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(54) Title: IMPROVED LEAD FRAME SYSTEM

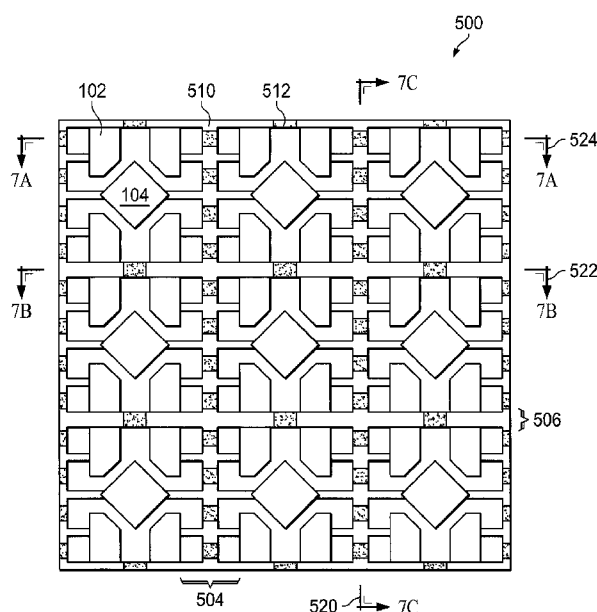


FIG. 6

(57) Abstract: A lead frame strip (500) with corrugated saw street metal (504, 506), where the corrugated saw street metal (510, 512) is comprised of a partial thickness of the lead frame strip metal. A lead frame strip (500) with corrugated saw street metal (504, 506), where the corrugated saw street metal (510, 512) is comprised of a half thickness of the lead frame strip metal.



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IMPROVED LEAD FRAME SYSTEM

FIELD

[0001] This disclosure relates to the field of integrated circuit packaging. More particularly, this disclosure relates lead frames.

BACKGROUND

[0002] Lead frame strips made primarily of copper or a copper alloy are typically provided for semiconductor devices in order to provide a stable support for firmly positioning an integrated circuit (IC) chip within a package, and to electrically connect the IC chip to various other components via a circuit board. Lead frames vary in size. The size of the lead frame is commonly dependent upon the size of the IC chip and the number of connections that are made to the IC chip. The number of connections may vary from a few to over a hundred.

[0003] As is illustrated in FIG. 1, the lead frame strip 100 may be comprised of multiple lead frames 101 connected together by saw streets 110.

[0004] As is illustrated in FIG. 2A the lead frames 201 are typically comprised of a plurality of wirebond pads 102 that are electrically isolated from each other and electrically isolated from a centrally located IC chip pad 104. The IC chip pad 104 provides a surface on which the IC chip 202 (FIG. 2B) may be mounted. The wirebond pads 102 are typically connected to the saw scribes 110 with tie bars 108. Wire bonds 206 (FIGS. 2B and 2C) are typically used to electrically connect individual bond pads on the IC chip 202 to individual wirebond pads 102. The illustrative example in FIG. 2A has four wirebonds 102 but the lead frame 201 may have any number of wirebond pads 102. Some lead frames 201 have over one hundred wirebond pads 102.

[0005] An alternative lead frame 301 is illustrated in FIG. 3A. This lead frame 301 is commonly referred to as a chip on lead (COL) lead frame. As shown in FIG. 3A, the COL has no IC chip pad 104. The COL has only wirebond pads 102. As is illustrated in the top down view of FIG. 3B and the cross section in FIG. 3C, the IC chip

302 is mounted on top of the edges of at least two of the wirebond pads 102. A support 304 that is not electrically conductive provides support for the IC chip 302 and also electrically isolates the IC chip 302 from the edges of the wirebond pads 102.

[0006] The saw streets 110 and tie bars 108 are typically comprised of thin metal strips between the lead frames 101. The saw streets 110 support the lead frames 101 during die attach (IC chip attachment to the lead frame), wire bonding (wire connecting IC bond pads to wirebond pads), and potting (encapsulation of the IC chip, wire bonds, and lead frames 101 with molding compound). Sawing along the saw streets 110 is then used to separate the individual packaged IC chips.

[0007] FIG. 4A, 4B, 4C, 4D, and 4E illustrate a lead frame for an IC chip 201 with four bondwire pads 102.

[0008] FIG. 4A is a top down view of the lead frame 400. The example lead frame 400 accommodates the attachment of four IC chips 400 to four centrally located IC chip pads 104. In this illustrative example, there is one wirebond pad 102 on each side of the IC chip pad 104. The wirebond pads 102 are separated from the IC chip pad 104 by slotted openings 106 in the lead frame. The IC chip pads 104 and the wirebond pads 102 are formed with a full thickness of lead frame metal. The saw lanes 110 and tie bars 108 which connect the IC chip pads 104 and the wirebond pads 102 to the saw streets 110 are typically formed with a partial thickness of lead frame metal (typically a half thickness.)

[0009] As shown in the cross section taken along cut line 424 in FIG. 4A, the full thickness IC chip pads 104 are attached on the bottom side to lead frame support tape 112. The half thickness tie bars 108 which connect the IC chip pads 104 to the saw scribe 110 are separated from the lead frame support tape 112 by voids 114.

[0010] As shown in the cross section taken along cut line 422 in FIG. 4A, the full thickness wirebond pads 102 are attached on the bottom side to lead frame support tape 112. The half thickness tie bars 108 which connect the wirebond pads 102 to the saw street 110 are separated from the lead frame support tape 112 by voids 114.

[0011] As shown in the cross section taken along cut line 420 in FIG. 4A, the full thickness wirebond pads 102 are attached on the bottom side to lead frame support tape 112. The half thickness saw streets 110 are separated from the lead frame tape 112 by voids 114.

[0012] As shown in the cross section taken along cut line 426 in FIG. 4A, the half thickness saw streets 110 are separated from the lead frame support tape 112 by voids 114.

[0013] The plan view of the lead frame in FIG 5A shows the lead frame material that is removed by sawing along the horizontal saw streets 504 and along the vertical saw streets 502 to separate the packaged die 520 as shown in FIGS. 5B, 5C, and 5D.

[0014] FIG. 5C is a cross section through one of the packaged die 520. The cross section is through the centrally located IC chip pad 104 and two of the wirebond pads 102. The IC chip (die) 202 is mounted on the centrally located IC chip pad 104. Wire bonds 206 electrically connect bond pads on the IC chip 202 to the wirebond pads 102.

[0015] After the IC chip 202 is mounted on the IC chip pad 104 and connected to the wirebond pads 102 with wire bonds 206, the lead frame 201, IC chip 202, wirebond pads 102, and wire bonds 206 are encapsulated in a molding compound 508 to provide mechanical stability and protection from the environment. The first lead frame support tape is then removed from the bottom of the lead frame 400 and a second lead frame support tape 512 is applied to the top surface of the molding compound 508.

[0016] The molding compound 508, the half thickness saw street 110 metal, and the half thickness tie bar 108 metal sawed from the scribe streets 502 and 504, to separate the packaged die 520 as shown in FIG. 5C.

[0017] FIG. 5D shows a cross section of two packaged die 520 taken along cut line 516 in FIG. 5B through two of the wirebond pads 102. The packaged die 520 are attached to the second lead frame tape 512.

[0018] FIG. 5E shows a cross section of two packaged die 520 taken along cut line 518 through the centrally located IC chip pad 104 and attached IC chip 202. The packaged die 520 are attached to the second lead frame tape 512.

[0019] FIG. 5F shows a cross section taken along cut line 522 in FIG. 5B through a saw street, 502 and 504 after sawing. As is shown all molding compound 508, half thickness saw scribe metal 110 and half thickness tie bar metal 108 are removed by sawing. Only the second lead frame support tape 512 remains in the saw scribe, 502 and 504, areas after sawing.

SUMMARY

[0020] The following presents a simplified summary in order to provide a basic understanding of one or more aspects of the invention. This summary is not an extensive overview of the invention, and is neither intended to identify key or critical elements of the invention, nor to delineate the scope thereof. Rather, the primary purpose of the summary is to present some concepts of the invention in a simplified form as a prelude to a more detailed description that is presented later.

[0021] A lead frame strip with corrugated saw street metal where the corrugated saw street metal is comprised of a partial thickness of the lead frame strip metal. A lead frame strip with corrugated saw street metal where the corrugated saw street metal is comprised of a half thickness of the lead frame strip metal.

DESCRIPTION OF THE VIEWS OF THE DRAWINGS

[0022] FIG. 1 (Prior art) is a plan view of a lead frame strip.

[0023] FIGS. 2A and 2B (Prior art) are a plan view of a lead frame and an IC chip pad with 4 package leads mounted on the lead frame.

[0024] FIG. 2C (prior art) is a cross section along the cut line in the plan view in FIG. 2B.

[0025] FIGS. 3A and 3B (Prior art) are a plan view of chip on lead IC package with 6 package leads.

[0026] FIG. 3C (prior art) is a cross section along the cut line in the plan view in FIG. 3B.

[0027] FIG. 4A (Prior art) is a plan view of a lead frame strip with 4 lead frames.

[0028] FIGS. 4B, 4C, 4D and 4E (Prior Art) are cross sections along cut lines in the plan view in FIG. 4A.

[0029] FIG. 5A (Prior art) is a plan view of a lead frame strip with 4 lead frames.

[0030] FIG. 5B (Prior art) is a plan view of two lead frames that are separated by sawing along the saw streets of FIG. 5A.

[0031] FIGS. 5C, 5D, 5E, and 5F (Prior Art) are cross sections along cut lines in the plan view in FIG. 5B.

[0032] FIG. 6 is a plan view of a lead frame strip with 9 lead frames and with embodiment corrugated saw streets.

[0033] FIGS. 7A, 7B, and 7C are cross sections along cut lines through embodiment saw streets in the plan view in FIG. 6.

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS

[0034] Embodiments of the disclosure are described with reference to the attached figures. The figures are not drawn to scale and they are provided merely to illustrate the disclosure. Several aspects of the embodiments are described below with reference to example applications for illustration. It should be understood that numerous specific details, relationships, and methods are set forth to provide an understanding of the disclosure. One skilled in the relevant art, however, will readily recognize that the disclosure can be practiced without one or more of the specific details or with other methods. In other instances, well-known structures or operations are not shown in detail to avoid obscuring the disclosure. The embodiments are not limited by the illustrated

ordering of acts or events, as some acts may occur in different orders and/or concurrently with other acts or events. Furthermore, not all illustrated acts or events are required to implement a methodology in accordance with the present disclosure.

[0035] An example improved lead frame strip 600 is illustrated in FIGS. 6 and 7. The portion of a lead frame strip 600 shown in FIG. 6A consists of 9 lead frames 606 (FIG. 6B) connected together by half thickness metal vertical saw streets 602 and half thickness metal horizontal saw streets 604

[0036] As shown in the cross section FIG. 7B taken along cut line 622 through a horizontal corrugated saw street 604 in FIG. 6A and FIG. 7C taken along cut line 620 through a vertical corrugated saw street 602, the half thickness metal in the corrugated saw streets, 602 and 604, have corrugations so that a portion of the half thickness metal in the corrugated scribe streets, 602 and 604, is attached to lead frame support tape 112. First portions 610 of the embodiment half thickness metal corrugated saw streets, 602 and 604, are separated from the first lead frame support tape 112 by voids 114 and second portions 612 of the embodiment half thickness metal corrugated saw streets, 602 and 604 are attached to the surface of the first lead frame support tape 112. Corrugation of the half thickness metal saw streets, 602 and 604, substantially improves the mechanical stability of the lead frame during wire bonding and during molding compound injection. The added strength of the lead frame improves yield by reducing the number of ball bonds that delaminate from the bond pads on the chip or that delaminate from the package leads due to stress caused when the lead frame flexes.

[0037] The corrugation of the half thickness metal in the saw streets, 602 and 604, adds significant strength and rigidity to the corrugated saw streets, 602 and 604, with little increase in the amount of metal used to manufacture the lead frame strip 600 and with little increase in the amount of metal that is sawed through when separating the packaged die. This keeps the cost of the lead frame manufacture and also avoids excessive wear and replacement of saw blades.

[0038] The embodiments are illustrated using lead frames with four wirebond pads. The idea is generic and may be used to improve lead frame strips with lead frames with any number of wire bond pads.

[0039] While various embodiments of the present disclosure have been described above, it should be understood that they have been presented by way of example only and not limitation. Numerous changes to the disclosed embodiments can be made in accordance with the disclosure herein without departing from the spirit or scope of the disclosure. Thus, the breadth and scope of the present disclosure should not be limited by any of the above described embodiments. Rather, the scope of the disclosure should be defined in accordance with the following claims and their equivalents.

CLAIMS

What is claimed is:

1. A lead frame strip with corrugated saw streets comprised of corrugated metal where a portion of the corrugated saw streets are attached to a lead frame strip support tape.
2. The lead frame strip of claim 1, further comprising a plurality of lead frames coupled to the corrugated saw streets by tie bars wherein a thickness of the lead frames are a full lead frame strip metal thickness and wherein a thickness of the corrugated metal and the tie bars are a partial lead frame strip metal thickness.
3. The lead frame strip of claim 1, further comprising a plurality of lead frames coupled to the saw streets by tie bars wherein a thickness of the lead frames are a full lead frame strip metal thickness and wherein a thickness of the corrugated metal and the tie bars are a half lead frame strip metal thickness.
4. The lead frame strip of claim 1, further comprising a plurality of lead frames coupled together with the corrugated saw streets.
5. The lead frame strip of claim 4, wherein the lead frames contain one IC chip pad and contain a plurality of wirebond pads.
6. The lead frame strip of claim 4, wherein the lead frames contain a plurality of wirebond pads and do not contain an IC chip pad.
7. The lead frame strip of claim 5, wherein the IC chip pad and the plurality of wirebond pads are formed of full lead frame strip metal thickness and are attached to the lead frame strip support tape.
8. The lead frame strip of claim 1, wherein the lead frame strip is composed of copper or a copper alloy.

9. A lead frame strip, comprising:
lead frame strip support tape;
a plurality of corrugated saw streets comprised of corrugated metal with a partial thickness of the lead frame strip metal and where a first portion of the corrugated saw street is separated from the lead frame strip support tape by a void and where a second portion of the corrugated saw street is attached to the lead frame strip support tape.
a plurality of lead frames coupled on all sides to corrugated saw streets; and
a plurality of wirebond pads within each lead frame comprised of a full thickness of lead frame strip metal and attached to the lead frame strip support tape and coupled to the corrugated saw streets.
10. The lead frame strip of claim 9, wherein the partial thickness of the Corrugated saw streets is 30% to 60% the thickness of the lead frame strip metal thickness.
11. The lead frame strip of claim 9, wherein the partial thickness of the Corrugated saw streets is about half the thickness of the lead frame strip metal thickness.
12. The lead frame strip of claim 9, further comprising an IC chip pad comprised of a full lead frame strip metal thickness and coupled to the corrugated saw streets and electrically isolated from the wirebond pads.
13. The lead frame strip of claim 12, wherein the IC chip pad is coupled to the corrugated saw streets with tie bars where the tie bars are comprised of a partial thickness of lead frame strip metal.
14. The lead frame strip of claim 9, further comprising tie bars with a partial thickness of the lead frame strip metal and wherein the tie bars couple the wirebond pads to the corrugated saw streets.

15. The lead frame strip of claim 9, wherein the lead frame strip is comprised of copper or a copper alloy.

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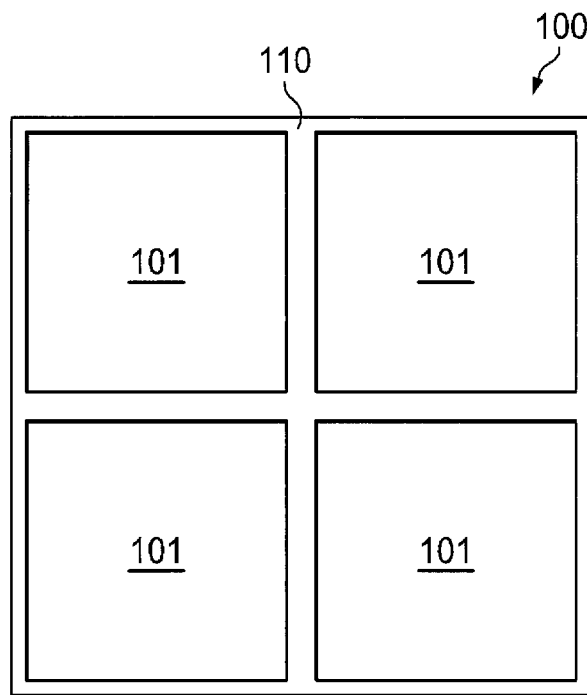


FIG. 1
(PRIOR ART)

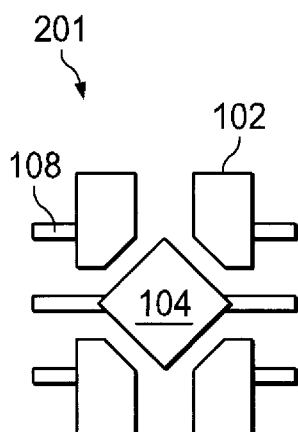


FIG. 2A
(PRIOR ART)

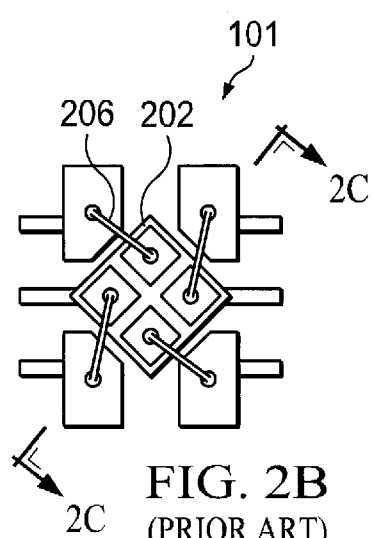


FIG. 2B
(PRIOR ART)

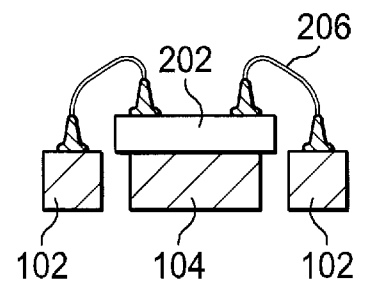


FIG. 2C
(PRIOR ART)

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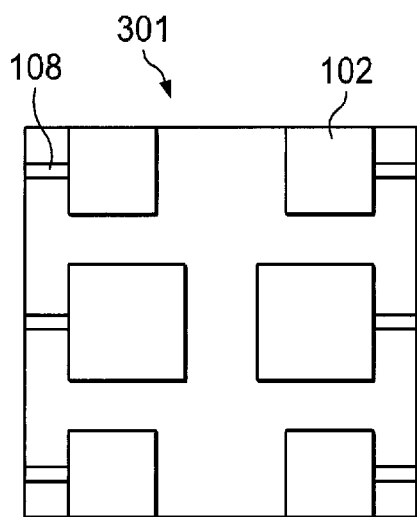


FIG. 3A
(PRIOR ART)

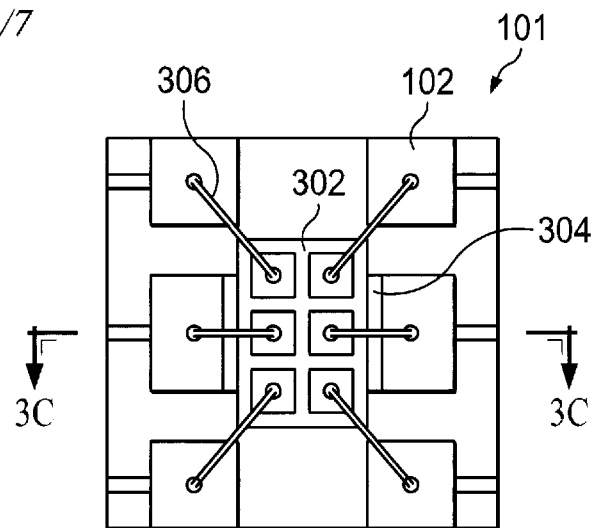


FIG. 3B
(PRIOR ART)

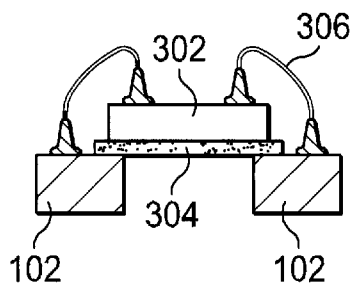


FIG. 3C
(PRIOR ART)

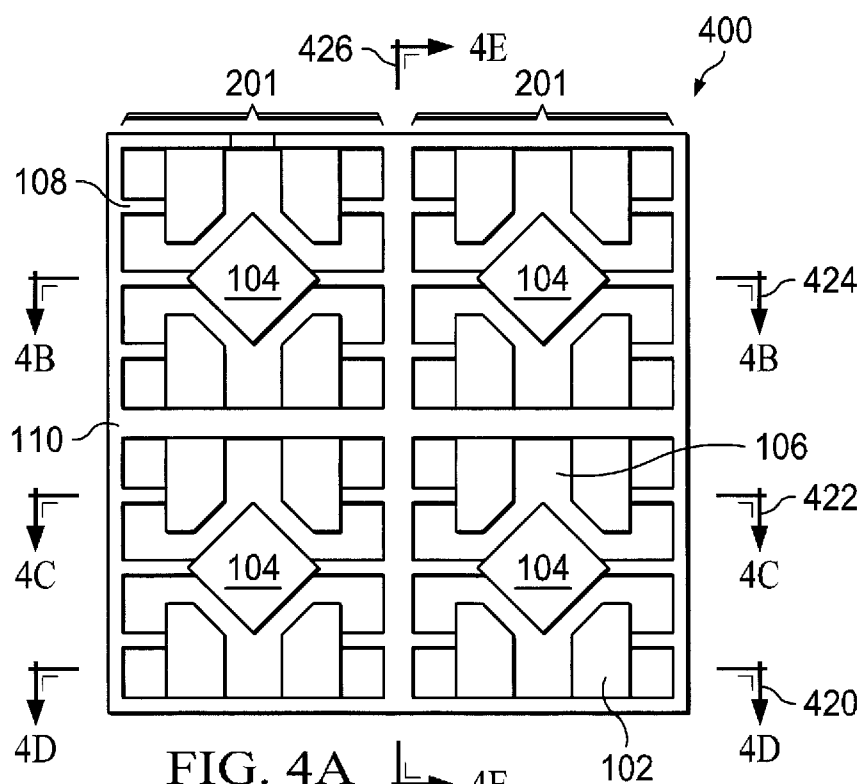


FIG. 4A
(PRIOR ART)

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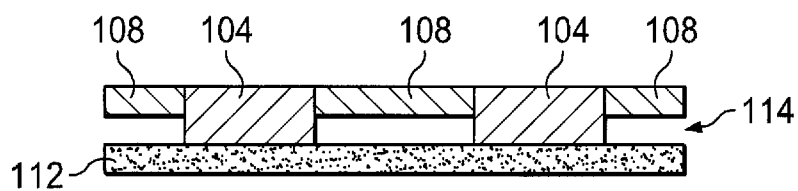


FIG. 4B
(PRIOR ART)

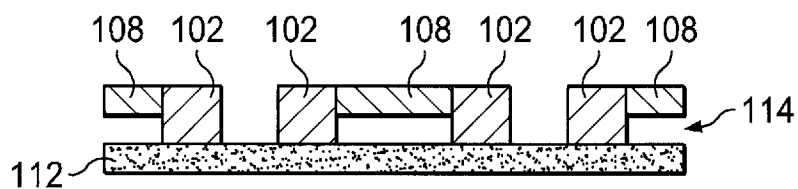


FIG. 4C
(PRIOR ART)

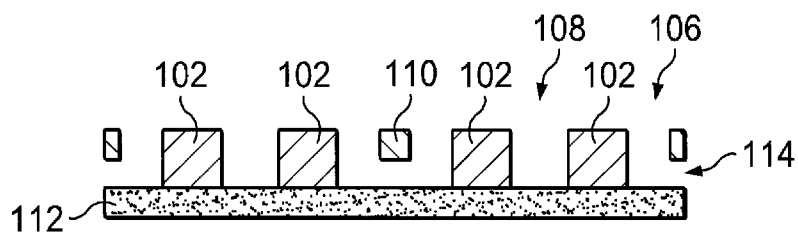


FIG. 4D
(PRIOR ART)

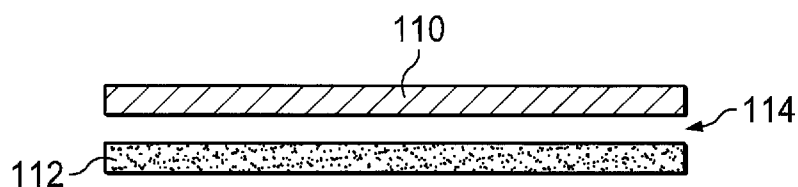


FIG. 4E
(PRIOR ART)

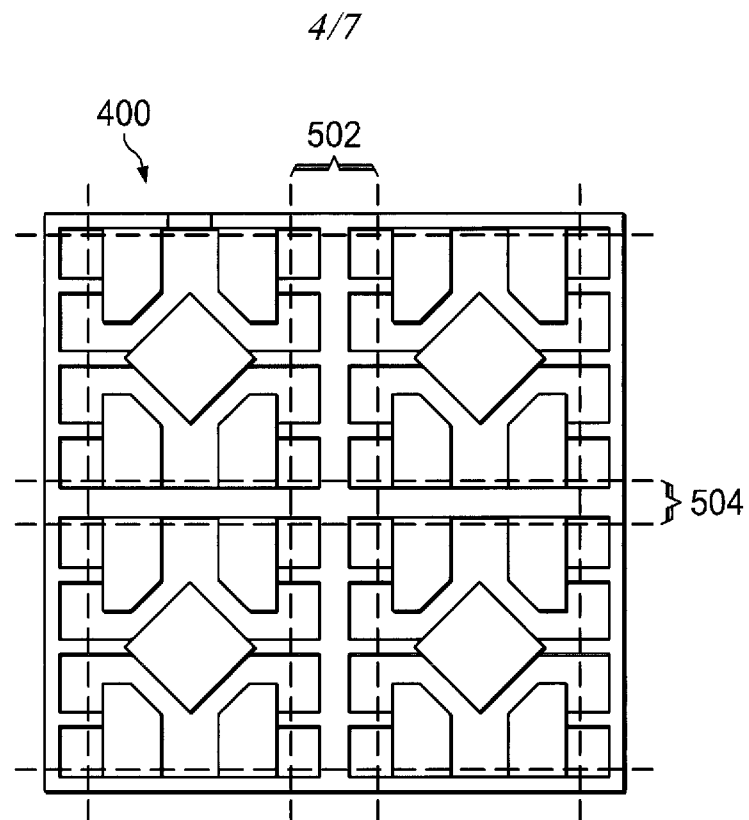


FIG. 5A
(PRIOR ART)

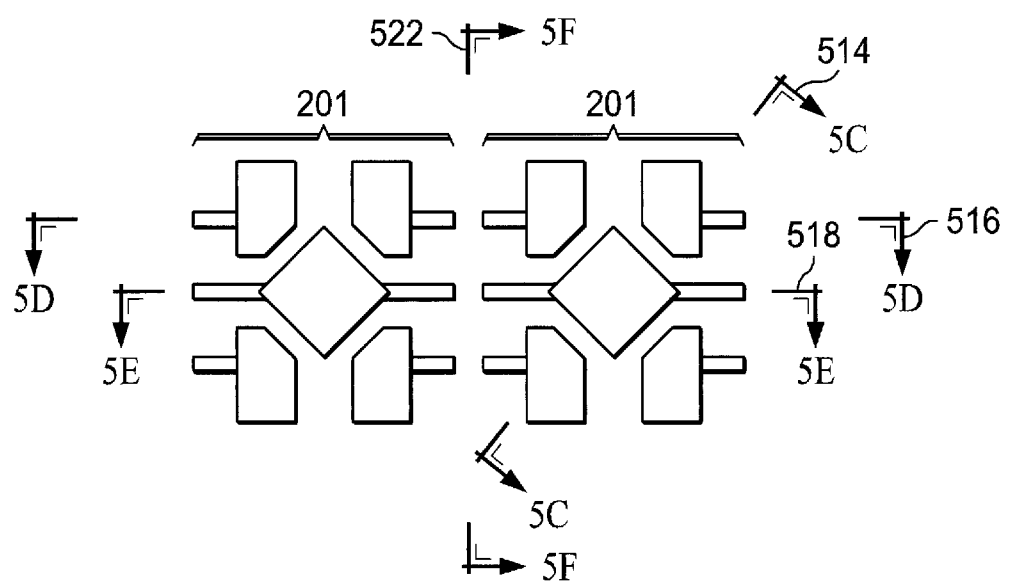


FIG. 5B
(PRIOR ART)

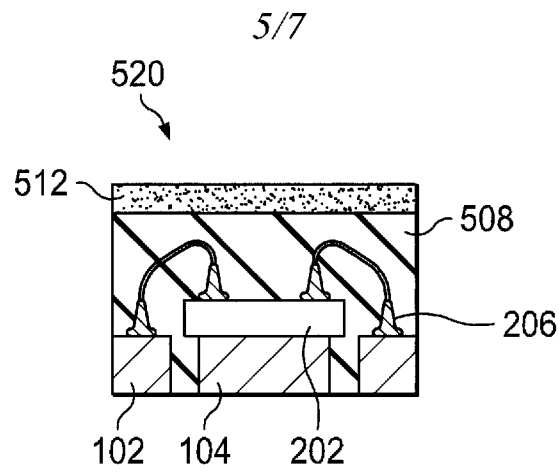


FIG. 5C
(PRIOR ART)

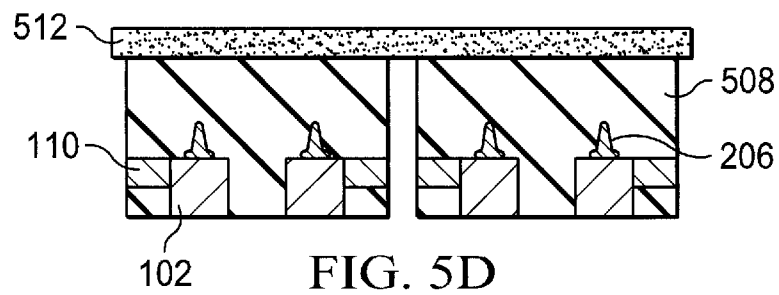


FIG. 5D
(PRIOR ART)

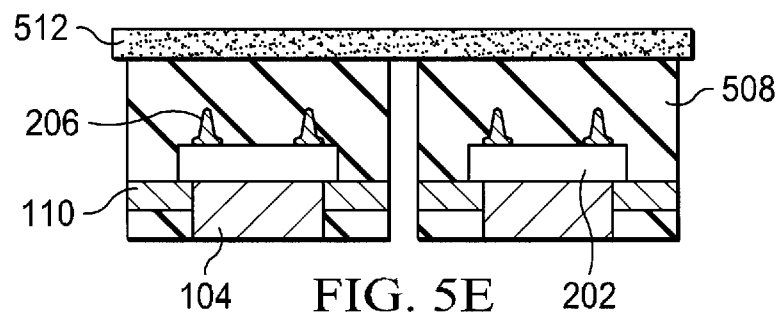


FIG. 5E
(PRIOR ART)



FIG. 5F
(PRIOR ART)

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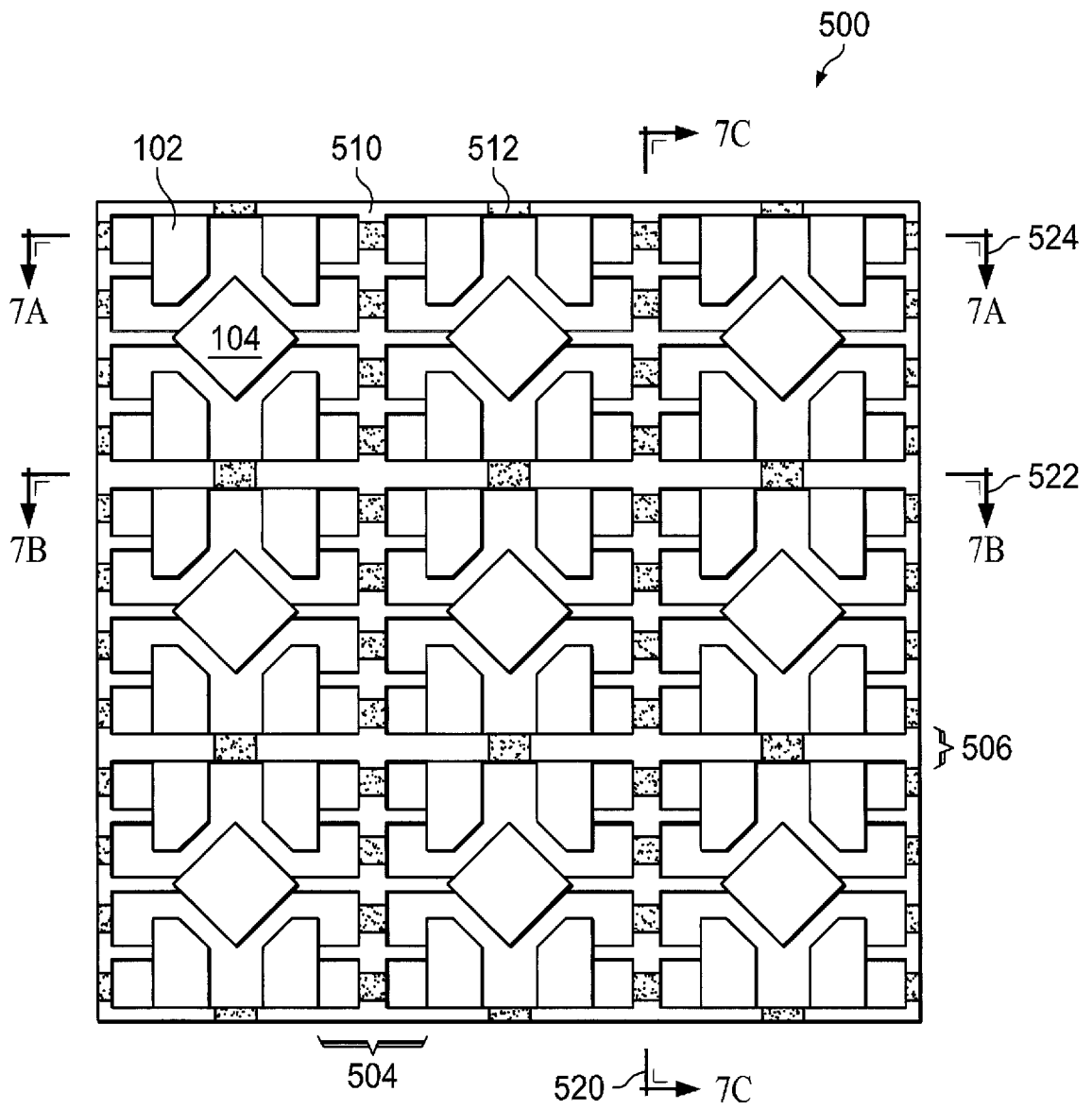


FIG. 6

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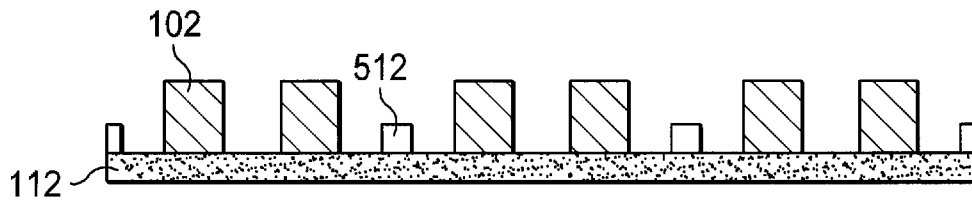


FIG. 7A

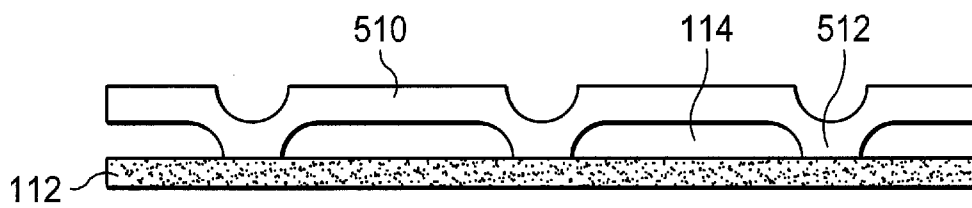


FIG. 7B

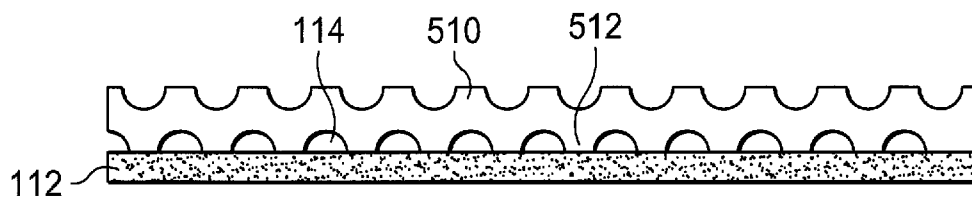


FIG. 7C

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2016/079981**A. CLASSIFICATION OF SUBJECT MATTER**

H01L 23/495(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT, WPI, EPODOC, CNKI: lead frame strip, partial thickness, saw street, cutting street, corrugated, crimped, recess, metal, support tape, tie bar, IC chip, copper, void, wirebond

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6608366 B1 (FOGELSON, HARRY J. ET AL.) 19 August 2003 (2003-08-19) Col. 1, lines 26-31; Col. 3, lines 25-29; Col. 5, lines 40-42, 51-59; Col. 6, lines 4-6, 15-19, 31-35; Col. 10, lines 55-57; Figs. 1-6, 16	1-15
A	US 6885086 B1 (AMKOR TECHNOLOGY, INC.) 26 April 2005 (2005-04-26) the whole document	1-15
A	US 2012252142 A1 (TEXAS INSTRUMENTS INCORPORATED) 04 October 2012 (2012-10-04) the whole document	1-15
A	CN 102237280 A (FREESCALE SEMICONDUCTOR, INC.) 09 November 2011 (2011-11-09) the whole document	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

- “A” document defining the general state of the art which is not considered to be of particular relevance
- “E” earlier application or patent but published on or after the international filing date
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- “P” document published prior to the international filing date but later than the priority date claimed

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- “X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- “Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- “&” document member of the same patent family

Date of the actual completion of the international search

10 January 2017

Date of mailing of the international search report

24 January 2017

Name and mailing address of the ISA/CN

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2016/079981

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