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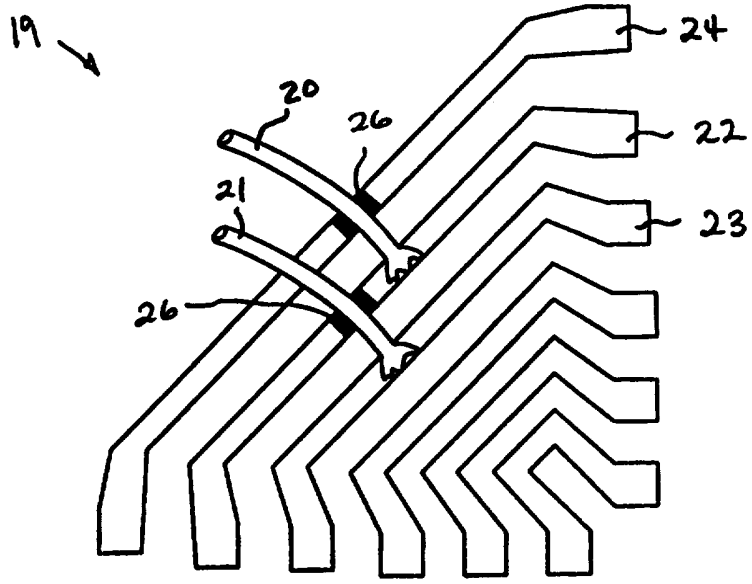
(54) Title: LEAD FRAME FOR HANDLING CROSSING BONDING WIRES

(57) Abstract

A method is disclosed for packaging for an integrated circuit (19) having lead frames with closely spaced leads (22, 23, 24) that are configured in such a way that the bonding wires (20, 21) must cross over other leads prior to bonding to the appropriate lead. The method includes the formation of a modified lead frame such that the likelihood of electrical contact between the bonding wires (20, 21) and leads crossed (22, 24) over by bonding wires is reduced. In one embodiment, insulating film (26) is placed on an adjacent lead (22, 24), or additionally on a number of crossed over leads, directly under the path of the bonding wire (20, 21) such that the potential for electrical contact is reduced. In a second embodiment, a depression (32) is formed on an adjacent lead (30), or additionally on a number of crossed over leads, causing additional clearance to be created between the bonding wire (28) and the lead (30) such that the likelihood of contact is reduced. In a third embodiment, a stepped depression (34) is formed on the bonded lead (36) such that the depression (34) facilitates the bonding of the wire (38) at an increased incline resulting in additional space between bonding wire (38) and the crossed leads (37) thereby reducing the likelihood of contact.



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LEAD FRAME FOR HANDLING CROSSING BONDING WIRES

BY INVENTOR

Chainarong Asanasavest

BACKGROUND OF THE INVENTION

This invention relates generally to lead frames for use in integrated circuits packages. More particularly it relates to a modified lead frame for reducing the likelihood of electrical contact between the bonding wires and leads crossed over by the bonding wire.

As technology advances, the dimensions of integrated circuit packages continues to decrease therefore requiring corresponding decreases in integrated circuit dies. The decrease in the physical size of integrated circuit dies necessitates a similar reduction in the size of lead frames. This coincides with the leads of the lead frame approaching smaller and smaller dimensions (fine lead pitch) which increases the likelihood of electrical contact between bonding wires and other leads of the lead frame. This is especially a problem with lead frames having leads that are arranged in such a fashion that the path of the bonding wire, from the die to the appropriate lead to which it is bonded, crosses over other leads. In a conventional lead frame, as shown Fig. 1, the leads 4 form a radial pattern away from a die 6. The die 6 is wire bonded to leads 4 by bonding wires 8 such that they do not cross any other leads prior to bonding, therefore the aforementioned problem is not an issue. In lead frames where the leads are very small or are closely spaced, then there is an increased likelihood that the bonding wires may contact leads during the wire bonding process. A major factor influencing whether undesired contact will occur is the tolerance and precision of the wire bonding equipment during wire bonding.

There are also situations where undesired contact of bonding wires may result from random factors. By way of example, bonding wire sweep during the injection molding process

causes the viscous encapsulating material to move the delicate bonding wires which may, in turn, cause contact with the leads. There have been a number of methods employed to deal with bonding wire sweep. One successful technique is by using a glob-topping material to form a hardened barrier over the bonding wires prior to injection molding. Another has been to inject the material in such a way that the impact on the bonding wires is minimized, namely, injecting in direction as parallel to the bonding wires as possible. A disadvantage with glob-topping is that it adds additional steps and cost to the manufacturing process. Both methods are preventative type measures taken after a successful bonding process and neither will prevent contact caused by the wire bonding process itself. It is therefore an objective of the present invention to provide a method and apparatus that reduces the likelihood of bonding wire contact with crossed leads that is both simple and cost effective.

SUMMARY OF THE INVENTION

To achieve the foregoing and other objects and in accordance with the purpose of the present invention, a method is disclosed for packaging an integrated circuit using a lead frame having closely spaced leads that are patterned in such a way that one or more bonding wires must cross over another lead in order to be bonded to its associated lead. The method includes the formation of a modified lead frame such that the likelihood of electrical contact between the bonding wires and leads crossed over by bonding wires is reduced.

In a first embodiment of the invention, an insulating film is formed on an adjacent lead such that it is directly under the path where the bonding wire crosses the adjacent lead so that even if the bonding wire inadvertently contacts the crossed lead, an electrical connection will not be made between the crossed lead and the bonding wire. In one preferred embodiment in which the lead frame is formed by etching using a mask, the insulating film may take the form of a portion of the mask left in place for etching the lead frame. The insulating film may also be positioned on additional crossed leads for an added margin of safety.

In a second embodiment of the present invention, the insulating film is replaced by a depression formed on the adjacent lead such that additional clearance is created between the bonding wire and the adjacent lead thus reducing the likelihood of electrical contact. The depression can be formed by either coining (stamping) or by etching. To increase the margin of safety, additional depressions may further be formed into other crossed leads as well.

In a third embodiment, the method a stepped depression is formed on a lead at the point where the bonding wire bonds to the lead. The walls of the depression cause the inclination of the bonding wire to be at an increased incline such that additional clearance is created between the bonding wire and the adjacent leads to reduce the likelihood of electrical contact. Again, the depression on the bonded lead may be formed by coining (stamping) or etching. Further, depressions on the adjacent and crossed leads may be formed, either by coining or etching, to further increase the margin of safety from contact.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention, together with further objects and advantages thereof, may best be understood by reference to the following description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a diagrammatic top view of a conventional lead frame wire bonded to a die.

Fig. 2a is a diagrammatic top view of a lead frame with diagonal leads.

Fig. 2b is a diagrammatic top view of die wire bonded on both sides of the lead frame in Fig. 2a.

Fig. 2c is a partial perspective view of bonding wires ball bonded to a die and stitch bonded to leads where the bonding wire crosses over an adjacent leads.

Fig. 3 is a diagrammatic top sectional view of a first embodiment of the present invention having an insulating film positioned on a crossed lead below the region that a bonding wire crosses the crossed lead.

Fig. 4 is a partial perspective view of a second embodiment of the present invention illustrating a depression formed on an adjacent crossed lead.

Fig. 5 is a partial perspective view of a third embodiment illustrating a stepped depression formed at the point of bonding.

Fig. 6 is a partial perspective view of a modification of the embodiment of Fig. 5 which further includes a depression on an adjacent crossed lead.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

One lead frame configuration that may encounter the types of problems described in the background section of this application is illustrated in Figure 2. Such a lead frame is disclosed in Matthew et al. co-pending application Serial No. 08/329997 entitled "A Leadframe for an Integrated Circuit Package which Electrically Interconnects Multiple Integrated Circuit Die" and filed 10/27/94. The referenced application is incorporated by reference herein in its entirety. As will be apparent to those skilled in the art after reading the present application, the invention is applicable to a wide variety of other lead frame designs as well.

In the embodiment illustrated in Fig. 2a, leads 13 of lead frame 12 are configured in a diagonal and substantially parallel pattern. The leads are closely spaced (fine pitch) and run through the die attach area 14. The die attach area, used in this context, refers to a support area on a lead frame. In other embodiments, it may refer to a conventional die attach pad, a cleared or void area on a substrate, or as in this case, a support area on a lead frame. The lead frame illustrated in Fig. 2 may allow for two sided bonding and is particularly useful in instances where common leads may be bonded to multiple integrated circuits (IC) dies. By way of example, IC dies for memory circuits may be connected to common leads used for address lines. EPROMs, DRAMs and SRAMs are some examples of memory circuits which are ideal applications for such lead frames. Also, any application where multiple dies may use common leads are good candidates for these types of lead frames. Fig. 2b shows an example of a pair of die 19 bonded on opposite sides of lead frame 12 of Fig. 2a. Each die 19 has a plurality of bond pads 16 to which the bonding wires 15 are bonded to electrically couple the die to common leads of the lead frame 12.

Fig. 2c illustrates a common bonding technique that may be used in conjunction with the present invention. A first end of bonding wire 15 is bonded to an associated die bond pad 16, with a ball bond where the wire bonding is typically performed by a wire bonder. The second end of bonding wire 15 is bonded to an associated lead, as for example, using a stitch bond.

A typical wire bonder bonds bonding wires by ultrasonic welding using a transducer and capillary arrangement (not shown). The ball bond bonded to the die bond pad 16 is initially performed by placing the transducer arrangement over a die bond pad 16 where bonding wire 15 is ultrasonically attached in a substantially vertical manner. The bonding wire 15 is then continuously fed through the capillary until the arrangement is positioned over an appropriate lead. The bonding wire 15 is then cut off and laid down on lead 17 in a substantially horizontal position, relative to the leads, and ultrasonically bonded by transducer. This type of substantially horizontal bond is referred to as a stitch bond. Since the stitch bond attaches substantially horizontally to lead 17, the bonding wire 15, in its approach to lead 17, crosses very closely over an adjacent lead 18 and stands a good chance of contact if the bonding wire 15 moves slightly such during injection molding. Hence, the following discussion is directed toward several effective techniques for reducing the likelihood of such contact.

Referring next to Fig. 3 a first embodiment of a lead frame in accordance with the present invention will be described. Fig. 3 illustrates a corner portion of a lead frame 12 of the general type shown in Figs. 2a and 2b. A first bonding wire 20 is bonded at one end to an associated bonding pad 16 on a die 19 located in the die attach area 14 (of Fig. 2a) near the center of the lead frame as seen in Fig 2b. The other end of bonding wire 20 is bonded to lead 22. As seen best in Fig. 3, the bonding wires must cross over an adjacent lead 24. An electrically insulating film 26 is positioned on leads 22 and 24 so that it lies directly under the path of bonding wires 20 and 21 to prevent electrical shorting if the bonding wires should come into contact with the insulating film 26. To prevent electrical contact, the length of the insulating film should be at least the diameter of the bonding wire, but more preferably, it should be several times longer than the bonding wire diameter (typically around 1.3 mils) in order to protect an adequate size area. A length of about six times the diameter of the bonding wire (about 8 mils) has been found to provide sufficient protection.

The method used to manufacture the lead frames may be exploited to lay down the insulating film during the lead frame manufacturing process. Lead frames are typically formed

either by stamping or etching a sheet of electrically conductive material such as copper or a copper alloy, both techniques are well known to those skilled in the art. When etching is used, an etching mask is typically laid down on the copper sheet with the desired lead pattern. Rather than removing the entire mask, portions of the mask may be left on leads for use as insulating film. As those skilled in the art can appreciate, when the lead frame is etched, using portions of the mask as the insulating film is both economical and efficient. In the case where the lead frame is formed by stamping, a subsequent step of laying down the insulating film must be performed prior to wire bonding.

A second embodiment in accordance with the present invention is illustrated in Fig. 4. This technique involves "coining" the crossed lead in the region where a bonding wire crosses the lead to create a depression that provides additional space between the bonding wire and the crossed lead(s) thereby reducing the likelihood of contact. As illustrated in Fig. 4, a first end of a bonding wire 28 is connected to a die (not shown). The second end of the bonding wire is bonded to a lead 31 and is positioned such that it crosses over an adjacent lead 30 before being bonded to the lead 31. Since the adjacent lead 30 is the most likely lead to come into contact with bonding wire 28, a depression 32 is "coined" into lead 30 directly beneath the path of bonding wire 28 where contact is most likely. This increases the space between bonding wire 28 and lead 30 therefore reducing the likelihood of contact. As used herein, the term "coined" and "coining" are intended to refer to the creation of depressions in a lead, regardless of whether the depression is formed by stamping, etching, molding or other suitable techniques.

The depression 32 is preferably made during formation of the lead frame and therefore takes place prior to wire bonding. When the lead frame is formed by etching, then etching the depression during the lead frame's formation is most efficient so that the depression may be formed together with the lead frame. When the lead frame is stamped, the depressions may be formed by coining at the same time the lead frame is stamped. The length of the depression must be sufficiently long for the bonding wire to fit in between the depression without contacting the sidewalls, i.e., the depression must be somewhat longer than the diameter of the

bonding wire. The depth of the depression may be anywhere in the range of about one half to three forths of the lead's thickness since further increases in depth may affect the structural integrity of the lead. In accordance with the preferred embodiment, a depression length of at least five times the diameter of the bonding wire of 1.3 mils and a depth of about half the depth of the lead has been found to work well. A higher margin of safety may be achieved by forming depressions on additional crossed leads in the bonding wire path as well.

Referring next to Fig. 5, a third embodiment in accordance with the present invention will be described. In this embodiment, a stepped depression is formed at the point at which bonding to the lead occurs. The depression is positioned such that the bonding wire will be forced to pass over an unstepped portion of the lead, which serves to force the bonding wire to be "lifted" away from the lead frame surface. This serves to reduce the likelihood of contact between the bonding wire and an adjacent lead. As seen in Fig. 5, a stepped depression 34 is formed on lead 36 such that when the bonding wire 38 is bonded to depression 34, the back wall 39 of the depression 34 supports the bonding wire 38 at an increased incline thereby creating additional space between bonding wire 38 and adjacent lead 37. The length of depression 34 must be sufficiently long to allow for bonding. Since the end of the bonding wire tends to spread out when pounded during ultrasonic bonding, shown as a flattened end 40, the length must be long enough to accommodate. The depth of the depression may vary a great deal in accordance with the needs of a particular system. By way of example, depths in the range of about 2 to 3 mils, have been found to work well for 6 mil lead frames. In one embodiment, a 3 mil depression (i.e. about a half the lead frame thickness) works well. It should be appreciated that the width of the depression must allow for a sufficiently sturdy back wall to support the bonding wire in its inclined position. In one preferred embodiment, a length of about five times the diameter of the bonding wire, a depth of about half of the depth of the lead, and a width of about half of the width of the lead has been found to work well.

Formation of the depression may be accomplished using any suitable method, including, stamping, etching or molding. Again, it is generally preferred that the method used

to form the depression is the same as the method used in forming the lead frame so that they may both be formed during the same step, although this is not a requirement.

Although three embodiments of the present invention have been described in detail, it should be understood that the present invention may be embodied in other specific forms without departing from the spirit or scope of the invention. For example, the various described embodiments may be used together in any combination to further reduce the likelihood of electrical contact between the bonding wire(s) and the crossed lead(s). For example, as illustrated in Fig. 6, a depression 42 in accordance with the second described embodiment may be formed an adjacent crossed lead 43, while a stepped depression 34 is formed in the bonded lead 44 in accordance with the third described embodiment. Additional depressions may also be formed on other crossed leads if so desired and/or insulating surfaces may be provided.

While this invention has been described primarily in terms of a lead frame having diagonally patterned leads, it should be understood that the diagonally pattered leads are for illustrative purposes only and that the invention may be applied to any type of lead frames where leads are crossed by bonding wires such as in lead frames for multi-chip applications, for example. Therefore the present examples are to be considered as illustrative and not restrictive, and the invention is not to be limited to the details given herein, but may be modified within the scope of the appended claims.

What is claimed is:

CLAIMS

A1. A method for packaging an integrated circuit die having a plurality of bond pads, comprising the steps of:

forming a lead frame having a plurality of leads, said lead frame defining a die attach area;

affixing a die in the die attach area;

wire bonding a first end of a bonding wire to an associated one of the bond pads, wire bonding a second end of the bonding wire to an associated first lead of the lead frame, the wire bonding steps being arranged such that the bonding wire passes over a second lead of the lead frame that is positioned adjacent to the first lead;

applying an insulating film to the second lead at a position directly under the path of the bonding wire to prevent electrical contact between the bonding wire and the second lead, wherein the insulating film applying step is performed prior to the wire bonding step; and

encapsulating the die, bonding wires, and inner portion of the lead frame to form a protective package.

A2. A method as recited in claim A1 wherein the lead frame is formed by stamping.

A3. A method as recited in claim A1 wherein the lead frame is formed by etching.

A4. A method as recited in claim A3 wherein the insulating film is a portion of an etching mask left on from the etching step.

A5. A method as recited in claim A3 wherein the insulating film is further applied on a plurality of crossed leads.

A6. A method as recited in claim A1 wherein the die attach area includes a die attach pad, a void area on a substrate, and a support area on a lead frame.

A7. A method as recited in claim A1 wherein the plurality of leads are arranged to form diagonal conductive strips through the die attach area.

B1. A method for packaging an integrated circuit die having a plurality of bond pads, comprising the steps of:

forming a lead frame having a plurality of leads, said lead frame defining a die attach area;

affixing a die in the die attach area;

wire bonding a first end of a bonding wire to an associated one of the bond pads, wire bonding a second end of the bonding wire to an associated first lead of the lead frame, the wire bonding steps being arranged such that the bonding wire passes over a second lead of the lead frame that is positioned adjacent to the first lead;

forming a depression on the second lead directly under the path of the bonding wire such that additional clearance is created between the bonding wire and the second lead thereby reducing the likelihood of electrical contact, wherein the depression forming step is performed prior to the wire bonding step; and

encapsulating the die, bonding wires, and inner portion of the lead frame to form a protective package.

B2. A method as recited in claim B1 wherein the lead frame is formed by stamping.

B3. A method as recited in claim B2 wherein the depression on the second lead is formed by coining during the lead frame stamping step.

B4. A method as recited in claim B1 wherein the lead frame is formed by etching.

B5. A method as recited in claim B4 wherein the depression on the second lead is formed by etching during the lead frame etching step.

B6. A method as recited in claim B1 wherein the plurality of leads are arranged to form diagonal conductive strips through the die attach area.

B7. A method as recited in claim B1 wherein the encapsulating material is an injection molded plastic.

C1. A method for packaging an integrated circuit die having a plurality of bond pads, comprising the steps of:

forming a lead frame having a plurality of leads, said lead frame defining a die attach area;

affixing a die in the die attach area;

wire bonding a first end of a bonding wire to an associated one of the bond pads, wire bonding a second end of the bonding wire to an associated first lead of the lead frame, the wire bonding steps being arranged such that the bonding wire passes over a second lead of the lead frame that is positioned adjacent to the first lead, the bond between the second end of the bonding wire and the associated lead on the lead frame defining a lead bonding area;

coining a depression on the lead bonding area such that the bonding wire attaches to the lead at an increased incline such that additional clearance is created between the bonding wire and the second lead thereby reducing the likelihood of electrical contact, wherein the depression forming step is performed prior to the wire bonding step; and

encapsulating the die, bonding wires, and inner portion of the lead frame to form a protective package.

C2. A method as recited in claim C1 wherein the lead frame is formed by stamping.

C3. A method as recited in claim C1 wherein the lead frame is formed by etching.

C4. A method as recited in claim C3 wherein the depression on the lead bonding area is formed by etching during the lead frame etching step.

C5. A method as recited in claim C1 wherein a further depression on the second lead is formed.

C6. A method as recited in claim C5 wherein further depressions on a plurality of crossed leads are formed.

D1. An integrated circuit package having a plurality of bond pads, comprising:

a lead frame having a plurality of leads, said lead frame defining a die attach area;

a die affixed in the die attach area;

bonding wires having two ends to electrically couple the die to the leads, the first end of the bonding wire being bonded to one of the bond pads on the die, the second end being

bonded to an associated first lead on the lead frame, the bonding wire being arranged such that the bonding wire passes over a second lead of the lead frame that is positioned adjacent to the first lead;

an insulating film applied to the second lead at a position directly under the path of the bonding wire such that the likelihood of electrical contact between the bonding wire and the second lead is reduced; and

an encapsulating material formed around the die, bonding wires, and inner portion of the lead frame to provide a protective package.

D2. A method as recited in claim D1 wherein the die attach area includes a die attach pad, a void area on a substrate, and a support area on a lead frame.

D3. An integrated circuit package as recited in claim D1 wherein the plurality of leads form diagonal conductive strips through the die attach area.

D4. A method as recited in claim D1 wherein the insulating film is a portion of the etching mask applied during the etching step.

D5. A method as recited in claim D4 wherein the insulating film is further applied to a plurality of crossed leads.

D6. A method as recited in claim D1 wherein the plurality of leads are arranged to form diagonal conductive strips through the die attach area.

D7. An integrated circuit package as recited in claim D1 wherein the encapsulating material is an injection molded plastic.

E1. An integrated circuit package having a plurality of bond pads, comprising:

a lead frame having a plurality of leads, said lead frame defining a die attach area;

a die affixed in the die attach area;

bonding wires having two ends to electrically couple the die to the leads, the first end of the bonding wire being bonded to one of the bond pads on the die, the second end being bonded to an associated first lead on the lead frame, the bonding wire being arranged such that the bonding wire passes over a second lead of the lead frame that is positioned adjacent to the first lead;

a depression formed on the second lead directly under the path of the bonding wire such that additional clearance is created between the bonding wire and the second lead thereby reducing the likelihood of electrical contact; and

an encapsulating material formed around the die, bonding wires, and inner portion of the lead frame to provide a protective package.

E2. An integrated circuit package as recited in claim E1 wherein the plurality of leads form diagonal conductive strips through the die attach area.

E3. An integrated circuit package as recited in claim E1 wherein the encapsulating material is an injection molded plastic.

E4. An integrated circuit package as recited in claim E1 wherein further depressions are formed on a plurality of crossed leads.

F1. An integrated circuit package having a plurality of bond pads, comprising:

a lead frame having a plurality of leads, said lead frame defining a die attach area;

a die affixed in the die attach area;

bonding wires having two ends to electrically couple the die to the leads, the first end of the bonding wire being bonded to one of the bond pads on the die, the second end being bonded to an associated first lead on the lead frame, the bonding wire being arranged such that the bonding wire passes over a second lead of the lead frame that is positioned adjacent to the first lead, the bond between the second end of the bonding wire and the associated lead on the lead frame defining a lead bonding area;

a depression formed on the lead bonding area thereby causing the bonding wire to be attached to the lead at an increased incline such that additional clearance is created between the bonding wire and the second lead thereby reducing the likelihood of electrical contact; and

an encapsulating material formed around the die, bonding wires, and inner portion of the lead frame to provide a protective package.

F2. An integrated circuit package as recited in claim F1 wherein a depression is formed on the second lead.

F3. An integrated circuit package as recited in claim F2 wherein further depressions are formed on a plurality of crossed leads.

F4. An integrated circuit package as recited in claim F1 wherein the encapsulating material is an injection molded plastic.

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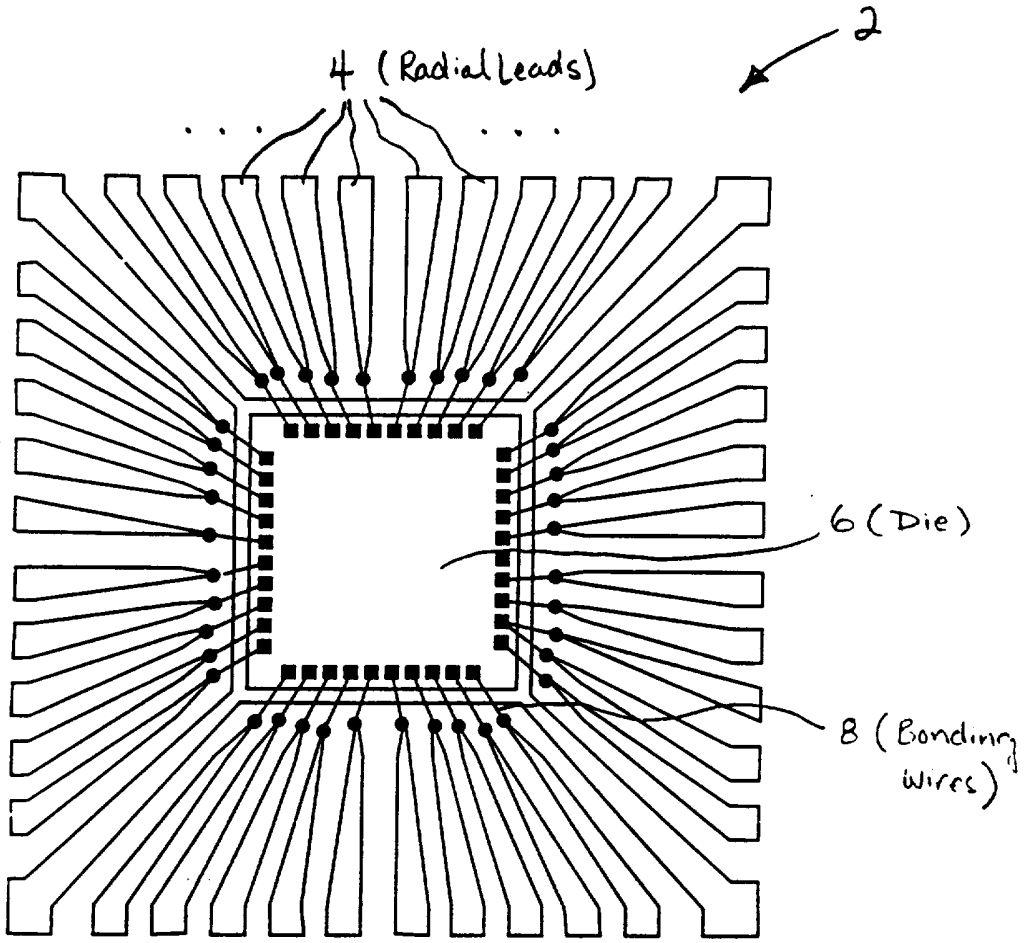

FIG. 1
(Prior Art)

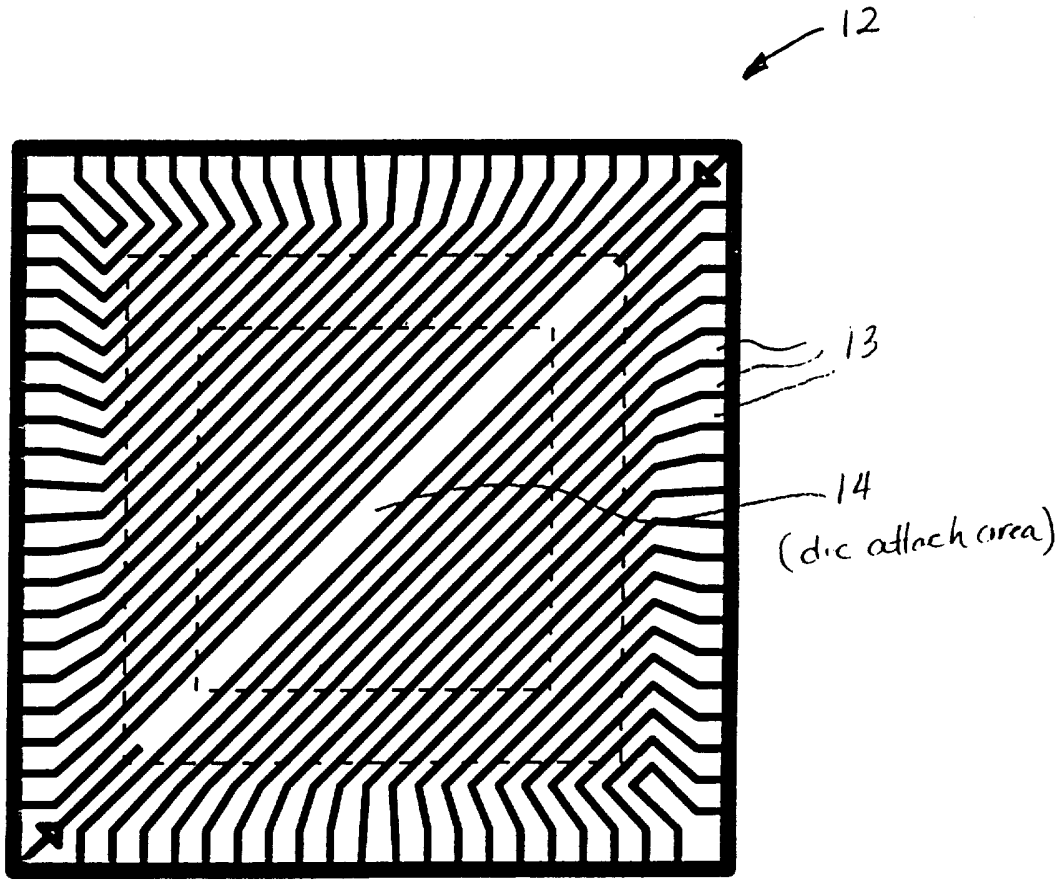

Fig. 2a

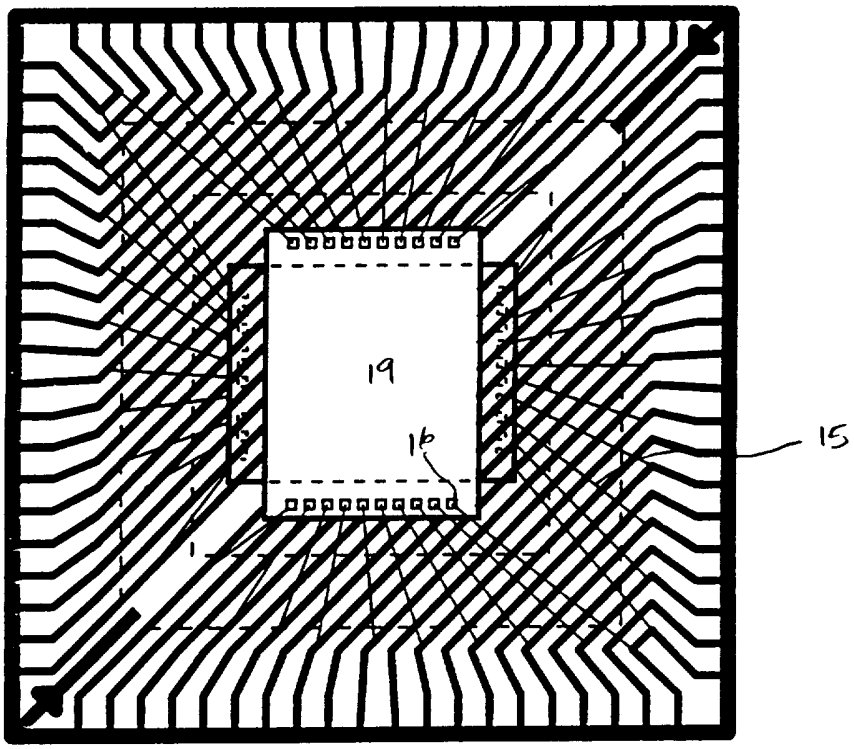

Fig 2b

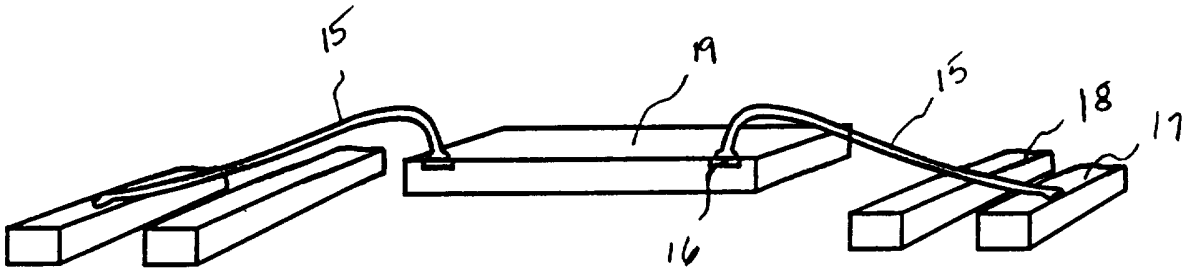

Fig 2c

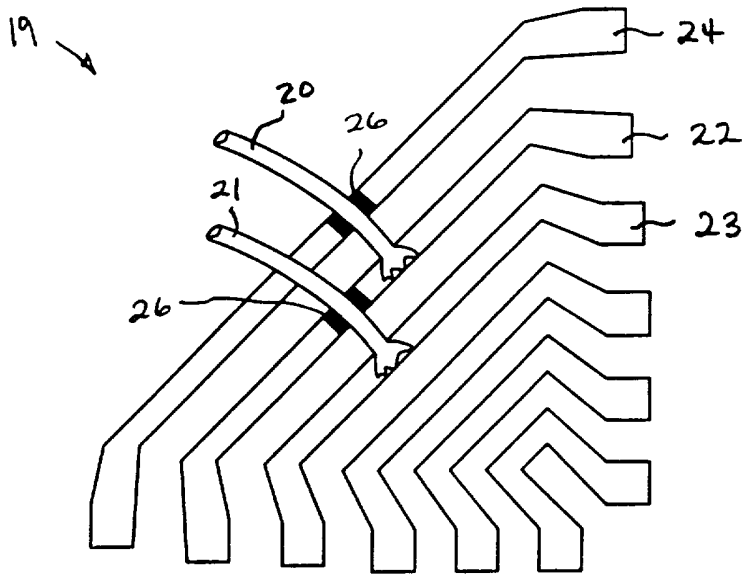

Fig. 3

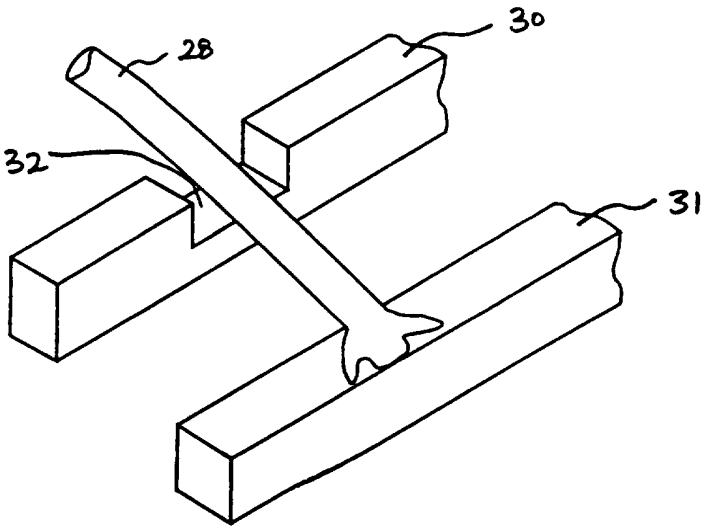

Fig. 4

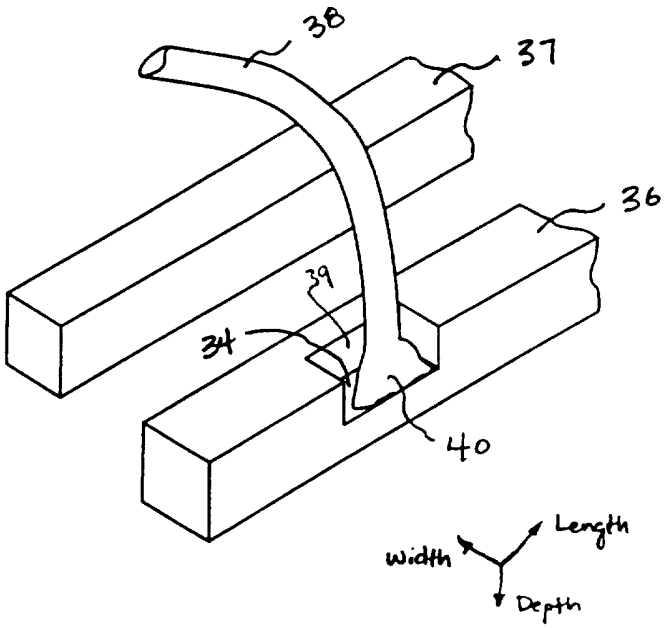

Fig. 5

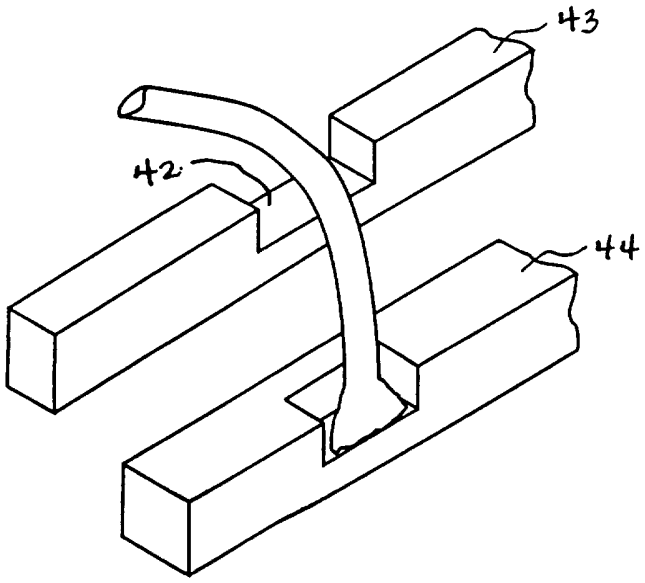

Fig. 6

INTERNATIONAL SEARCH REPORT

I· ational Application No
PCT/US 95/16240

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H01L23/495

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)
IPC 6 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 practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP,A,0 478 240 (TEXAS INSTRUMENTS INC) 1 April 1992 see page 5, line 17 - line 32; figure 3	1-3,6, 21,22,27
X	US,A,5 086 018 (CONRU H WARD ET AL) 4 February 1992 see column 4, line 47 - column 5, line 13; figure 5	1-3,6, 21,22,27
X	US,A,5 072 280 (MATSUKURA TAKUMI) 10 December 1991 see the whole document	1-3,6, 21,22,27
X	US,A,5 229 329 (CHAI TAI C ET AL) 20 July 1993 see the whole document	1-3,6, 21,22,27

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in 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 document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"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	Date of mailing of the international search report
29 February 1996	11.06.96

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax (+ 31-70) 340-3016	ZEISLER, P

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 95/16240

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 017, no. 061 (E-1316) 5 February 1993 & JP,A,04 267 534 (NEC KYUSHU LTD) 24 September 1992 see abstract	1-3,6, 21,22,27
X	PATENT ABSTRACTS OF JAPAN vol. 016, no. 055 (E-1165) 12 February 1992 & JP,A,03 255 655 (NEC CORP) 14 November 1991 see abstract	1-3,5,6, 21,22,27 25
X	IBM TECHNICAL DISCLOSURE BULLETIN, vol.34, no.1, 1, NEW YORK US pages 358 - 359 'Thin Small Outline Packages' see the whole document	1-3,6, 21,22,27
A	GB,A,2 263 815 (FUJI ELECTRIC CO LTD) 4 August 1993 see the whole document	1,7, 21-23,26

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

.nternational application No.

PCT/US 95/ 16240

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

SEE ANNEXED SHEET

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searches without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

A1-A7, D1-D7

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

INVITATION TO PAY ADDITIONAL FEES

International application No.
PCT/US95/16240

1. Claims: A1-A7, D1-D7: Method of packaging an integrated circuit die by applying an insulating film on the lead crossed over by bonding wires.

2. Claims: B1-B7, E1-E4: Method of packaging an integrated circuit die by forming a depression on the leads crossed over by bonding wires.

3. Claims: C1-C6, F1-F4: Method of packaging an integrated circuit die by coining a depression on the lead bonding area to increase the incline of the bonding wires.

The first invention deals with a method for packaging an integrated circuit die to prevent short-circuits of bonding wires with leads by applying an insulating film on the leads, which are crossed over by a bonding wire. An integrated circuit package fabricated by such a method is also claimed.

The general problem underlying this invention is neither novel, because a solution to it has already been given nor does the solution given involve any inventive step regarding the 'state of the art' as illustrated by the documents EP-A-478240 and US-A-5229329.
Document EP-A-478240 for example, describes a Lead-on-Chip structure with a leadframe having a power supply bus and an insulator applied on the power supply bus to prevent short-circuits of bonding wires with the power supply bus (page 5, lines 17-32; figure 3). Document US-A-5086018 for example, describes a Lead-on-Chip structure with a leadframe, the leadframe having insulated regions to prevent short-circuits where the bonding wires pass over leads to connect leadframe conductors.The insulation can be any suitable polymer. (column 4, line 47-column 5, line 13; figure 5). All features as claimed in claims A1 and D1 are also described in the documents EP-A-478240 and US-A-5229329.

Therefore, the original general inventive concept of a method for packaging an integrated circuit die to prevent short-circuits of bonding wires with leads, which are crossed over by bonding wires and an integrated circuit die fabricated by such a method, is not acceptable anymore as required by rule 13.1 of the PCT.

This makes it necessary to reconsider the technical relationship between the different solutions mentioned for fabricating such an integrated circuit. The general single inventive concept falls apart into different subjects, each subject being a solution to the problem that differs from the 'state of the art'. Therefore it is necessary to regroup the claims under distinct subjetcs as listed above, each subject having it's own inventive concept.

Moreover, a complete search over all the subjects would request a major search effort.

INTERNATIONAL SEARCH REPORT

Information on patent family members

In tional Application No
PCT/US 95/16240

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP-A-0478240	01-04-92	EP-A-	0478241	01-04-92
		JP-A-	4246853	02-09-92
		JP-A-	4234155	21-08-92
		US-A-	5359224	25-10-94
US-A-5086018	04-02-92	EP-A-	0513521	19-11-92
		JP-A-	5109801	30-04-93
		JP-B-	7015917	22-02-95
		US-A-	5151559	29-09-92
US-A-5072280	10-12-91	JP-A-	3204965	06-09-91
US-A-5229329	20-07-93	NONE		
GB-A-2263815	04-08-93	JP-A-	5206365	13-08-93
		US-A-	5309017	03-05-94
		US-A-	5395800	07-03-95