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(54) Title: METHOD OF THERMOCOMPRESSSION BONDING OF LASER-ETCHED COPPER PADS TO COB MODULE

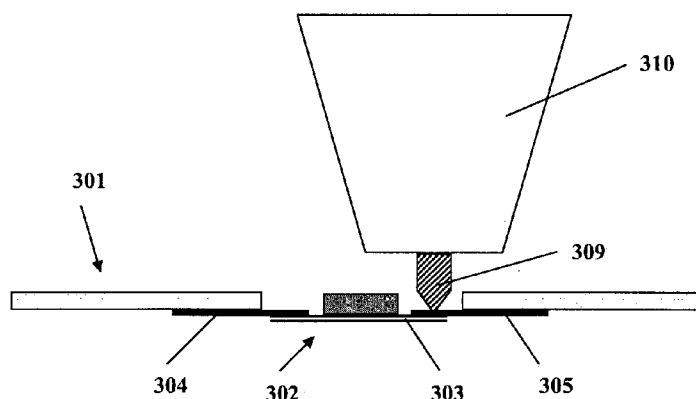


Fig. 3C

(57) Abstract: The present invention provides an RFID board comprising antenna and chip-on board module, wherein the antenna having two terminals in a form of pads, is bonded to lead frame of the chip-on-board module via the thermocompression bonding, without the use of any intermediate electrically conductive materials. A method to fabricate the RFID board via thermocompression bonding is also provided herewith.



Method of Thermocompression Bonding of Laser-Etched Copper Pads to COB Module

Field of the Invention

[0001] The present invention relates to method of chip-on-board (COB) module
5 bonding. In particular, the present invention relates to method of thermocompression
bonding, which affects a direct bonding of copper antenna, which terminal pads are
laser-etched within predefined window area, to COB module.

Background

[0002] Radio-frequency identification (RFID) has amazingly been used in wide
10 range of applications, which includes identification and tracking of objects, such as
persons, products, and animals. RFID, which comes in many different forms and
shapes like tag, board or card, communicates with a reader via electromagnetic
waves. Typically, RFID comprises a chip-on-board (COB) module for storing and
processing data, and a coil antenna for radio-frequency communication purpose.

15 [0003] To manufacture an RFID tag, board or card, an arrangement of COB module
bonded to antenna is mounted onto a tag substrate. In order to bond the COB module
to the antenna, intermediate epoxy is applied in between the COB module and the
antenna.

[0004] US Patent Publication no. 2007/0193021 discloses a method for
20 manufacturing RFID Tag. The RFID tag comprises an antenna, an integrated circuit
(IC) chip, and gold bumps wherein gold bumps are used as intermediate material to

bond the antenna to the IC chip by means of heating and pressing. The gold bumps are provided on the surface of the IC chip.

[0005] US Patent Publication No. 2007/0158804 discloses another method for manufacturing RFID Tag. The method uses an anisotropic conductive paste or film, to serve as intermediate binder layer between IC chip and antenna in RFID Tag. The anisotropic conductive paste or film contains either nickel or gold. The IC chip is then pressure-bonded to the antenna.

Summary

[0006] In one aspect of the present invention, there is provided an RFID board comprising a chip-on-board module having a lead frame and an antenna having terminals in a form of pads, wherein the terminal pads of the antenna are bonded to the lead frame of the chip-on-board module via thermocompression bonding, without the use of any intermediate electrically conductive materials.

[0007] In one embodiment, the antenna and the lead frame of the chip on board module are made of any electrically conducted metals/alloys having similar melting points.

[0008] In another embodiment, wherein the antenna is made of copper and the lead frame of the chip-on-board module is made of copper alloy with silver plating

[0009] In a further embodiment of the present invention, the antenna of the RFID board is a single-sided copper substrate antenna.

[0010] In yet a further embodiment, the antenna of the RFID board is a double-sided copper substrate antenna.

[0011] In yet another embodiment, when the terminal pads of the antenna is covered with any substrate or adhesive materials, a bareback area is then defined underneath
5 the terminal pads to expose the terminal pads plainly without any substrate or adhesive materials.

[0012] In another aspect of the present invention, there is provided a method for fabricating RFID board via thermocompression bonding. The method comprises providing an antenna with terminal pads, aligning the antenna with a chip-on board
10 (COB) module, wherein lead frame of the COB module is positioned within terminal pads of the antenna, bringing the COB module towards the antenna, so that the lead frame of the COB module is in physical contact with the terminal pads of the antenna, and applying heat and pressure so as to weld and bond the terminal pads of the antenna to the lead frame of the chip-on-board module. The method of fabricating the
15 RFID board via thermocompression bonding might further comprises laser-etching area underneath the terminal pads to remove any substrate/adhesive materials away from the terminal pads.

[0013] In one embodiment of the present invention, non-conductive heat-reactive adhesive is used to align the antenna with the chip-on-board module

20 [0014] In a further embodiment, the antenna is a single-sided copper substrate antenna or a double-sided copper substrate antenna. Preferably, the lead frame of the COB module is made of copper alloy with silver plating.

[0015] In yet a further embodiment of the present invention, the operating temperature for the thermocompression bonding is 300°C ~ 400°C and the operating pressure for the same is 340 ~ 680 atm.

Brief Description of the Drawings

5 [0016] This invention will be described by way of non-limiting embodiments of the present invention, with reference to the accompanying drawings, in which:

[0017] Fig. 1 illustrates an exemplary RFID board 100 in accordance with one embodiment of the present invention;

[0018] Fig. 2 is an exemplary cross-sectional view of the RFID board 100 across the
10 line A-A' of Fig. 1 with a single sided copper antenna in accordance with one embodiment of the present invention;

[0019] Fig. 3A to 3C illustrate a flow diagram of thermocompression bonding process for fabricating the RFID board in accordance with one embodiment of the present invention;

15 [0020] Fig. 4 is another exemplary cross-sectional view of the RFID board 100 across the line A-A' of Fig. 1 with a dual layer copper antenna in accordance with another embodiment of the present invention; and

[0021] Figs. 5A to 5C illustrate a flow diagram of thermocompression bonding process of the double-sided copper substrate antenna of Fig. 4 with a COB module in
20 accordance with another embodiment of the present invention.

Detailed Description

[0022] The following descriptions of a number of specific and alternative embodiments are provided to understand the inventive features of the present invention. It shall be apparent to one skilled in the art, however that this invention may be practiced without such specific details. Some of the details may not be described in length so as to not obscure the invention. For ease of reference, common reference numerals will be used throughout the figures when referring to same or similar features common to the figures.

[0023] The present invention provides an RFID board comprising an antenna and a chip on board (COB) module, wherein the antenna and the COB module is bonded by way of thermocompression bonding and no intermediate electrically conductive material is used therebetween. It is desired that the antenna and the COB module are made from any electrically conducted metals/alloys that have similar melting points. As such, when heat and pressure is applied, the antenna and the COB module are simultaneously softened and welded together, forming electrically non-intermittent connection therebetween.

[0024] Now referring to **Fig 1**, there is provided an exemplary RFID board **100** in accordance with one embodiment of the present invention. The RFID board **100** comprises copper antenna **101** having terminals in a form of terminal pads **104**, **105** of specified thickness and a COB module **103** with lead frame **108**. To form the

copper antenna 101, it is desired that a copper tracks 106 is etched or deposited onto a substrate 102.

[0025] Still referring to Fig. 1, the lead frame 108 of the COB module 103 in the present embodiment is made of copper alloy with silver plating, although other metal and/or plating may be desired. The lead frame 108 is bonded to the terminal pads 104, 105 via thermocompression bonding. Preferably, the thermocompression bonding is carried out without the use of any electrically conductive materials as intermediate bonding material between the lead frame 108 and the antenna pads 104, 105. Typically, conventional thermocompression bonding require intermediate materials, such as gold, to bond the COB module 103 onto the copper antenna 101.

[0026] Fig. 2 is an exemplary cross-sectional view of the RFID board 100 across the line A-A' of Fig. 1 with a single sided copper substrate antenna 200 having terminal pads 204, 205 in accordance with one embodiment of the present invention. For a better visualization, COB module of the RFID board 100 is not shown herein. The single sided copper antenna 200 is bonded onto the substrate 212 by a heat-reactive adhesive 201. The substrate 212 may be made of PET or any other suitable materials. The substrate 212 defines a punched hole 203 across the terminal pads 204, 205. In the antenna 200, there is provided a bareback 202. The bareback 202 implies a pre-defined window, in which bonding site within the terminal pads 204, 205 of the antenna 200 is exposed plainly without any substrate or adhesive materials. To form the bareback 202, it is desired that substrate and adhesive materials under the terminal pads 204, 205 are removed by laser-etching.

[0027] Figs. 3A to 3C illustrate a flow diagram of thermocompression bonding process for fabricating the RFID board in accordance with one embodiment of the present invention. In this process, a COB module 302 is to be bonded to a single sided copper substrate antenna 301.

5 [0028] In Fig. 3A, the antenna 301 is flipped downwardly and aligned with the COB Module 302. When the antenna 301 is flipped, the bareback areas 320 of the terminal pads 304, 305 are upwardly facing. Similarly, the COB module 302 is also flipped with the lead frame 303 upwardly facing. The lead frame 303 of the COB module 302 is positioned to align with the terminal pads 304, 305 of the antenna
10 301 within the bareback area 320.

[0029] Once the antenna 301 and the COB module 302 are aligned, in Fig. 3B, the COB module 302 is brought towards the antenna 301 so that the lead frame 303 is in physical contact with the terminal pads 304, 305 within the bareback area 320. A non-conductive heat-reactive adhesive (not shown) may be used to pre-hold the
15 antenna 301 onto the COB module 302.

[0030] In Fig. 3C, a heated tip 309 of a thermocompression bonder machine 310 comes into contact with one of the terminal pad 305 through the bareback area 320. The heated tip 309 applies heat and pressure onto the terminal pad 305 to bond the terminal pads 305 of the copper antenna 301 with the lead frame 303 of the COB
20 module 302 within the opening area 306. As the copper of the antenna terminals 305 and the lead frame 303 soften due to the heat and pressure applied, the terminal 305 and the lead frame 303 are welded together to form an electrical connection

therebetween, without any intermediate conductive materials. Same treatment is also applied to the terminal pads 304. Depending on the material used by the antenna coil and the lead frame, the operating temperature and pressure used in the process can be selected at 300°C ~ 400°C and 340 ~ 680 atm respectively. The
5 selected operating temperature and pressure is suitable for bonding copper antenna to lead frame of copper alloy with silver plating.

[0031] It is understood to a skilled person in the art that varieties of materials with/without platings can be used for RFID's antenna coils and the COB's lead frame. The copper selected for the antenna and the copper with silver plating
10 selected for the lead frame is to be understood as an example only, not limitation. Other metals such as gold, platinum, tungsten, aluminium, carbon, iron, nickel, chromium, and an alloy containing any of such elements, or any other suitable plating can be used.

[0032] Fig. 4 is another exemplary cross-sectional view of the RFID board 100
15 across the line A-A' of Fig. 1 with a double sided copper substrate antenna 400 in accordance with another embodiment of the present invention. The double sided copper substrate antenna 400 comprising a copper tracks and two groups of terminal pads 421, 422; one group of terminal pads 421 is formed and bonded on top of substrate 420, wherein another group of terminal pads 422 is formed and
20 bonded on bottom of substrate 420. The substrate 420 also defines a punched hole 423. The two groups of terminal pads 421, 422 are electrically interconnected to each other by blind plated 424 through the punched hole 423.

[0033] Figs. 5A to 5C illustrate a flow diagram of thermocompression bonding process of the double-sided copper substrate antenna 400 of Fig. 4 with a COB module 502 in accordance with another embodiment of the present invention.

[0034] In Fig. 5A, the antenna 400 is positioned so that the bottom group of terminal pads 422 is facing downwardly, whilst the lead frame 503 of the COB module 502 is upwardly facing. The lead frame 503 of the COB module 502 is positioned to align with the bottom group of terminal pads 422.

[0035] It is desired that the bottom group of the terminal pads 422 is laser-etched to remove any intermediate/adhesive materials away before it is bonded to the COB module 502.

[0036] Once the antenna 400 and the COB module 502 are aligned, in Fig. 3B, the COB module 502 is brought towards the antenna 400 so that the lead frame 503 is in physical contact with the bottom group of terminal pads 422. A non-conductive heat-reactive adhesive (not shown) may be used to pre-hold the antenna 400 onto the COB module 502.

[0037] In Fig. 5C, a heated tip 509 of a thermocompression bonder machine 510 comes into contact with top group of the terminal pads 421. As the heated tip 509 applies heat and pressure onto the top group of the terminal pads 421, which is electrically connected to the bottom group of the terminal pads 422, the heat and pressure are transferred to the bottom group of the terminal pads 422. Accordingly, the bottom group of the terminal pads 422 is melted and welded together with the leadframe 503 of the COB module 502 aligned with the bottom group of the

terminal pads 422, forming an electrical connection between the COB module 502 and the bottom group of the terminal pads 422. The operating temperature and pressure used in the process can be selected at 300°C ~ 400°C and 340 ~ 680 atm respectively.

- 5 [0038] The above description illustrates various embodiments of the present invention along with examples of how aspects of the present invention may be implemented. While specific embodiments have been described and illustrated it is understood that many changes, modifications, variations and combinations thereof could be made to the present invention without departing from the scope of the
- 10 present invention. The above examples, embodiments, instructions semantics, and drawings should not be deemed to be the only embodiments, and are presented to illustrate the flexibility and advantages of the present invention as defined by the following claims:

Claims

1. An RFID board comprising:

a chip-on-board module having a lead frame; and

an antenna having terminals in a form of pads,

5 wherein the terminal pads of the antenna are bonded to the lead frame of the chip-on-board module via thermocompression bonding, without the use of any intermediate electrically conductive materials.
2. The RFID board of claim 1, wherein the antenna and the lead frame of the chip on board module are made of any electrically conducted metals/alloys having similar
10 melting points.
3. The RFID board of claim 1, wherein the antenna is made of copper and the lead frame of the chip-on-board module is made of copper alloy with silver plating
4. The RFID board of claim 1, wherein the antenna is a single-sided copper substrate antenna.
- 15 5. The RFID board of claim 1, wherein the antenna is a double-sided copper substrate antenna.
6. The antenna of claim 4 or 5, wherein the antenna further comprises a bareback area underneath the terminal pads such that the terminal pads are exposed plainly without any substrate/adhesive materials.

7. A method for fabricating an RFID board via thermocompression bonding, the method comprising:
- providing an antenna with terminal pads;
 - aligning the antenna with a chip-on board (COB) module, wherein lead frame
5 of the COB module is positioned within terminal pads of the antenna;
 - bringing the COB module towards the antenna, so that the lead frame of the COB module is in physical contact with the terminal pads of the antenna; and
 - applying heat and pressure so as to weld and bond the terminal pads of the antenna to the lead frame of the chip –on-board module.
- 10 8. The method of claim 7, further comprising laser-etching area underneath the terminal pads to remove any substrate/adhesive materials away from the terminal pads.
9. The method of claim 7 or 8, wherein non-conductive heat-reactive adhesive is used to align the antenna with the chip-on-board module
10. The method of claim 9, wherein the antenna is a single-sided copper substrate
15 antenna.
11. The method of claim 9, wherein the antenna is a double-sided copper substrate antenna.
12. The method of claim 10 or 11, wherein the lead frame is made of copper alloy with silver plating.
- 20 13. The method of claim 12, wherein the operating temperature is 300°C ~ 400°C.

14. The method of claim 12, wherein the operating pressure is 340 ~ 680 atm.

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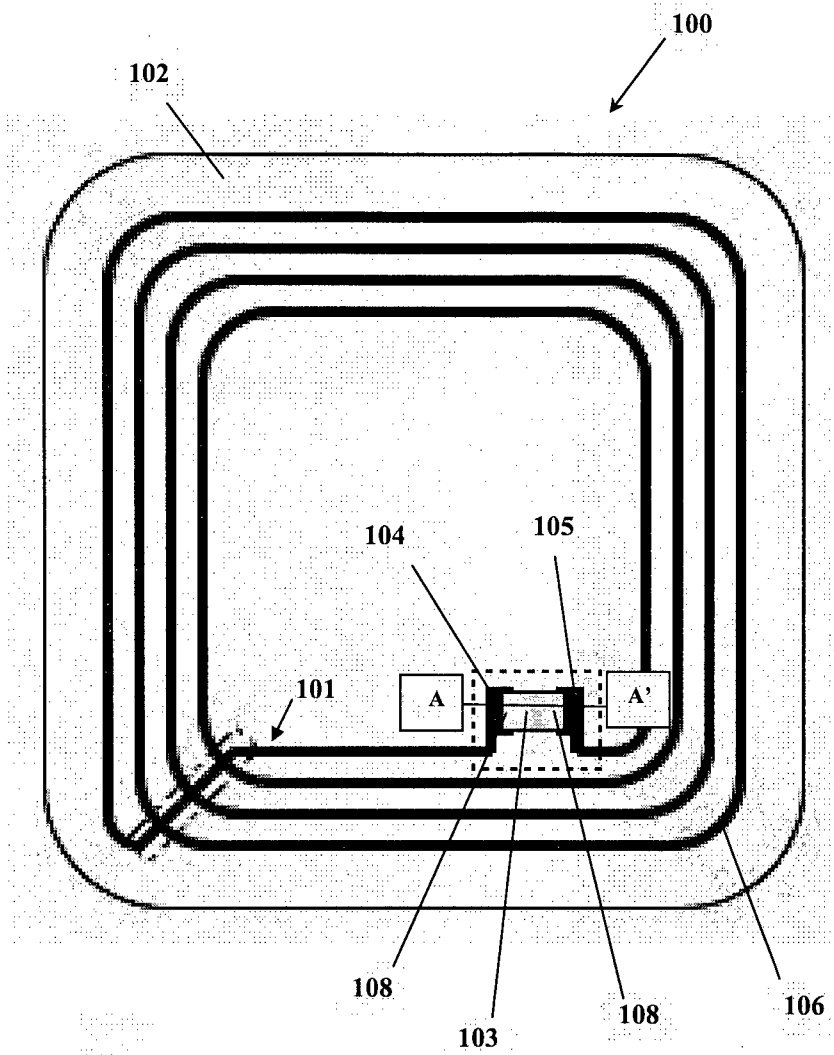


Fig. 1

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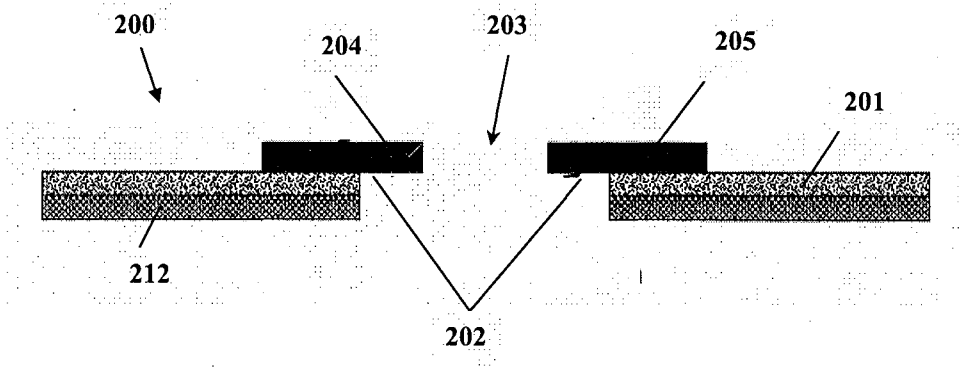


Fig. 2

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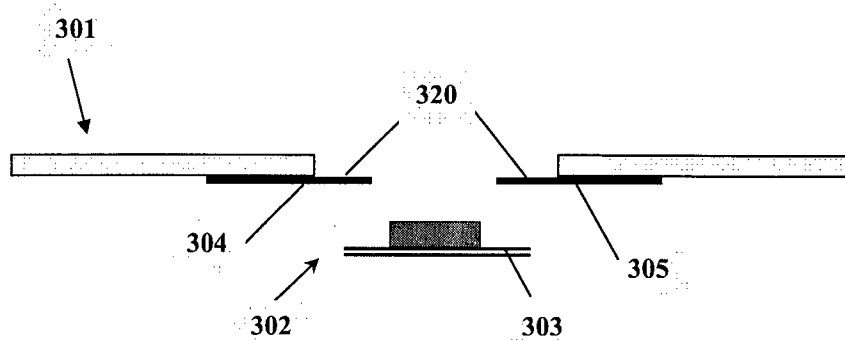


Fig. 3A

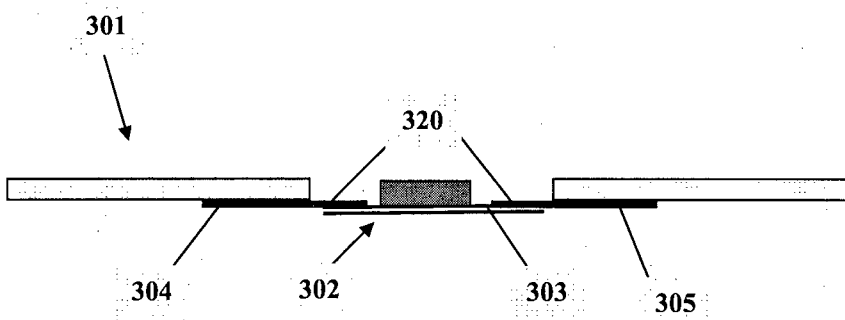


Fig. 3B

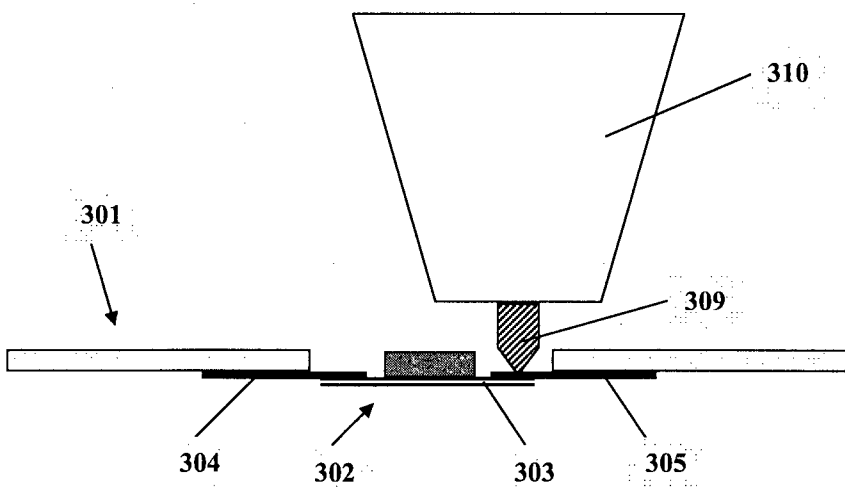


Fig. 3C

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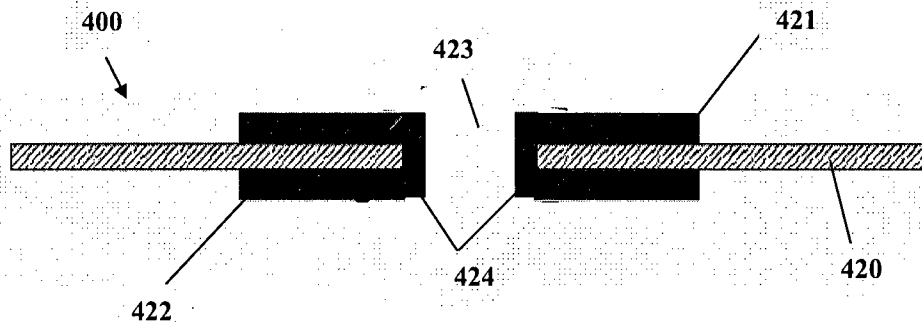


Fig. 4

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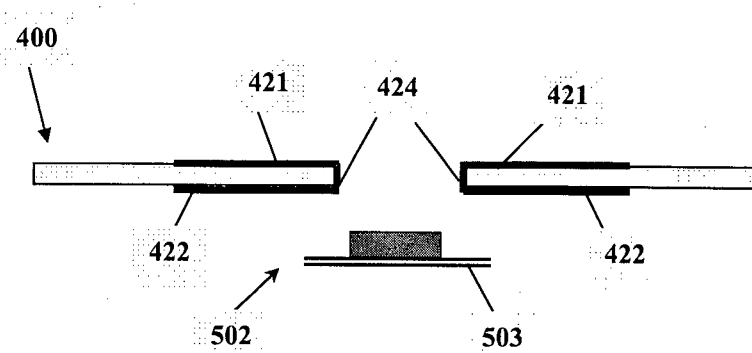


Fig. 5A

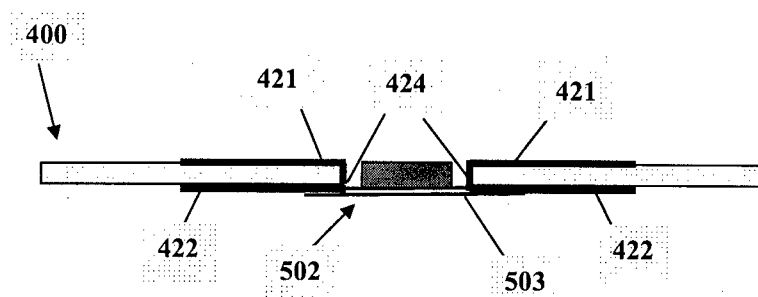


Fig. 5B

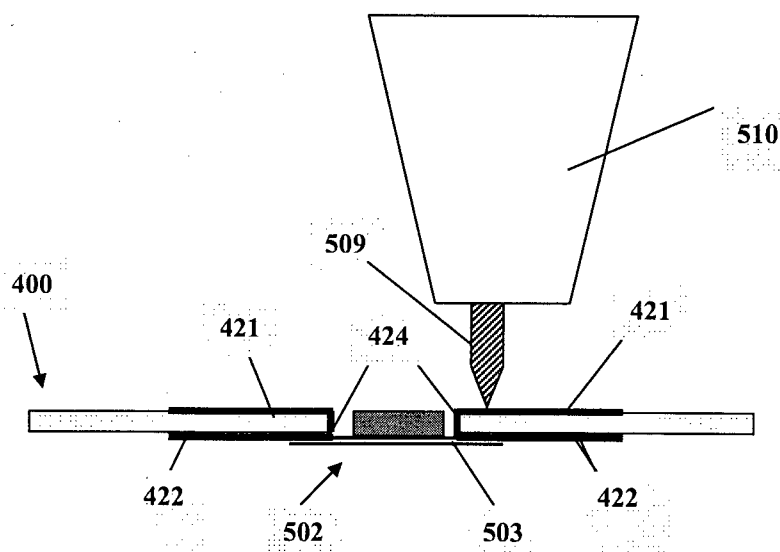


Fig. 5C