the PCB substrate 62_2.

An example of length of the contact trace 32 is from several ten micrometers to several hundred micrometers. Because of the short path length, the packaging and interconnection of the present invention can be easily operable in a high frequency band such as several GHz or even higher. Moreover, because of the lower total number of

components to be assembled, the interconnection and packaging of the present invention can be fabricated with low cost and high reliability as well as high productivity.

Figures 14-21 show a third embodiment of the present invention wherein the top type contact trace is coupled to a contact target through a double layer lead formed by a tape automated bonding (TAB) process. In the first example of Figure 14, the contact structure 30 formed on a contact substrate 20 is electrically connected to the contact pad 33 via the contact trace 32. The contact pad 33 is connected at its upper surface with a TAB lead 76 which is also connected to a printed circuit board (PCB) interconnect pad 38 provided on a PCB substrate 62_2.

The contact substrate 20 is mounted on the PCB substrate 62_2 through an elastomer 42_2 and a support structure 52_4. The contact substrate 20, the elastomer 42_2, the support structure 52_4 and the PCB substrate 62_2 are fixed with one another by, for example, an adhesive (not shown). In this example, the double layered TAB lead 76 for connecting the contact pad 33 and the PCB pad 38 has an upper lead A and a lower lead B. A support member 54_2 is provided between the upper lead and the lower lead of the TAB lead 76.

The TAB lead 76 has a gull-wing shape which is similar to the standard "gull-wing lead" used in a surface mount technology. Because of the down-ward bent of the gull-wing type TAB lead 76, a sufficient vertical clearance is achieved at the left end of Figure 14 over the contact portion between the PCB pad 38 and the lead 76. The lead form of the TAB lead 76 (downward bent, gull-wing lead) may require special tooling to produce the same. Since a large number of interconnection between the contact trace and the PCB pad will be used in the application such as semiconductor testing, several hundred connections, such tooling may be standardized for a multiple of contact traces with given pitch.

The structure of the TAB lead 76 having the tiered leads A and B establish a low resistance in a signal path because of two leads. This is useful in transmitting a large current such as in a ground line or a power line for testing a semiconductor device with high speed without deforming the waveforms of test signals.

The electrical connections between the contact pad 33 and the TAB lead 76 and between the TAB lead 76 and the PCB pad 38 will be established by various bonding technologies including thermosonic bonding, thermocompression bonding, and ultrasonic bonding technique. In another aspect, such electrical connections will be established through a surface mount technology (SMT) such as using a screen printable solder paste. A soldering process is carried out based on the reflow characteristics of the solder paste and other solder materials well known in the art.

The PCB substrate 62_2 itself may be a probe card such as shown in Figure 3 or provided separately and mounted directly or indirectly on the probe card. In the former case, the PCB 62_2 may make direct contact with an interface of a test system such as an IC tester in a manner shown in Figure 2. In the latter case, the PCB substrate 62_2 is pinned or in use of a conductive polymer for establishing an electrical contact to the next level of a contact mechanism on the probe card. Such types of electrical connection between the PCB substrate 62_2 and the probe card through pins or conductive polymer would allow for field repairability.

The PCB substrate 62_2 may be a multiple layer structure which is capable of providing high bandwidth signals, distributed high frequency capacitance and integrated high frequency chip capacitors for power supply decoupling as well as high pin counts (number of I/O pins and associated signal paths). An example of material of the PCB 62_2 is standard high performance glass epoxy resin. Another example of material is ceramics which is expected to minimize mismatch

in coefficient of temperature expansion (CTE) rates during high temperature application such as a burn-in test of semiconductor wafers and packaged IC devices.

The support structure 52_4 is to establish a physical strength of the packaging and interconnection of the contact structure. The support structure 52_4 is made of, for example, ceramic, molded plastic or metal. The elastomer 42_2 is to establish flexibility in the packaging and interconnection of the present invention to overcome a potential planarization mechanism. The elastomer 42_2 also functions to absorb a mismatch in temperature expansion rates between the contact substrate 20 and the PCB substrate 62_2.

An example of overall length of the contact trace 32 and the TAB lead 76 is in the range from several ten micrometers to several hundred micrometers. Because of the short path length, the packaging interconnection of the present invention can be easily operable in a high frequency band such as several GHz or even higher. Moreover, because of a relatively small number of overall components to be assembled, the packaging and interconnection of the present invention can be fabricated with low cost and high reliability as well as high productivity.

Figure 15 shows another example of the third embodiment of the present invention. In this example, a double layered TAB lead 76_2 having upper and lower leads A and B is provided to the contact pad 33 connected to the contact structure 30. The upper lead A is provided in an upper and outer position of Figure 15 than the lower lead B. The upper lead is connected to a PCB pad 38 and the lower lead B is connected to a PCB pad 39. To accommodate the PCB pads 38 and 39 thereon, a PCB substrate 62_4 is arranged to have an edge having a larger thickness, i.e., a step, to mount the PCB pad 38, and an inner portion adjacent to the edge portion having a smaller thickness to mount the PCB pad 39.

The electrical connection between the TAB lead 76_2 and

the PCB pads 38 and 39 will be established by a surface mount technology (SMT) such as using a screen printable solder paste as well as various other bonding technologies including thermosonic bonding, thermocompression bonding, and ultrasonic bonding technique. Because of the significantly small sizes of the components and signal path lengths involved in the contact structure 30, contact trace 32, and the TAB lead 76_2, the example of Figure 15 can operate at a very high frequency band, such as several GHz. Moreover, because of the small number and simple structure of components to be assembled, the interconnection and packaging of the present invention can be fabricated with low cost and high reliability as well as high productivity.

The structure of the TAB lead 76_2 having the double layered leads A and B establish a fan out in the vertical dimension. This is useful in distributing a signal or power to two or more paths. Another advantage of the fan out is to increase the number of contact pads, i.e., to decrease the effective pitch (distance) between the contact pads.

Figure 16 shows a further modification of the third embodiment of the present invention wherein the top type contact trace 32 is coupled to a connector provided on a printed circuit board or other structure. In the example of Figure 16, a contact pad 33 connected to the contact trace 32 is connected to a connector 46 via a double layer TAB lead 76_4. The connector 46 is provided on a support structure 52_5. Typically, the contact structure 30, contact trace 32 and the contact pad 33 are formed on the contact substrate 20 through photolithography processes. The contact substrate 20 is a silicon substrate although other types of dielectric substrate, such as glass epoxy, polyimide, ceramic, and alumina substrates are also feasible.

The connector 46 may be mechanically fixed to the support structure 52_5 through an attachment mechanism (not shown). The end of the TAB lead 76_4 is inserted in a

receptacle (not shown) of the connector 46. As is well known in the art, such a receptacle has a spring mechanism to provide a sufficient contact force when receiving the end of the TAB lead 76_4 therein. Between the upper lead A and the lower lead B of the double layer TAB lead 76_4, there is provided a support member 54_2 to support the leads A and B of the TAB lead 76_4 extending between the contact pad 33 and the connector 46. Also well known in the art, an inner surface of such receptacles are provided with conductive metal such as gold, silver, palladium or nickel.

The structure of the TAB lead 76_4 having the tiered leads A and B establish a low resistance in a signal path because of the two leads. This is useful in transmitting a large current such as in a ground line or a power line for testing a semiconductor device with high speed without deforming the waveforms of the test signals.

The connector 46 may be integrated with straight or right angle pins, which may be connected to the receptacle noted above, for direct connection to a printed circuit board (PCB). A PCB to mount the connector 46 thereon can be either solid or flexible. As is known in the art, a flexible PCB is formed on a flexible base material and has flat cables therein. Alternatively, the connector 46 may be integrated with a coaxial cable assembly in which a receptacle is attached to an inner conductor of the coaxial cable for receiving the ends of the TAB lead 76_4 therein. The connection between the connector 46 and the TAB lead 76_4 or the support structure 52_5 is not a permanent attachment method, allowing for field replacement and repairability of the contact portion.

Typically, the contact substrate 20 is a silicon substrate although other types of substrate, such as glass epoxy, polyimide, ceramic, and alumina substrates are also feasible. The support structure 52_5 is to establish a physical strength of the packaging and interconnection of the

contact structure. The support structure 52_5 is made of, for example, ceramic, molded plastic or metal. The elastomer 42_2 is to establish flexibility in the interconnection and packaging of the present invention to overcome a potential planarization mechanism. The elastomer 42_2 also functions to absorb a mismatch in temperature expansion rates between the contact substrate 20 and a PCB substrate to mount the connector 46 thereon.

Figure 17 shows a further modification of the third embodiment of the present invention wherein the top type contact trace 32 is coupled to a connector provided on a printed circuit board or other structure. In the example of Figure 17, a contact pad 33 connected to the contact trace 32 is connected to a connector 46_2 via a double layer TAB lead 76_6. The double layer TAB 76_6 has an upper lead A and a lower lead B each of which is separated at the end. The connector 46_2 is provided on a support structure 52_5.

The connector 46_2 may be mechanically fixed to the support structure 52_5 through an attachment mechanism (not shown). The ends of the leads A and B of the TAB lead 76_6 are inserted in receptacles (not shown) of the connector 46_2. As is well known in the art, such a receptacle has a spring mechanism to provide a sufficient contact force when receiving the end of the TAB lead 76_6 therein. Between the upper lead A and the lower lead B of the double layer TAB lead 76_6, there is provided a support member 54_4 to support the leads A and B.

The structure of the TAB lead 76_6 having the double layered leads A and B establish a fan out in the vertical dimension. This is useful in distributing a signal or power to two or more paths. Another advantage of the fan out is to increase the number of contact pads, i.e., to decrease the effective pitch (distance) between the contact pads.

Figures 18 shows a further example of the third embodiment of the present invention wherein the top type

contact trace is coupled to a pad provided on a printed circuit board through a conductive bump. In the example of Figure 18, a contact structure 30, a contact trace 32 and a contact tab 33 are formed on a contact substrate 20. Typically, the contact substrate 20 is a silicon substrate although other types of dielectric substrate, such as glass epoxy, polyimide, ceramic, and alumina substrates are also feasible. The contact trace 32 is connected to a PCB (print circuit board) pad 38 provided on a PCB substrate 62_2 through a conductive bump 56 via a double layer TAB lead 76_4.

The contact substrate 20 is mounted on the PCB substrate 62_2 through a support structure 52_4 and an elastomer 42_2. The contact substrate 20, the elastomer 42_2, the support structure 52_4, and the PCB substrate 62_2 are attached with one another by, for example, an adhesive (not shown). Between the upper lead A and the lower lead B of the TAB lead 76_4, there is provided with a support member 54_2 to support the upper and lower leads A and B.

By the application of the heat, the conductive bump 56 is reflowed onto the PCB pad 38 for attachment between the TAB lead 76_4 and the PCB pad 38. An example of the conductive bump 56 is a solder bump used in a standard solder ball technology. Another example of the conductive bump 56 is a fluxless solder ball used in a plasma-assisted dry soldering technology.

Further examples of the conductive bump 56 are a conductive polymer bump and a compliant bump which involve the use of polymer in the bump. This helps in minimizing planarization problems or CTE (coefficient of temperature expansion) mismatches in the packaging and interconnection. There is no reflowing of metal, which prevents bridging between contact points. The conductive polymer bump is made of a screen printable conductive adhesive. The compliant bump is a polymer core bump with a metal coating. The polymer is typically plated with gold and is elastically

compressible. Still further example of the conductive bump 56 is a bump used in a controlled collapse chip connection technology in which solder balls are formed by an evaporation process.

The structure of the TAB lead 76_4 having the tiered leads A and B establish a low resistance in a signal path because of the two leads. This is useful in transmitting a large current such as in a ground line or a power line for testing a semiconductor device with high speed without deforming the waveforms of the test signals.

Figure 19 shows another example of the third embodiment of the present invention. In this example, a double layered TAB lead 76_2 having upper and lower leads A and B are provided to the contact pad 33 connected to the contact structure 30. The upper lead A is provided in an upper and outer position than the lower lead B in Figure 19. The upper lead is connected to a PCB pad 38 via a conductive dump 56 and the lower lead B is connected to a PCB pad 39 via a conductive dump 57. To accommodate the PCB pads 38 and 39 thereon, a PCB substrate 62_4 is arranged to have an edge having a larger thickness, i.e., a step, to mount the PCB pad 38, and an inner portion adjacent to the edge portion having a smaller thickness to mount the PCB pad 39.

By the application of the heat, the conductive bumps 56 and 57 are reflowed onto the PCB pads 38 and 39 for attachment between the TAB lead 76_2 and the PCB pads 38 and 39. An example of the conductive bumps 56 and 57 is a solder bump used in a standard solder ball technology. Another example of the conductive bumps 56 and 57 is a fluxless solder ball used in a plasma-assisted dry soldering technology.

The structure of the TAB lead 76_2 having the double layered leads A and B establish a fan out in the vertical dimension. This is useful in distributing a signal or power to two or more paths. Another advantage of the fan out is to

increase the number of contact pads, i.e., to decrease the effective pitch (distance) between the contact pads.

Figures 20 shows a further example of the third embodiment of the present invention wherein the top type contact trace is coupled to a pad provided on a printed circuit board through a conductive polymer. In the example of Figure 20, a contact structure 30, a contact trace 32 and a contact tab 33 are formed on a contact substrate 20. Typically, the contact substrate 20 is a silicon substrate although other types of dielectric substrate, such as glass epoxy, polyimide, ceramic, and alumina substrates are also feasible. The contact trace 32 is connected to a PCB (print circuit board) pad 38 provided on a PCB substrate 62_2 through a conductive polymer 66 via a double layer TAB lead 76_4.

The contact substrate 20 is mounted on the PCB substrate 62_2 through a support structure 52_4 and an elastomer 42_2. The contact substrate 20, the elastomer 42_2, the support structure 52_4, and the PCB substrate 62_2 are attached with one another by, for example, an adhesive (not shown). Between the upper lead A and the lower lead B of the TAB lead 76_4, there is provided with a support member 54_2 to support the upper and lower leads A and B.

Most conductive polymers are designed to be conductive between the mating electrodes normally in vertical of angled directions and not conductive in the horizontal direction. An example of the conductive polymer 66 is a conductive elastomer which is filled with conductive wire that extends beyond the surface of the elastomer.

Various other examples of the conductive polymer 66 are possible such as an anisotropic conductive adhesive, anisotropic conductive film, anisotropic conductive paste, and anisotropic conductive particles. The anisotropic conductive adhesive is filled with conductive particles that do not touch each other. The conductive path is formed by pressing the adhesive between the two electrodes at a

specific location. The anisotropic conductive film is a thin dielectric resin filled with conductive particles that do not touch each other. The conductive path is formed by pressing the film between the two electrodes at a specific location.

The anisotropic conductive paste is a screen printable paste which is filled with conductive particles that do not touch each other. The conductive path is formed by pressing the paste between the two electrodes at a specific location. The anisotropic conductive particle is a thin dielectric resin filled with conductive particles coated with a very thin layer of dielectric material to improve isolation. The conductive path is formed by pressing the particle with enough force to explode the dielectric coating on the particles, between the two electrodes at a specific location.

The structure of the TAB lead 76_4 having the tiered leads A and B establish a low resistance in a signal path because of the two leads. This is useful in transmitting a large current such as in a ground line or a power line for testing a semiconductor device with high speed without deforming the waveforms of the test signals.

Figure 21 shows another example of the third embodiment of the present invention. In this example, a double layered TAB lead 76_2 having upper and lower leads A and B are provided to the contact pad 33 connected to the contact trace 32 and contact structure 30. The upper lead A is provided in an upper and outer position than the lower lead B in Figure 21. The upper lead is connected to a PCB pad 38 via a conductive polymer 66 and the lower lead B is connected to a PCB pad 39 via a conductive polymer 67. To accommodate the PCB pads 38 and 39 thereon, a PCB substrate 62_4 is arranged to have an edge having a larger thickness, i.e., a step, to mount the PCB pad 38, and an inner portion adjacent to the edge portion having a smaller thickness to mount the PCB pad 39.

The electrical connection between the TAB lead 76_2 and

the PCB pads 38 and 39 will be established by a surface mount technology (SMT) such as using a screen printable solder paste as well as various other bonding technologies including thermosonic bonding, thermocompression bonding, and ultrasonic bonding technique.

The structure of the TAB lead 76_2 having the double layered leads A and B establish a fan out in the vertical dimension. This is useful in distributing a signal or power to two or more paths. Another advantage of the fan out is to increase the number of contact pads, i.e., to decrease the effective pitch (distance) between the contact pads.

Figures 22-29 show a fourth embodiment of the present invention wherein the top type contact trace is coupled to a contact target through a triple layer lead formed by a tape automated bonding (TAB) process. In the first example of Figure 22, the contact structure 30 formed on a contact substrate 20 is electrically connected to the contact pad 33 via the contact trace 32. The contact pad 33 is connected at its upper surface with a TAB lead 78 which is also connected to a printed circuit board (PCB) interconnect pad 38 provided on a PCB substrate 62_2.

The contact substrate 20 is mounted on the PCB substrate 62_2 through an elastomer 42 and a support structure 52_6. The contact substrate 20, the elastomer 42, the support structure 52_6 and the PCB substrate 62_2 are fixed with one another by, for example, an adhesive (not shown). In this example, the triple layered TAB lead 78 for connecting the contact pad 33 and the PCB pad 38 has an upper lead A, intermediate lead B and a lower lead C. A support member 59_1 is provided between the upper lead A and the intermediate lead B of the triple layered TAB lead 78. A support member 59_2 is provided between the intermediate lead B and the lower lead C of the triple layered TAB lead 78.

The TAB lead 78 as a whole has a gull-wing shape which is similar to the standard "gull-wing lead" used in a surface

mount technology. Because of the down-ward bent of the gull-wing type TAB lead 78, a sufficient vertical clearance is achieved at the left end of Figure 22 over the contact portion between the PCB pad 38 and the TAB lead 78. The lead form of the TAB lead 78 (downward bent, gull-wing lead) may require special tooling to produce the same. Since a large number of interconnection between the contact trace and the PCB pad will be used in the application such as semiconductor testing, several hundred connections, such tooling may be standardized for a multiple of contact traces with given pitch.

The structure of the TAB lead 78 having the tiered leads A, B and C establish a low resistance and a large current capacity in a signal path because of the three conductive leads. This is useful in transmitting a large current such as in a ground line or a power line for testing a semiconductor device with high speed without deforming the waveforms of test signals.

Figure 23 shows another example of the fourth embodiment of the present invention. In this example, a triple layered TAB lead 78_2 having upper, intermediate and lower leads A, B and C is provided to the contact pad 33 connected to the contact trace 32 and contact structure 30. The upper lead A is provided in an upper and outer position of Figure 23 than the intermediate lead B. The intermediate lead B is provided in an upper and outer position of Figure 23 than the lower lead C. The upper lead A is connected to a PCB pad 38, the intermediate lead B is connected to a PCB pad 39, and the lower lead C is connected to a PCB pad 40. To accommodate the PCB pads 38, 39 and 40 thereon, a PCB substrate 62_6 is arranged to have steps to mount the PCB pads 38, 39 and 40 with different vertical positions. A support member 54_5 is provided between the upper lead A and the intermediate lead B and a support member 54_6 is provided between the intermediate lead B and the lower lead C.

The electrical connection between the TAB lead 78_2 and the PCB pads 38, 39 and 40 will be established by a surface mount technology (SMT) such as using a screen printable solder paste as well as various other bonding technologies including thermosonic bonding, thermocompression bonding, and ultrasonic bonding technique. Because of the significantly small sizes of the components and signal path lengths involved in the contact structure 30, contact trace 32, and the TAB lead 78_2, the example of Figure 23 can operate at a very high frequency band, such as several GHz. Moreover, because of the small number and simple structure of components to be assembled, the interconnection and packaging of the present invention can be fabricated with low cost and high reliability as well as high productivity.

The structure of the TAB lead 78_2 having the triple layered leads A, B and C establish a fan out in the vertical dimension. This is useful in distributing a signal or power to two or more paths. Another advantage of the fan out is to increase the number of contact pads, i.e., to decrease the effective pitch (distance) between the contact pads.

Figure 24 shows a further modification of the fourth embodiment of the present invention wherein the top type contact trace 32 is coupled to a connector provided on a printed circuit board or other structure. In the example of Figure 24, a contact pad 33 connected to the contact trace 32 is connected to a connector 46_3 via a triple layer TAB lead 78 which has the same shape as that shown in Figure 22. The connector 46_3 is provided on a support structure 52_5.

The connector 46_3 may be mechanically fixed to the support structure 52_5 through an attachment mechanism (not shown). The end of the TAB lead 78 is inserted in a receptacle (not shown) of the connector 46_3. As is well known in the art, such a receptacle has a spring mechanism to provide a sufficient contact force when receiving the end of the TAB lead 78 therein. Between the upper lead A and the

intermediate lead B of the triple layer TAB lead 78, there is provided a support member 59_1 to support the leads A and B. Between the intermediate lead B and the lower lead C of the double layer TAB lead 78, there is provided a support member 59_2 to support the leads B and C.

The structure of the TAB lead 78 having the tiered leads A, B and C establish a low resistance and a large current capacity in a signal path because of the three conductive leads. This is useful in transmitting a large current such as in a ground line or a power line for testing a semiconductor device with high speed without deforming the waveforms of test signals.

Figure 25 shows a further modification of the third embodiment of the present invention wherein the top type contact trace 32 is coupled to a connector provided on a printed circuit board or other structure. In the example of Figure 25, a contact pad 33 connected to the contact trace 32 is connected to a connector 46_4 via a triple layer TAB lead 78_4. The triple layer TAB 78_4 has an upper lead A, an intermediate lead B and a lower lead C each of which is separated at the end. The connector 46_4 is provided on a support structure 52_6.

The connector 46_4 may be mechanically fixed to the support structure 52_6 through an attachment mechanism (not shown). The ends of the leads A, B and C of the TAB lead 78_4 are inserted in receptacles (not shown) of the connector 46_4. As is well known in the art, such a receptacle has a spring mechanism to provide a sufficient contact force when receiving the end of the TAB lead 78_4 therein. A support member 59_3 is provided between the upper lead A and the intermediate lead B and a support member 59_4 is provided between the intermediate lead B and the lower lead C of the triple TAB lead 78_4.

The structure of the TAB lead 78_4 having the triple layered leads A, B and C establish a fan out in the vertical

dimension. This is useful in distributing a signal or power to two or more paths. Another advantage of the fan out is to increase the number of contact pads, i.e., to decrease the effective pitch (distance) between the contact pads.

Figures 26 shows a further example of the fourth embodiment of the present invention wherein the top type contact trace is coupled to a pad provided on a printed circuit board through a conductive bump. In the example of Figure 26, a contact structure 30, a contact trace 32 and a contact tab 33 are formed on a contact substrate 20. Typically, the contact substrate 20 is a silicon substrate although other types of dielectric substrate, such as glass epoxy, polyimide, ceramic, and alumina substrates are also feasible. The contact pad 33 is connected to a PCB (print circuit board) pad 38 provided on a PCB substrate 62_2 through a conductive bump 56 via a triple layer TAB lead 78.

The contact substrate 20 is mounted on the PCB substrate 62_2 through a support structure 52_6 and an elastomer 42. The contact substrate 20, the elastomer 42, the support structure 52_6, and the PCB substrate 62_2 are attached with one another by, for example, an adhesive (not shown). Between the upper lead A and the intermediate lead B of the triple layer TAB lead 78, there is provided a support member 59_1 to support the leads A and B. Between the intermediate lead B and the lower lead C of the triple layer TAB lead 78, there is provided a support member 59_2 to support the leads B and C.

The structure of the TAB lead 78 having the tiered leads A, B and C establish a low resistance and a large current capacity in a signal path because of the three conductive leads. This is useful in transmitting a large current such as in a ground line or a power line for testing a semiconductor device with high speed without deforming the waveforms of test signals.

By the application of the heat, the conductive bump 56 is reflowed onto the PCB pad 38 for attachment between the

TAB lead 78 and the PCB pad 38. An example of the conductive bump 56 is a solder bump used in a standard solder ball technology. Another example of the conductive bump 56 is a fluxless solder ball used in a plasma-assisted dry soldering technology.

Figure 27 shows another example of the fourth embodiment of the present invention. In this example, a triple layered TAB lead 78_2 having upper, intermediate and lower leads A, B and C is provided to the contact pad 33 connected to the contact structure 30. The upper lead A is provided in an upper and outer position of Figure 27 than the intermediate lead B. The intermediate lead B is provided in an upper and outer position than the lower lead C in Figure 27. The upper lead A is connected to a PCB pad 38 through a conductive bump 56, the intermediate lead B is connected to a PCB pad 39 through a conductive bump 57, and the lower lead C is connected to a PCB pad 40 through a conductive bump 58. To accommodate the PCB pads 38, 39 and 40 thereon, a PCB substrate 62_6 is arranged to have steps to mount the PCB pads 38, 39 and 40 with different vertical positions. A support member 54_5 is provided between the upper lead A and the intermediate lead B and a support member 54_6 is provided between the intermediate lead B and the lower lead C.

By the application of the heat, the conductive bumps 56, 57 and 58 are reflowed onto the PCB pads 38, 39 and 40 for attachment between the TAB lead 78_2 and the PCB pads 38, 39 and 40. An example of the conductive bumps 56, 57 and 58 is a solder bump used in a standard solder ball technology. Another example of the conductive bumps 56, 57 and 58 is a fluxless solder ball used in a plasma-assisted dry soldering technology.

The structure of the TAB lead 78_2 having the triple layered leads A, B and C establish a fan out in the vertical dimension. This is useful in distributing a signal or power to two or more paths. Another advantage of the fan out is to

increase the number of contact pads, i.e., to decrease the effective pitch (distance) between the contact pads.

Figures 28 shows a further example of the fourth embodiment of the present invention wherein the top type contact trace is coupled to a pad provided on a printed circuit board through a conductive polymer. In the example of Figure 28, a contact structure 30, a contact trace 32 and a contact tab 33 are formed on a contact substrate 20. Typically, the contact substrate 20 is a silicon substrate although other types of dielectric substrate, such as glass epoxy, polyimide, ceramic, and alumina substrates are also feasible. The contact pad 33 is connected to a PCB (print circuit board) pad 38 provided on a PCB substrate 62_2 through a conductive polymer 66 via a triple layer TAB lead 78.

The contact substrate 20 is mounted on the PCB substrate 62_2 through a support structure 52_6 and an elastomer 42. The contact substrate 20, the elastomer 42, the support structure 52_6, and the PCB substrate 62_2 are attached with one another by, for example, an adhesive (not shown). Between the upper lead A and the intermediate lead B of the triple layer TAB lead 78, there is provided a support member 59_1 to support the leads A and B. Between the intermediate lead B and the lower lead C of the triple layer TAB lead 78, there is provided a support member 59_2 to support the leads B and C.

Most conductive polymers are designed to be conductive between the mating electrodes normally in vertical of angled directions and not conductive in the horizontal direction. An example of the conductive polymer 66 is a conductive elastomer which is filled with conductive wire that extends beyond the surface of the elastomer.

Various other examples of the conductive polymer 66 are possible such as an anisotropic conductive adhesive, anisotropic conductive film, anisotropic conductive paste, and anisotropic conductive particles. The anisotropic conductive adhesive is filled with conductive particles that

do not touch each other. The conductive path is formed by pressing the adhesive between the two electrodes at a specific location. The anisotropic conductive film is a thin dielectric resin filled with conductive particles that do not touch each other. The conductive path is formed by pressing the film between the two electrodes at a specific location.

The anisotropic conductive paste is a screen printable paste which is filled with conductive particles that do not touch each other. The conductive path is formed by pressing the paste between the two electrodes at a specific location. The anisotropic conductive particle is a thin dielectric resin filled with conductive particles coated with a very thin layer of dielectric material to improve isolation. The conductive path is formed by pressing the particle with enough force to explode the dielectric coating on the particles, between the two electrodes at a specific location.

The structure of the TAB lead 78 having the tiered leads A, B and C establish a low resistance and a large current capacity in a signal path because of the three conductive leads. This is useful in transmitting a large current such as in a ground line or a power line for testing a semiconductor device with high speed without deforming the waveforms of test signals.

Figure 29 shows another example of the fourth embodiment of the present invention. In this example, a triple layered TAB lead 78_2 having upper, intermediate and lower leads A, B and C is provided to the contact pad 33 connected to the contact trace 32 and contact structure 30. The upper lead A is provided in an upper and outer position than the intermediate lead B in Figure 29. The intermediate lead B is provided in an upper and outer position of Figure 29 than the lower lead C. The upper lead A is connected to a PCB pad 38 through a conductive polymer 66, the intermediate lead B is connected to a PCB pad 39 through a conductive polymer 67, and the lower lead C is connected to a PCB pad 40 through a

conductive polymer 68. To accommodate the PCB pads 38, 39 and 40 thereon, a PCB substrate 62_6 is arranged to have steps to mount the PCB pads 38, 39 and 40 with different vertical positions. A support member 54_5 is provided between the upper lead A and the intermediate lead B and a support member 54_6 is provided between the intermediate lead B and the lower lead C.

The structure of the TAB lead 78_2 having the triple layered leads A, B and C establish a fan out in the vertical dimension. This is useful in distributing a signal or power to two or more paths. Another advantage of the fan out is to increase the number of contact pads, i.e., to decrease the effective pitch (distance) between the contact pads.

According to the present invention, the packaging and interconnection has a very high frequency bandwidth to meet the test requirements in the next generation semiconductor technology. The packaging and interconnection is able to mount the contact structure on a probe card or equivalent thereof by electrically connecting therewith through the upper surface of the contact structure. Moreover, because of a relatively small number of overall components to be assembled, the interconnection and packaging of the present invention can be fabricated with low cost and high reliability as well as high productivity.

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 packaging and interconnection of a contact structure, comprising:

a contact structure made of conductive material and formed on a contact substrate through a photolithography process, said contact structure having a base portion vertically formed on said contact substrate, a horizontal portion, one end of which being formed on said base portion, and a contact portion vertically formed on another end of said horizontal portion;

a contact trace formed on said contact substrate and electrically connected to said contact structure at one end, the other end of said contact trace being formed of a contact pad;

a contact target provided at an outer periphery of said contact trace to be electrically connected with said contact pad;

a bonding wire for electrically connecting an upper surface of the contact pad and the contact target;

an elastomer provided under said contact substrate for allowing flexibility in said interconnection and packaging; and

a support structure provided under said elastomer for supporting said contact structure, said contact substrate and said elastomer.

2. A packaging and interconnection of a contact structure as defined in Claim 1, wherein said contact substrate is a silicon substrate on which said contact structure is directly formed through said photolithography process.

3. A packaging and interconnection of a contact structure as defined in Claim 1, wherein said contact substrate is a dielectric substrate on which said contact structure is directly formed through said photolithography process.



4. A packaging and interconnection of a contact structure as defined in Claim 1, wherein said contact target is provided on a printed circuit board (PCB) substrate.

5. A packaging and interconnection of a contact structure, comprising:

a contact structure made of conductive material and formed on a contact substrate through a photolithography process, said contact structure having a base portion vertically formed on said contact substrate, a horizontal portion, one end of which being formed on said base portion, and a contact portion vertically formed on another end of said horizontal portion;

a contact trace formed on said contact substrate and electrically connected to said contact structure at one end, the other end of said contact trace being formed of a contact pad;

a printed circuit board (PCB) pad provided on a printed circuit board (PCB) substrate positioned at an outer periphery of said contact structure to be electrically connected with said contact pad;

a single layer lead for electrically connecting an upper surface of the contact pad and the PCB pad;

an elastomer provided under said contact substrate for allowing flexibility in said interconnection and packaging; and

a support structure provided between said elastomer and said PCB substrate for supporting said contact structure, said contact substrate and said elastomer.

6. A packaging and interconnection of a contact structure as defined in Claim 5, wherein said PCB substrate is made of glass epoxy resin or ceramics.

7. A packaging and interconnection of a contact structure as defined in Claim 5, wherein said PCB substrate is a multilayer printed circuit board.

8. A packaging and interconnection of a contact

structure as defined in Claim 5, wherein said support structure is made of ceramic, molded plastic or metal.

9. A packaging and interconnection of a contact structure as defined in Claim 5, wherein said single layer lead is formed in a tape automated bonding (TAB) structure to be used in the packaging and interconnection.

10. A packaging and interconnection of a contact structure as defined in Claim 5, wherein said single layer lead has a gull-wing shape for electrically connecting said contact pad and said PCB pad.

11. A packaging and interconnection of a contact structure as defined in Claim 5, wherein one end of said single layer lead is connected to said PCB pad through a conductive bump.

12. A packaging and interconnection of a contact structure as defined in Claim 11, wherein said conductive bump is a solder ball which reflows by application of heat to electrically connect said other end of said single layer lead and said PCB pad.

13. A packaging and interconnection of a contact structure as defined in Claim 11, wherein said conductive bump is a conductive polymer bump or a compliant bump to electrically connect said other end of said single layer lead and said PCB pad.

14. A packaging and interconnection of a contact structure as defined in Claim 5, wherein one end of said single layer lead is connected to said PCB pad through a conductive polymer.

15. A packaging and interconnection of a contact structure as defined in Claim 14, wherein said conductive polymer is a conductive adhesive, conductive film, conductive paste or conductive particles.

16. A packaging and interconnection of a contact structure as defined in Claim 14, wherein said conductive polymer is a conductive elastomer including an anisotropic



conductive adhesive, anisotropic conductive film, anisotropic conductive paste or anisotropic conductive particles to electrically connect said other end of said contact trace and said PCB pad.

17. A packaging and interconnection of a contact structure, comprising:

a contact structure made of conductive material and formed on a contact substrate through a photolithography process, said contact structure having a base portion vertically formed on said contact substrate, a horizontal portion, one end of which being formed on said base portion, and a contact portion vertically formed on another end of said horizontal portion;

a contact trace formed on said contact substrate and electrically connected to said contact structure at one end, the other end of said contact trace being formed of a contact pad;

a printed circuit board (PCB) pad provided on a printed circuit board (PCB) substrate positioned at an outer periphery of said contact structure to be electrically connected with said contact pad;

a double layer lead for electrically connecting an upper surface of the contact pad and the PCB pad;

an elastomer provided under said contact substrate for allowing flexibility in said interconnection and packaging; and

a support structure provided between said elastomer and said PCB substrate for supporting said contact structure, said contact substrate and said elastomer.

18. A packaging and interconnection of a contact structure as defined in Claim 17, wherein said PCB substrate is made of glass epoxy resin or ceramics.

19. A packaging and interconnection of a contact structure as defined in Claim 17, wherein said PCB substrate is a multilayer printed circuit board.



20. A packaging and interconnection of a contact structure as defined in Claim 17, wherein said support structure is made of ceramic, molded plastic or metal.

21. A packaging and interconnection of a contact structure as defined in Claim 17, wherein said double layer lead is formed in a tape automated bonding (TAB) structure to be used in the packaging and interconnection.

22. A packaging and interconnection of a contact structure as defined in Claim 17, wherein said double layer lead has a gull-wing shape for electrically connecting said contact pad and said PCB pad.

23. A packaging and interconnection of a contact structure as defined in Claim 17, wherein one end of said double layer lead is connected to said PCB pad through a conductive bump.

24. A packaging and interconnection of a contact structure as defined in Claim 23, wherein said conductive bump is a solder ball which reflows by application of heat to electrically connect said other end of said single layer lead and said PCB pad.

25. A packaging and interconnection of a contact structure as defined in Claim 23, wherein said conductive bump is a conductive polymer bump or a compliant bump to electrically connect said other end of said single layer lead and said PCB pad.

26. A packaging and interconnection of a contact structure as defined in Claim 17, wherein one end of said double layer lead is connected to said PCB pad through a conductive polymer.

27. A packaging and interconnection of a contact structure as defined in Claim 26, wherein said conductive polymer is a conductive adhesive, conductive film, conductive paste or conductive particles.

28. A packaging and interconnection of a contact structure as defined in Claim 26, wherein said conductive

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polymer is a conductive elastomer including an anisotropic conductive adhesive, anisotropic conductive film, anisotropic conductive paste or anisotropic conductive particles to electrically connect said other end of said contact trace and said PCB pad.

29. A packaging and interconnection of a contact structure as defined in Claim 17, wherein one end of said double layer lead is formed of an upper lead and a lower lead to be respectively connected to corresponding PCB pads provided on said PCB substrate.

30. A packaging and interconnection of a contact structure as defined in Claim 29, wherein said upper lead and said lower lead are respectively connected to corresponding PCB pads provided on said PCB substrate through corresponding conductive bumps.

31. A packaging and interconnection of a contact structure as defined in Claim 29, wherein said upper lead and said lower lead are respectively connected to corresponding PCB pads provided on said PCB substrate through corresponding conductive polymers.

32. A packaging and interconnection of a contact structure, comprising:

a contact structure made of conductive material and formed on a contact substrate through a photolithography process, said contact structure having a base portion vertically formed on said contact substrate, a horizontal portion, one end of which being formed on said base portion, and a contact portion vertically formed on another end of said horizontal portion;

a contact trace formed on said contact substrate and electrically connected to said contact structure at one end, the other end of said contact trace being formed of a contact pad;

a printed circuit board (PCB) pad provided on a printed circuit board (PCB) substrate positioned at an

outer periphery of said contact structure to be electrically connected with said contact pad;

a triple layer lead for electrically connecting an upper surface of the contact pad and the PCB pad;

an elastomer provided under said contact substrate for allowing flexibility in said interconnection and packaging; and

a support structure provided between said elastomer and said PCB substrate for supporting said contact structure, said contact substrate and said elastomer.

33. A packaging and interconnection of a contact structure as defined in Claim 32, wherein said PCB substrate is made of glass epoxy resin or ceramics.

34. A packaging and interconnection of a contact structure as defined in Claim 32, wherein said PCB substrate is a multilayer printed circuit board.

35. A packaging and interconnection of a contact structure as defined in Claim 32, wherein said support structure is made of ceramic, molded plastic or metal.

36. A packaging and interconnection of a contact structure as defined in Claim 32, wherein said triple layer lead is formed in a tape automated bonding (TAB) structure to be used in the packaging and interconnection.

37. A packaging and interconnection of a contact structure as defined in Claim 32, wherein said triple layer lead has a gull-wing shape for electrically connecting said contact pad and said PCB pad.

38. A packaging and interconnection of a contact structure as defined in Claim 32, wherein one end of said triple layer lead is connected to said PCB pad through a conductive bump.

39. A packaging and interconnection of a contact structure as defined in Claim 38, wherein said conductive bump is a solder ball which reflows by application of heat to electrically connect said other end of said single layer lead



and said PCB pad.

40. A packaging and interconnection of a contact structure as defined in Claim 38, wherein said conductive bump is a conductive polymer bump or a compliant bump to electrically connect said other end of said single layer lead and said PCB pad.

41. A packaging and interconnection of a contact structure as defined in Claim 32, wherein one end of said triple layer lead is connected to said PCB pad through a conductive polymer.

42. A packaging and interconnection of a contact structure as defined in Claim 41, wherein said conductive polymer is a conductive adhesive, conductive film, conductive paste or conductive particles.

43. A packaging and interconnection of a contact structure as defined in Claim 41, wherein said conductive polymer is a conductive elastomer including an anisotropic conductive adhesive, anisotropic conductive film, anisotropic conductive paste or anisotropic conductive particles to electrically connect said other end of said contact trace and said PCB pad.

44. A packaging and interconnection of a contact structure as defined in Claim 32, wherein one end of said triple layer lead is formed of an upper lead, an intermediate lead, and a lower lead to be respectively connected to corresponding PCB pads provided on said PCB substrate.

45. A packaging and interconnection of a contact structure as defined in Claim 44, wherein said upper lead, said intermediate lead, and said lower lead are respectively connected to corresponding PCB pads provided on said PCB substrate through corresponding conductive bumps.

46. A packaging and interconnection of a contact structure as defined in Claim 44, wherein said upper lead, said intermediate lead, and said lower lead are respectively connected to corresponding PCB pads provided on said PCB



substrate through corresponding conductive polymers.

47. A packaging and interconnection of a contact structure, comprising:

a contact structure made of conductive material and formed on a contact substrate through a photolithography process, said contact structure having a base portion vertically formed on said contact substrate, a horizontal portion, one end of which being formed on said base portion, and a contact portion vertically formed on another end of said horizontal portion;

a contact trace formed on said contact substrate and electrically connected to said contact structure at one end, the other end of said contact trace being formed of a contact pad;

a connector for establishing electrical connection with said contact pad;

a conductive lead for electrically connecting an upper surface of the contact pad and the connector;

an elastomer provided under said contact substrate for allowing flexibility in said interconnection and packaging; and

a support structure provided under said elastomer for supporting said contact structure, said contact substrate, said elastomer and said connector.

48. A packaging and interconnection of a contact structure as defined in Claim 47, wherein said contact substrate is a silicon substrate on which said contact structure is directly formed through said photolithography process.

49. A packaging and interconnection of a contact structure as defined in Claim 47, wherein said contact substrate is a dielectric substrate on which said contact structure is directly formed through said photolithography process.

50. A packaging and interconnection of a contact

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structure as defined in Claim 47, wherein said contact trace is made of conductive material and formed through either a deposition, evaporation, sputtering or plating process.

51. A packaging and interconnection of a contact structure as defined in Claim 47, wherein said support structure is made of ceramic, molded plastic or metal.

52. A packaging and interconnection of a contact structure as defined in Claim 47, wherein said conductive lead has a plurality of vertically aligned leads to be received by said connector.

53. A packaging and interconnection of a contact structure as defined in Claim 47, wherein said conductive lead is a double layer lead which is formed in a tape automated bonding (TAB) structure to be used in the packaging and interconnection.

54. A packaging and interconnection of a contact structure as defined in Claim 47, wherein said conductive lead is a triple layer lead which is formed in a tape automated bonding (TAB) structure to be used in the packaging and interconnection.

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