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United States Patent	12394743
Kind Code	B2
Date of Patent	August 19, 2025
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Die attachment structure and method for manufacturing the same

Abstract

A die attachment structure can include: a base; a die located above a first surface of the base; a first adhesive layer located on a back surface of the die, wherein the die is pasted on the first surface of the base at least by the first adhesive layer; and a second adhesive layer at least partially covering the sidewalls of the die.

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Appl. No.:	17/335195
Filed:	June 01, 2021

Prior Publication Data

Document Identifier	Publication Date
US 20210384155 A1	Dec. 09, 2021

Foreign Application Priority Data

CN	202010503945.0	Jun. 05, 2020
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Publication Classification

Int. Cl.: H01L23/00 (20060101)

U.S. Cl.:

CPC **H01L24/30** (20130101); **H01L24/83** (20130101); H01L2224/30051 (20130101);
H01L2224/8385 (20130101)

Field of Classification Search

CPC: H01L (2224/80); H01L (2224/83); H01L (2224/8319); H01L (2224/83192); H01L (2224/83193); H01L (2224/8389); H01L (2224/8385-83885); H01L (2224/8185-8189); H01L (2224/2969-29691); H01L (2224/2919-29191); H01L (2224/1369-13691); H01L (2224/271); H01L (2224/2711); H01L (2224/2712); H01L (2224/273); H01L (2224/27331); H01L (2224/27312); H01L (23/12); H01L (23/13); H01L (21/56); H01L (23/36); H01L (23/3171); H01L (23/3185); H01L (23/3192); H01L (23/3735); H01L (2224/30051); H01L (2224/2731); H01L (2224/27416); H01L (2224/27436); H01L (2224/27515); H01L (2224/32053); H01L (2224/32105); H01L (2224/32106); H01L (2224/32237); H01L (2224/32257); H01L (2224/83856); H01L (24/30); H01L (24/83); H01L (24/27); H01L (24/29); H01L (24/32)

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Background/Summary

RELATED APPLICATIONS

(1) This application claims the benefit of Chinese Patent Application No. 202010503945.0, filed on Jun. 5, 2020, which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

(2) The present invention generally relates to the field of die packages, and more particularly to die attachment structures and associated manufacturing methods.

BACKGROUND

(3) With the rapid improvement of package integration, more than two silicon dice can be integrated within the same package. In addition, because of different wafer process requirements,

different dice in the same package may have different substrate voltages, and some dice may need to be insulated and isolated within the package.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIG. 1 is a sectional view of a first example die attachment structure, in accordance with embodiments of the present invention.

(2) FIG. 2 is a sectional view of a second example die attachment structure, in accordance with embodiments of the present invention.

(3) FIG. 3 is a sectional view of a third example die attachment structure, in accordance with embodiments of the present invention.

DETAILED DESCRIPTION

(4) Reference may now be made in detail to particular embodiments of the invention, examples of which are illustrated in the accompanying drawings. While the invention may be described in conjunction with the preferred embodiments, it may be understood that they are not intended to limit the invention to these embodiments. On the contrary, the invention is intended to cover alternatives, modifications and equivalents that may be included within the spirit and scope of the invention as defined by the appended claims. Furthermore, in the following detailed description of the present invention, numerous specific details are set forth in order to provide a thorough understanding of the present invention. However, it may be readily apparent to one skilled in the art that the present invention may be practiced without these specific details. In other instances, well-known methods, procedures, processes, components, structures, and circuits have not been described in detail so as not to unnecessarily obscure aspects of the present invention.

(5) Currently, the processes of the non-conductive adhesive used for isolation include an adhesive-brushing process, an attaching die attach film (DAF) film process, and an adhesive-dispensing process. The adhesive-brushing process and the DAF film can well control the thickness of the adhesive layer, and voids therein are not easily produced. The insulation reliability of the adhesive-brushing process and the DAF film are typically better than that of the adhesive-dispensing process, but the thermal conductivity of the two materials is relatively low (e.g., <1 W/mK), and thus is not conducive to the overall heat dissipation design of the package.

(6) The adhesive-dispensing process can use a non-conductive adhesive having high thermal conductivity (e.g., >2 W/mK) to improve the heat dissipation, but the adhesive-dispensing process has difficulty controlling the thickness of the adhesive, and voids therein may be produced. This can affect the insulation ability of the adhesive layer, especially in high-voltage products (e.g., >100 V), with a potential risk of high voltage breakdown failure. Accordingly, current approaches may not have good compatibility while meeting isolation and heat dissipation requirements.

(7) In particular embodiments, a die attachment structure can include a base, a die located on a first surface of the base, a first adhesive layer located on a back surface of the die, and a second adhesive layer at least covering the sidewalls of the die. For example, the die is attached to the first surface of the base at least by the first adhesive layer. Also, the first adhesive layer and the second adhesive layer may be formed by different processes.

(8) Referring now to FIG. 1, shown is a sectional view of a first example die attachment structure, in accordance with embodiments of the present invention. The die attachment structure can include base **101**, adhesive layer **103** (black structure in FIG. 1), adhesive layer **102**, and die **104**. For example, die **104** can be located above a first surface of base **101**, adhesive layer **103** can be located on a back surface of die **104**, and adhesive layer **102** may at least partially cover the sidewalls of die **104**. Die **104** can be pasted on the first surface of base **101** by adhesive layer **103**. For example, the first surface of base **101** can be flat, and adhesive layer **102** can include a first part

located on the first surface of base **101** and a second part that “crawls” on the sidewalls of die **104**. That is, die **104** can be pasted on the first surface of base **101** by adhesive layer **103** and the first part of adhesive layer **102**. Further, adhesive layer **102** can cover part of the sidewalls of die **104**, and may cover adhesive layer **103** on the back surface of die **104**.

(9) It should be noted that adhesive layer **102** may not crawl to an upper surface (e.g., active surface) of the die, and the upper surface of the die is opposite to the back surface of the die. Further, the height of the second part of the second adhesive layer that crawls on the sidewalls of the die may not be more than, e.g., about 90% of the thickness of the die. Further, the direction of adhesive layer **102** crawling on the sidewalls of the die may extend from the back surface of the die toward the upper surface of the die.

(10) In this example, adhesive layers **102** and **103** may both be non-conductive adhesive layer, but these adhesive layers can be different. For example, adhesive layer **102** may be formed by an adhesive-dispensing process, and adhesive layer **102** may have a high thermal conductivity. For example, the thermal conductivity of adhesive layer **102** may not be less than, e.g., about 2 W/mK. Adhesive layer **103** can be formed by an adhesive-brushing process or by sticking a DAF film on the back surface of the die, such that adhesive layer **103** may have a uniform thickness that does not easily produce voids. In addition, the first surface of the base further can include pads; that is, die **104** can be pasted on the pads on the first surface of the base.

(11) In particular embodiments, a method of manufacturing a die attachment structure can include providing a die and a base, forming a first adhesive layer on the back surface of the die, forming a second adhesive layer at least partially covering the sidewalls of the die, and pasting the die on the first surface of the base at least by the first adhesive layer. For example, adhesive layer **103** may be formed on a back surface of die **104**, and adhesive layer **103** may be formed by an adhesive-brushing process, or by sticking a DAF film on the back surface of the die. Adhesive layer **103** formed by such processes can more easily control the thickness of adhesive layer **103** to have a uniform thickness, and not easily produce voids, which can ensure the insulation and isolation of the die. The first adhesive layer can be non-conductive adhesive, such as 8006 adhesive.

(12) For example, the adhesive-brushing process can include the adhesive being evenly attached to the back surface of the die by a scraper coating or a high-speed spin coating, and pre-curing the adhesive to ensure the connection between the adhesive and the back surface of the die. Generally, the die can be thinned to a specified thickness before adhesive layer **103** is formed on the back surface of the die.

(13) Adhesive layer **102** can be formed on a first surface of base **101**. For example, an adhesive-dispensing process can be used to form adhesive layer **102** on the first surface of base **101**. The adhesive-dispensing process can include application of the adhesive material in a needle tube by pressure or other transfer methods to the designated position on the first surface of the base to form adhesive layer **102**, and adhesive layer **102** may not be cured. For example, adhesive layer **102** is non-conductive adhesive layer (e.g., 8472 adhesive, 8488 adhesive, etc.) Adhesive layer **102** may have a high thermal conductivity, e.g., the thermal conductivity of adhesive layer **102** may not be less than 2 W/mK. In this example, the first surface of the base can also include pads, and adhesive layer **102** may be located on the pads of the base. It should also be noted that the order of the above steps is not restricted, and the order can be reversed, or the two steps may be performed at substantially the same time.

(14) The method can also include pasting die **104** on the first surface of base **101** with the back surface facing the first surface of base **101**. For example, when die **104** is pasted on the first surface of base **101**, a certain pressure may be applied to make part of adhesive layer **102** effectively crawl up the sidewalls of die **104**. For example, the height of adhesive layer **102** crawling on the sidewalls of the die may not be more than 90% of the thickness of the die, and the direction of adhesive layer **102** crawling on the sidewalls of the die may extend from the back surface of the die to an upper surface of the die, whereby the upper surface of the die is opposite to the back surface

of the die. In this example, the thickness of the die can be appropriately increased to facilitate control of the height of adhesive layer **102** formed by the adhesive-dispensing process on the sidewalls of the die. Also, the contact area between the sidewalls of the die and adhesive layer **102** can be increased, in order to improve heat dissipation capacity.

(15) Referring now to FIG. 2, shown is a sectional view of a second example die attachment structure, in accordance with embodiments of the present invention. In this particular example, the die attachment structure can include base **201**, adhesive layer **202**, adhesive layer **203**, and die **204**. For example, the first surface of the base can be flat, a back surface of die **204** may be pasted on the first surface of base **201** by adhesive layer **202**, and adhesive layer **203** can cover the side surfaces of adhesive layer **202**, and at least partially the sidewalls of die **204**. For example, the height of adhesive layer **203** crawling on the sidewalls of the die may not be greater than 90% of the thickness of the die, and the direction of adhesive layer **203** crawling on the sidewalls of the die may extend from the back surface of the die to the upper surface of the die, whereby the upper surface of the die is opposite to the back surface of the die. Adhesive layer **203** may also have a relatively high thermal conductivity (e.g., not less than about 2 W/mK). Adhesive layer **202** may have a uniform thickness without voids. In this example, adhesive layer **203** may be formed by an adhesive-dispensing process, and adhesive layer **202** may be formed by adhesive-brushing process or by sticking a DAF film on the back surface of the die. The first surface of base **201** can also include pads; that is, die **204** is pasted on the pads on the first surface of the base.

(16) In particular embodiments, a method of manufacturing the die attachment structure shown in FIG. 2 can include forming adhesive layer **202** on a back surface of die **204**. For example, adhesive layer **202** can be formed by an adhesive-brushing process, or by sticking a DAF film on the back surface of die **204**. Adhesive layer **202** formed by these two processes can be easier to control the thickness of the adhesive layer without easily producing voids, and may ensure the insulation and isolation of the die. Adhesive layer **202** can be a non-conductive adhesive.

(17) The method can also include pasting die **204** on the first surface of the base by adhesive layer **202** with the back surface of the die facing the first surface of base **201**, and using an adhesive-dispensing process to form adhesive layer **203** covering the sidewalls of die **204**. For example, the adhesive-dispensing process may apply the adhesive material in a needle tube by pressure or other transfer methods to sidewalls of the die to form adhesive layer **203**. Adhesive layer **203** can cover the side surface of adhesive layer **202** (shown in black in FIG. 2). For example, adhesive layer **203** may be non-conductive adhesive layer, and can have a relatively high thermal conductivity (e.g., not less than about 2 W/mK).

(18) For example, the height of adhesive layer **203** crawling on the sidewalls of the die may not be more than 90% of the thickness of the die. In this example, the thickness of the die can be appropriately increased to facilitate control of the height of adhesive layer **203** formed by the adhesive-dispensing process on the sidewalls of the die, and the contact area between the sidewalls of the die and adhesive layer **203** can also be increased to improve heat dissipation capacity.

(19) In particular embodiments, two layers of non-conductive adhesive can be formed by different processes, such that the junction temperature generated by the die during operation can be transmitted to the base through adhesive layer **202** under the die, and to the base through adhesive layer **203** on the sidewalls of the die, thereby improving the heat dissipation capability of the package. In addition, adhesive layer **202** formed by the adhesive-brushing process and sticking DAF film process may have a uniform thickness that does not easily produce voids, and may provide good insulation and isolation for the die.

(20) Referring now to FIG. 3, shown is a sectional view of a third example die attachment structure, in accordance with embodiments of the present invention. The die attachment structure in this particular example can include base **301**, adhesive layer **302**, adhesive layer **303**, and die **304**. Here, the first surface of base **301** can include a groove structure, and die **304** may be mounted in the groove structure. In this example, the size of the groove structure may be sufficient to

accommodate the lateral width of die **304**, and at least part of the thickness of die **304** can be located in the groove structure. That is, the upper surface of die **304** can be higher than a top surface of the groove structure.

(21) Die **304** can be pasted on the bottom of the groove structure by adhesive layers **302** (shown in black in FIG. **3**) and **303**. Adhesive layer **303** may not only crawl up the sidewalls of the die, but can also fill the gap between the groove structure and die **304**. In this example, the groove structure can be a structure with a narrow bottom and a wide top; that is, a width of a bottom part of the groove structure can be less than that of a top part of the groove structure. Of course, those skilled in the art will recognize that other suitable structures may also be supported in certain embodiments. The base structure of this example can also be applicable to the die attachment structure shown in FIG. **2**. That is, die **204** can also be pasted on the bottom of the groove structure of the first surface of the base only through adhesive layer **302**, and adhesive layer **303** may only cover the side surfaces of adhesive layer **302** and the sidewalls of die **304**.

(22) In particular embodiments, the manufacturing method of the die bond structure of the example of FIG. **3** can include, before forming adhesive layers **302** and **303**, forming a groove structure on the first surface of base **301**. For example, the groove structure can be formed by chemical etching or mechanical denting. In the die attachment structure provided in this example, by forming a groove structure on the first surface of the base and mounting the die in the groove structure, the distance between the periphery of the die and the pad can be reduced. That is, the heat dissipation path on the side of the die can be shortened, and this arrangement may further improve the heat dissipation capacity.

(23) The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, to thereby enable others skilled in the art to best utilize the invention and various embodiments with modifications as are suited to particular use(s) contemplated. It is intended that the scope of the invention be defined by the claims appended hereto and their equivalents.

Claims

1. A die attachment structure, comprising: a) a base; b) a die located above a first surface of the base; c) a first adhesive layer located on and fully covering a back surface of the die, wherein the die is pasted on the first surface of the base at least by the first adhesive layer; and d) a second adhesive layer at least partially covering only the two sidewalls of the die, e) wherein the first adhesive layer and the second adhesive layer are different and are set as non-conductive adhesive layers, and wherein the first surface of the base comprises a groove structure, and the die is mounted in the groove structure, and f) wherein a height of the second adhesive layer crawling on the sidewalls of the die is not more than 90% of the thickness of the die, the direction of the second adhesive layer crawling on the sidewalls of the die extends from the back surface of the die to an upper surface of the die, and the upper surface of the die is opposite to the back surface of the die.
2. The die attachment structure of claim 1, wherein the first adhesive layer and the second adhesive layer are formed by different processes.
3. The die attachment structure of claim 1, wherein the second adhesive layer is also located on the first surface of the base, and the die is pasted on the first surface of the base by the first adhesive layer and the second adhesive layer.
4. The die attachment structure of claim 1, wherein the first surface of the base is flat.
5. The die attachment structure of claim 1, wherein an upper surface of the die is higher than a top of the groove structure, and the upper surface of the die is opposite to the back surface of the die.
6. The die attachment structure of claim 1, wherein a width of a bottom part of the groove structure is less than that of a top part of the groove structure.
7. The die attachment structure of claim 1, wherein the first adhesive layer is formed by an

adhesive-brushing process or sticking a die attach film (DAF) on the back surface of the die.

8. The die attachment structure of claim 1, wherein the second adhesive layer is formed by an adhesive-dispensing process.

9. The die attachment structure of claim 1, wherein the groove structure is formed by etching process or mechanically denting process.

10. A die attachment structure, comprising: a) a base; b) a die located above a first surface of the base; c) a first adhesive layer located on a back surface of the die, wherein the die is pasted on the first surface of the base at least by the first adhesive layer; and d) a second adhesive layer at least partially covering the sidewalls of the die, e) wherein a thermal conductivity of the second adhesive layer is not less than 2 W/mK.

11. The die attachment structure of claim 10, wherein the first adhesive layer and the second adhesive layer are formed by different processes.

12. The die attachment structure of claim 10, wherein the first adhesive layer and the second adhesive layer are different.

13. The die attachment structure of claim 10, wherein the second adhesive layer is also located on the first surface of the base, and the die is pasted on the first surface of the base by the first adhesive layer and the second adhesive layer.

14. The die attachment structure of claim 10, wherein the first surface of the base is flat.

15. The die attachment structure of claim 10, wherein the first surface of the base comprises a groove structure, and the die is mounted in the groove structure.

16. The die attachment structure of claim 15, wherein an upper surface of the die is higher than a top of the groove structure, and the upper surface of the die is opposite to the back surface of the die.

17. The die attachment structure of claim 15, wherein a width of a bottom part of the groove structure is less than that of a top part of the groove structure.
