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AN INTEGRATED CIRCUIT ARRAY STRUCTURE AND METHOD OF MANUFACTURING INTEGRATED CIRCUIT PACKAGES

Field of the Invention

The present invention relates to an integrated circuit array structure, to an integrated circuit package and to a method of manufacturing integrated circuit packages.

Background of the Invention

It is known to produce integrated circuit packages by manufacturing an integrated circuit array structure having a plurality of contiguous integrated circuit packages, and subsequently singulating the integrated circuit packages from the integrated circuit array structure. The integrated circuit array structure generally includes a metal leadframe, a plurality of integrated circuit die pads disposed on the leadframe, and encapsulant material disposed over the leadframe and the die pads.

However, singulation of the integrated circuit packages by die punching or sawing has a tendency to cause delamination between the leadframe and the encapsulant material at the periphery of the integrated circuit packages. Singulation with a saw also has a tendency to cause metal burr during cutting of the leadframe which can cause shorts between adjacent portions of the leadframe and thereby failure of an integrated circuit package during package testing.

It is possible to reduce the likelihood of delamination by using a high quality encapsulant compound, or by increasing the space between adjacent integrated circuit packages. However, both of these arrangements cause significant cost increases due to the high cost of the

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high quality encapsulant compound and wastage of useful space on the integrated circuit array structure.

Summary of the Invention

In accordance with a first aspect of the present invention, there is provided an integrated circuit array structure comprising:

an electrically conductive leadframe;

encapsulant material disposed over the electrically conductive leadframe; and

a plurality of integrated circuit die pads disposed between the encapsulant material and the electrically conductive leadframe;

wherein the electrically conductive leadframe and the die pads are arranged so as to form a plurality of contiguous integrated circuit packages; and

wherein the electrically conductive leadframe includes at least one discontinuous portion disposed adjacent the periphery of at least one integrated circuit package and arranged so as to cause engagement of the electrically conductive leadframe with the encapsulant material and thereby restriction of delamination of the encapsulant material from the electrically conductive leadframe during singulation of integrated circuit packages from the integrated circuit array structure.

In one arrangement, the at least one discontinuous portion includes at least one aperture.

In addition, or alternatively, the at least one discontinuous portion includes at least one recess.

In one arrangement, adjacent integrated circuit packages are separated by a singulation region and a portion of the electrically conductive leadframe at the singulation

region is provided with at least one discontinuous portion.

Preferably, the at least one discontinuous portion is an aperture formed in the leadframe so as to minimise the amount of leadframe material in the singulation region.

The at least one discontinuous portion in the singulation region may include at least one internal cavity.

In one arrangement, each integrated circuit package has an associated outer boundary and the electrically conductive leadframe is provided inwardly of the outer boundary with at least one discontinuous portion. Each integrated circuit package may include one or more integrated circuit die pads fixed to the leadframe.

In accordance with a second aspect of the present invention, there is provided an integrated circuit package comprising:

an electrically conductive leadframe;

encapsulant material disposed over the electrically conductive leadframe; and

at least one integrated circuit die pad disposed between the encapsulant material and the electrically conductive leadframe;

wherein the electrically conductive leadframe includes at least one discontinuous portion disposed adjacent the periphery of the integrated circuit package and arranged so as to cause engagement of the electrically conductive leadframe with the encapsulant material and thereby restriction of delamination of the encapsulant material from the electrically conductive leadframe.

In one arrangement, the at least one discontinuous portion includes at least one aperture.

In addition, or alternatively, the at least one discontinuous portion includes at least one recess.

In one arrangement, each integrated circuit package has an associated outer boundary and the electrically conductive leadframe is provided inwardly of the outer boundary with at least one discontinuous portion. Each integrated circuit package may include one or more integrated circuit die pads fixed to the leadframe.

In accordance with a third aspect of the present invention, there is provided a method of forming integrated circuit packages, said method comprising the steps of:

providing an electrically conductive leadframe;

disposing a plurality of integrated circuit die pads on the electrically conductive leadframe;

disposing encapsulant material over the integrated circuit die pads and the electrically conductive leadframe; and

arranging the electrically conductive leadframe and the die pads so as to form a plurality of contiguous integrated circuit packages; and

wherein the step of providing the electrically conductive leadframe includes the steps of forming the electrically conductive leadframe with at least one discontinuous portion disposed adjacent the periphery of at least one integrated circuit package, and arranging the at least one discontinuous portion so as to cause engagement of the electrically conductive leadframe with the encapsulant material and thereby restriction of delamination of the encapsulant material from the electrically conductive leadframe during singulation of integrated circuit packages from the integrated circuit array structure.

In one arrangement, the at least one discontinuous portion includes at least one aperture.

In addition, or alternatively, the at least one discontinuous portion includes at least one recess.

The method may further include the steps of providing a singulation region between adjacent integrated circuit packages and providing a portion of the electrically conductive leadframe at the singulation region with at least one discontinuous portion.

Preferably, the step of forming the electrically conductive leadframe with at least one discontinuous portion comprises the step of forming an aperture in the singulation region so as to minimise the amount of leadframe material in the singulation region.

The at least one discontinuous portion in the singulation region may include at least one internal cavity.

In one arrangement, each integrated circuit package has an associated outer boundary and the step of forming the electrically conductive leadframe with at least one discontinuous portion comprises the step of forming the at least one discontinuous portion inwardly of the outer boundary. Each integrated circuit package may include one or more integrated circuit die pads fixed to the leadframe.

Brief Description of the Drawings

The present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic plan view of an integrated circuit array structure in accordance with an embodiment

of the present invention, with the array structure shown without encapsulant material;

Figure 2 is diagrammatic side view of a singulated integrated circuit package of an integrated circuit array structure in accordance with an embodiment of the present invention; and

Figures 3 to 5 are diagrammatic representations illustrating singulation steps of a method of manufacturing integrated circuit packages in accordance with an embodiment of the present invention.

Description of an Embodiment of the Present Invention

Referring to Figure 1 of the drawings, there is shown a portion of an integrated circuit array structure 10 including a plurality of contiguous integrated circuit packages 12. For clarity, encapsulant material of the structure 10 is not shown

Each integrated circuit package 12 is defined by an outer boundary 23. A singulation region 25 is provided between adjacent integrated circuit packages 12 for facilitating cutting and thereby singulation of the packages 12.

The integrated circuit array structure 10 includes an electrically conductive leadframe 14, in this example formed of copper material, and a plurality of integrated circuit die pads 16 fixed to the leadframe 14, each integrated circuit die pad 16 including connection wires 20 extending between the integrated circuit die pad 16 and the leadframe 14.

In the example shown in Figure 1, each integrated circuit package 12 includes a plurality of integrated circuit die pads 16. However, it will be understood that any number of integrated circuit die pads 16 may be provided.

As shown in Figure 1, each integrated circuit package 12 includes discontinuous portions disposed adjacent peripheral edges of the integrated circuit packages 12, in this example the discontinuous portions being in the form of recesses 22 disposed inwardly of the outer boundary 23, and apertures 24 disposed outwardly of the outer boundary 23 between adjacent integrated circuit packages 12 in the singulation region 25.

It will be understood that in the present example, the recesses 22 are of non-through hole type and the apertures 24 are of through hole type, although it will be understood that the discontinuous portions 22, 24 may be of non-through hole type, through hole type, or a combination of non-through hole and through hole types.

It will be understood that the discontinuous portions 22, 24 serve to encourage engagement between the leadframe 14 and encapsulant material disposed during manufacture over the leadframe 14, and in this way the discontinuous portions 22, 24 assist in preventing delamination of the encapsulant material from the leadframe 14 during singulation of the integrated circuit packages 12 from the integrated circuit array structure 10.

It will also be understood that various types of discontinuous portion are envisaged, the important aspect being that at least some of the discontinuous portions are arranged to encourage engagement of encapsulant material with the leadframe 14 adjacent the outer boundary 23 of each integrated circuit package 12 and thereby a reduction in delamination of the encapsulant material from the leadframe 14 during singulation.

It will also be understood that the discontinuous portions 24 in the singulation region 25 serve to reduce the risk of metal burr during singulation since the amount of metal

to cut through is reduced. In this regard, the discontinuous portions 24 in the singulation region 25 may be formed as internal cavities instead of recesses or apertures.

Referring to Figure 2, a singulated integrated circuit package 30 including a single die pad 16 is shown. Like and similar features are indicated with like reference numerals.

As shown in Figure 2, the integrated circuit package 30 includes an integrated circuit die pad 16 fixed to the leadframe 14 using a die attach medium 18, and encapsulant material 26 disposed over the integrated circuit die pad 16. As with the integrated circuit package 12 shown in Figure 1, the die pad 16 is electrically connected to the leadframe using connection wires 20.

The die attach medium 18 may be any suitable material including epoxy material, silicone or adhesive tape.

In this example, the integrated circuit package 30 is shown disposed on a tape 32 used during manufacture to prevent leakage of encapsulant material during the encapsulation process.

Singulation steps of an integrated circuit package manufacturing process are shown in Figures 3 to 5.

As shown in Figure 3, in order to singulate the integrated circuit packages 30, a cut is first made using a first saw 33 of relatively thin profile, the first cut being made to a depth such that adjacent portions of the leadframe 14 are separated from each other but the integrated circuit packages 12 are still held together by the encapsulant material 26. This facilitates testing of the integrated circuit packages 12 with test contacts 34 whilst the

integrated circuit packages 12 are still mechanically connected to each other, as shown in Figure 4.

Following testing of the integrated circuit packages 12, a further cut is made using a second saw 36 of relatively wide profile so as to mechanically separate the integrated circuit packages 12 from each other.

It will be understood that by providing the discontinuous portions 22, 24 adjacent the outer boundary 23 of each integrated circuit package 12 the likelihood of delamination when cutting with the first and second saws 33, 34 is minimised.

It will also be understood that by providing the discontinuous portions 24 in the singulation region 25 as shown in Figure 1, the likelihood of metal burr is reduced since less metal material is present to be cut by the first and second saws 33, 34.

Furthermore, it will be understood that by providing the discontinuous portions 23, 24, the weight of the leadframe 14 is reduced, thereby reducing the weight of the integrated circuit packages 12 and the associated transportation costs.

In the claims of this application and in the description of the invention, except where the context requires otherwise due to express language or necessary implication, the words "comprise" or variations such as "comprises" or "comprising" are used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the invention.

Modifications and variations as would be apparent to a skilled addressee are deemed to be within the scope of the present invention.

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CLAIMS:

1. An integrated circuit array structure comprising:

an electrically conductive leadframe;

encapsulant material disposed over the electrically conductive leadframe; and

a plurality of integrated circuit die pads disposed between the encapsulant material and the electrically conductive leadframe;

wherein the electrically conductive leadframe and the die pads are arranged so as to form a plurality of contiguous integrated circuit packages; and

wherein the electrically conductive leadframe includes at least one discontinuous portion disposed adjacent the periphery of at least one integrated circuit package and arranged so as to cause engagement of the electrically conductive leadframe with the encapsulant material and thereby restriction of delamination of the encapsulant material from the electrically conductive leadframe during singulation of integrated circuit packages from the integrated circuit array structure.

2. A structure as claimed in claim 1, wherein the at least one discontinuous portion includes at least one aperture.

3. A structure as claimed in claim 1 or claim 2, wherein the at least one discontinuous portion includes at least one recess.

4. A structure as claimed in any one of claims 1 to 3, wherein adjacent integrated circuit packages are separated by a singulation region and a portion of the electrically conductive leadframe at the singulation region is provided with at least one discontinuous portion.

5. A structure as claimed in claim 4, wherein the at least one discontinuous portion is an aperture formed in the leadframe so as to minimise the amount of leadframe material in the singulation region.

6. A structure as claimed in claim 4, wherein the at least one discontinuous portion in the singulation region may include at least one internal cavity.

7. A structure as claimed in any one of the preceding claims, wherein each integrated circuit package has an associated outer boundary and the electrically conductive leadframe is provided inwardly of the outer boundary with at least one discontinuous portion.

8. An integrated circuit package comprising:

an electrically conductive leadframe;

encapsulant material disposed over the electrically conductive leadframe; and

at least one integrated circuit die pad disposed between the encapsulant material and the electrically conductive leadframe;

wherein the electrically conductive leadframe includes at least one discontinuous portion disposed adjacent the periphery of the integrated circuit package and arranged so as to cause engagement of the electrically conductive leadframe with the encapsulant material and thereby restriction of delamination of the encapsulant material from the electrically conductive leadframe.

9. A package as claimed in claim 8, wherein the at least one discontinuous portion includes at least one aperture.

10. A package as claimed in claim 8 or claim 9, wherein the at least one discontinuous portion includes at least one recess.

11. A package as claimed in any one of claims 8 to 10, wherein each integrated circuit package has an associated outer boundary and the electrically conductive leadframe is provided inwardly of the outer boundary with at least one discontinuous portion. Each integrated circuit package may include one or more integrated circuit die pads fixed to the leadframe.

12. A method of manufacturing integrated circuit packages, said method comprising the steps of:

providing an electrically conductive leadframe;

disposing a plurality of integrated circuit die pads on the electrically conductive leadframe; and

disposing encapsulant material over the integrated circuit die pads and the electrically conductive leadframe;

arranging the electrically conductive leadframe and the die pads so as to form a plurality of continuous integrated circuit packages; and

wherein the step of providing the electrically conductive leadframe includes the steps of forming the electrically conductive leadframe with at least one discontinuous portion disposed adjacent the periphery of at least one integrated circuit package, and arranging the at least one discontinuous portion so as to cause engagement of the electrically conductive leadframe with the encapsulant material and thereby restriction of delamination of the encapsulant material from the electrically conductive leadframe during singulation of integrated circuit packages from the integrated circuit array structure.

13. A method as claimed in claim 12, wherein the at least one discontinuous portion includes at least one aperture.

14. A method as claimed in claim 12 or claim 13, wherein the at least one discontinuous portion includes at least one recess.

15. A method as claimed in any one of claims 12 to 14, further comprising the steps of providing a singulation region between adjacent integrated circuit packages and providing a portion of the electrically conductive leadframe at the singulation region with at least one discontinuous portion.

16. A method as claimed in claim 15, wherein the step of forming the electrically conductive leadframe with at least one discontinuous portion comprises the step of forming an aperture in the leadframe so as to minimise the amount of leadframe material in the singulation region.

17. A method as claimed in claim 15, wherein the at least one discontinuous portion in the singulation region may include at least one internal cavity.

18. A method as claimed in any one of claims 12 to 17, wherein each integrated circuit package has an associated outer boundary and the step of forming the electrically conductive leadframe with at least one discontinuous portion comprises the step of forming the at least one discontinuous portion inwardly of the outer boundary. Each integrated circuit package may include one or more integrated circuit die pads fixed to the leadframe.

19. An integrated circuit array structure substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

20. An integrated circuit package substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

21. A method of manufacturing integrated circuit packages substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.