



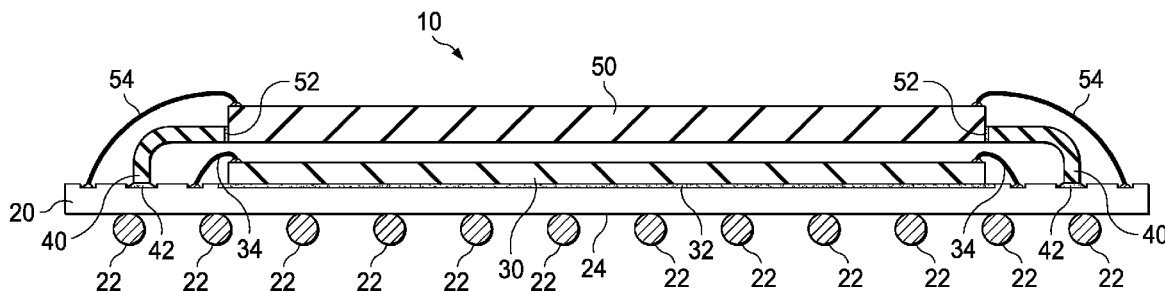
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**Caballero et al.**(10) **Pub. No.: US 2017/0025388 A1**(43) **Pub. Date: Jan. 26, 2017**(54) **BACKSIDE STACKED DIE IN AN  
INTEGRATED CIRCUIT (IC) PACKAGE****H01L 25/00** (2006.01)**H01L 23/528** (2006.01)(71) Applicant: **Microchip Technology Incorporated,**  
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Chandler, AZ (US)(21) Appl. No.: **15/215,743**

(57)

**ABSTRACT**(22) Filed: **Jul. 21, 2016****Related U.S. Application Data**(60) Provisional application No. 62/195,670, filed on Jul.  
22, 2015.**Publication Classification**(51) **Int. Cl.****H01L 25/065** (2006.01)**H01L 23/00** (2006.01)

An integrated circuit (IC) device may include a substrate including a first mounting area and a ground ring, a first integrated circuit die attached to the first mounting area, a die attach paddle mounted onto the ground ring and extending above the first integrated circuit die, and a second integrated circuit die mounted on a second mounting area, wherein the die attach paddle defines the second mounting area above the first integrated circuit die. The second integrated circuit die may have a backside oriented toward the substrate and connected to ground.



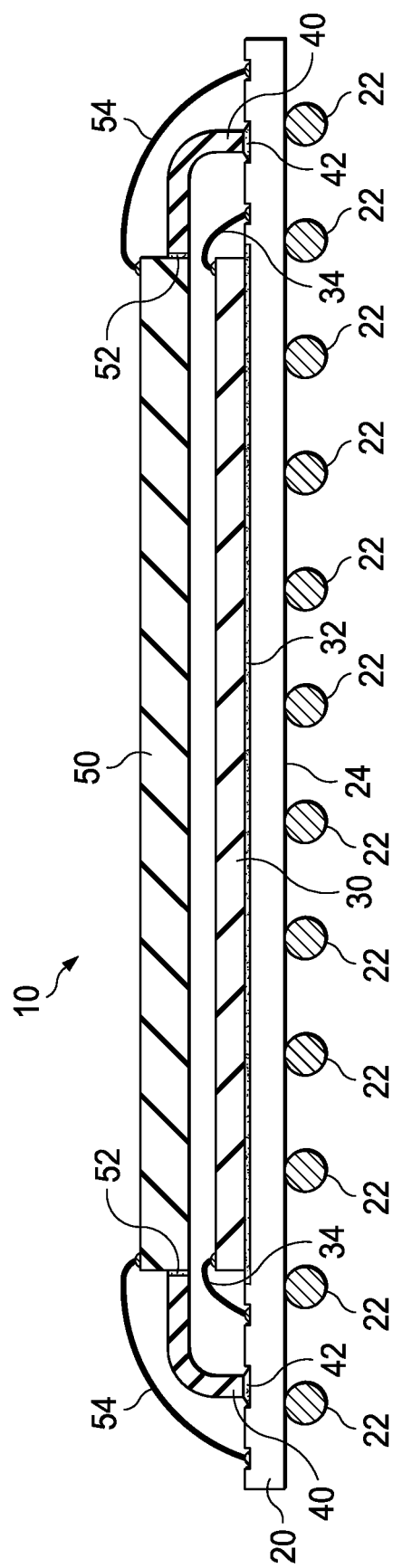


FIG. 1

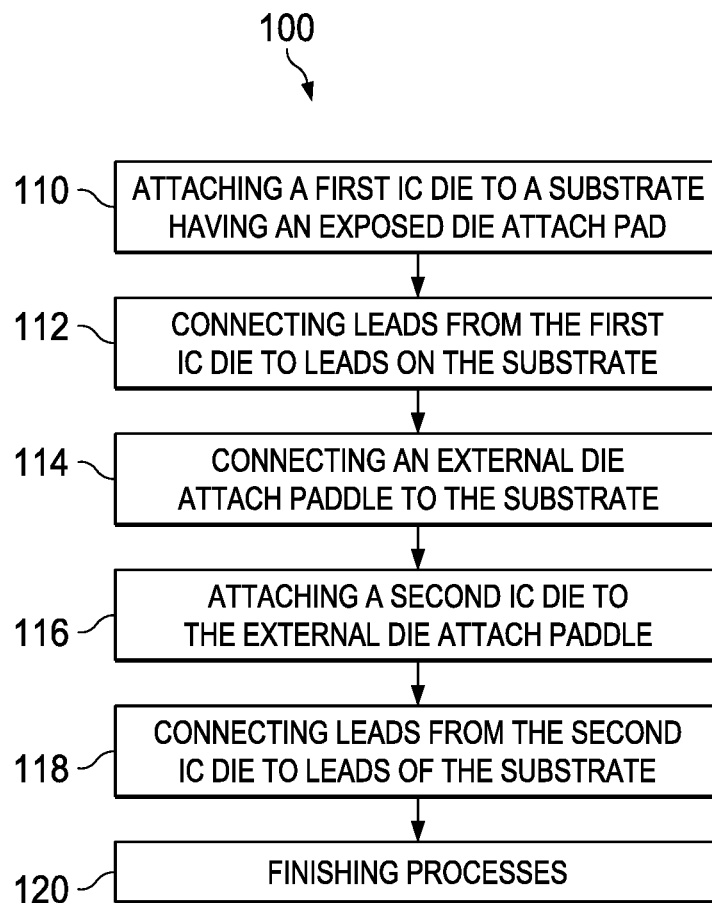


FIG. 2

## BACKSIDE STACKED DIE IN AN INTEGRATED CIRCUIT (IC) PACKAGE

### RELATED PATENT APPLICATION

[0001] This application claims priority to commonly owned U.S. Provisional Patent Application No. 62/195,670, filed Jul. 22, 2015, the entire contents of which are hereby incorporated by reference herein for all purposes.

### TECHNICAL FIELD

[0002] The present disclosure relates to semiconductor manufacturing technology, in particular to a manufacturing method for providing multiple electrically active dies in a single IC package, e.g., by providing a backside stacking of one or more dies in an IC package.

### BACKGROUND

[0003] In semiconductor manufacturing, multiple integrated circuit (IC) dies may be mounted to a common substrate. The footprint of each die may be important as the size requirements for IC devices are shrinking at the same time processing requirements are increasing. Redesigning a IC die/chip to increase performance and maintain or reduce footprint likely requires a new chip design, tooling a new mask, and/or additional costs and requirements.

### SUMMARY

[0004] One embodiment provides an integrated circuit (IC) device comprising: a substrate including a first mounting area and a ground ring, a first integrated circuit die attached to the first mounting area, a die attach paddle mounted onto the ground ring and extending above the first integrated circuit die, and a second integrated circuit die mounted on a second mounting area, wherein the die attach paddle defines the second mounting area above the first integrated circuit die.

[0005] In one embodiment, the second integrated circuit die includes a backside oriented toward the substrate and connected to ground.

[0006] In one embodiment, the IC device further comprises a conductive die attach material joining the die attach paddle to the substrate.

[0007] In one embodiment, the first integrated circuit die and the second integrated circuit die have matching footprints.

[0008] In one embodiment, the first integrated circuit die and the second integrated circuit die comprise identical devices.

[0009] In one embodiment, the first integrated circuit die and the second integrated circuit die comprise 4-channel pulser.

[0010] In one embodiment, the first mounting area comprises an exposed die attach pad.

[0011] In one embodiment, leads of the first and second integrated circuit dies are connected to the substrate using wirebond.

[0012] In one embodiment, the die attach paddle is attached to the ground ring with a copper clip.

[0013] Another embodiment provides a method for manufacturing a stacked integrated circuit device, the method comprising: attaching a first die to a substrate having an exposed die attach pad, connecting an external die attach

paddle to the substrate, the external die attach paddle extending over the first die, and attaching a second die to the external die attach paddle.

[0014] In one embodiment, the method further includes connecting leads of the first die to leads of the substrate by wire bonding.

[0015] In one embodiment, the method further includes connecting leads of the second die to leads of the substrate by wire bonding.

[0016] In one embodiment, the method further includes attaching the first and second dies using conductive die attach material.

[0017] In one embodiment, the external die attach paddle provides a backside connection to ground for the second die.

[0018] In one embodiment, connecting an external die attach paddle to the substrate includes using conductive die attach material.

[0019] In one embodiment, the first and second dies comprise matching integrated circuit devices.

[0020] In one embodiment, the first and second dies comprise 4-channel pulsers.

[0021] In one embodiment, the first and second dies have matching footprints.

[0022] Another embodiment provides an 8-channel pulser comprising: a substrate including a first mounting area and a ground ring, a first 4-channel pulser attached to the first mounting area, and a die attach paddle mounted onto the ground ring and extending above the first 4-channel pulser, and a second 4-channel pulser mounted on a second mounting area, wherein the die attach paddle defines the second mounting area above the first 4-channel pulser.

[0023] In one embodiment, the 8-channel pulser further includes a backside of the second 4-channel pulser connected to ground through the die attach paddle.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0024] FIG. 1 is a drawing illustrating a side view of an example integrated circuit device according to teachings of the present disclosure; and

[0025] FIG. 2 is a flowchart illustrating an example method according to teachings of the present disclosure.

### DETAILED DESCRIPTION

[0026] Although stacking IC dies may provide a reduced total footprint, known methods for stacking do not provide a ground connection for the backside of the upper or top die. In some embodiments of the present teaching, a copper clip may be mounted on top of a first die (the bottom die) and then used as a die attach paddle for the top die.

[0027] FIG. 1 is a drawing illustrating a side view of an example integrated circuit device 10 according to teachings of the present disclosure. Integrated circuit device 10 may include a substrate 20, a first IC die 30, an external die attach paddle 40, and a second IC die 50. In this embodiment, the backside of both first IC die 30 (on the bottom) and second IC die 50 (on the top) are ground connected.

[0028] As shown, substrate 20 may include solder balls 22 and an exposed die attach pad 24. Substrate 20 may comprise any appropriate material (e.g., silicon or other semiconductor). In some embodiments, substrate 20 may include features arranged to mate with a socket or other mounting apparatus deployed on a printed circuit board (PCB). Exposed die attach pad 24 may have any features appropri-

ate for mounting an IC die thereon, including exposed leads, a thermal/heat sink pad, etc. In some embodiments, substrate **20** may include alternative features for attaching an IC die. The substrate design may include exposed die attach pad **24** with a soldermask mesh design.

**[0029]** First IC die **30** may be attached to the substrate **20** (e.g., attached to the exposed die attach pad **24**). IC die **30** may comprise a set of electronic circuits on a plate of semiconductor material (e.g., silicon). IC die **30** may be any size, shape, or useful configuration. In some embodiments, such as that shown in FIG. 1, first IC die **30** may be attached to the substrate with die attach material **32**. Die attach material **32** may be a conductive material (e.g., a paste or a film) providing both electrical and mechanical connection between first IC die **30** and exposed die attach pad **24** or the other features of substrate **20**. In some embodiments, various leads of first IC die **30** may be connected to leads on substrate **20** and/or die attach pad **24** by wire bonding. As shown in FIG. 1, bond wires **34** provide electrical connection between first IC die **30** and leads on substrate **20**. In some embodiments, IC die **30** may comprise a 4-channel pulser.

**[0030]** External die attach paddle **40** may comprise any apparatus or device appropriate for attachment to the substrate **20** and providing a mount for the second IC die **50**. In some embodiments, external die attach paddle **40** comprises a copper clip. In these embodiments, the copper clip is connected to various feature of substrate **20** and attached using die attach material **42** (e.g., conductive paste or film), then the second IC die **50** is placed on the copper clip and attached using die attach material **52** (e.g., conductive paste/film). Substrate **20** may include a ground ring to serve as pad for a copper clip to establish the multi-layer die attach pad.

**[0031]** As shown in FIG. 1, the external die attach paddle **40** provides a second die attach pad allowing a stacked die package. The external die attach paddle **40** provide this additional layer of die attach pad allowing the top die (second IC die **50**) to be grounded at its backside. Die attach material **42** attaches the external die attach paddle **40** to the substrate. In some embodiments, a conductive die attach material **42** provides a ground connection to both the top and bottom die.

**[0032]** Second IC die **50** may be attached to the external die attach paddle **40** (e.g., attached to an exposed die attach pad disposed thereon). IC die **50** may comprise a set of electronic circuits on a plate of semiconductor material (e.g., silicon). IC die **50** may be any size, shape, or useful configuration. In some embodiments, such as that shown in FIG. 1, second IC die **50** may be attached to the external die paddle **40** with die attach material **52**. Die attach material **52** may be a conductive material (e.g., a paste or a film) providing both electrical and mechanical connection between second IC die **50** and external die attach paddle **40** or the features thereon. In some embodiments, various leads of second IC die **50** may be connected to leads on substrate **20** and/or die attach pad **24** by wire bonding. As shown in FIG. 1, bond wires **54** provide electrical connection between second IC die **50** and leads on substrate **20**. In some embodiments, IC die **50** may comprise a 4-channel pulser.

**[0033]** In some embodiments, the two IC dies **30**, **50** may have similar or identical function and form. Integrated circuit device **10** may provide, for example, two stacked IC dies **30**, **50** each comprising a four-channel feature of any type of functionality (e.g., driver, pulser, etc.). The stacked

formation incorporating teachings of the present disclosure may provide a IC device **10** with the same footprint as the four-channel device, but with 8-channel function. Instead of designing a completely new integrated circuit or doubling the required footprint, these teachings may be used to integrate two existing integrated circuit dies in a single package and wire them internally to provide for their respective functionality in a single device.

**[0034]** For example, a certain integrated circuit device may be currently offered in a 64L QFN 9x9 mm package. There may be a demand for the same functionality with twice the number of devices or channels. Rather than employing a new design for the desired device, for example an eight-channel pulser, a double stack of the original IC device may offer two four-channel pulser dies in one package, delivering an eight-channel pulser in a smaller package and without a new IC design.

**[0035]** In a stacked configuration according to the teachings of the present disclosure, the footprint of the device is not enlarged. In addition, the ground connection provided by the external die attach paddle **40** may be required for certain standards and/or applications (e.g., SOI wafers). A side-by-side solution may satisfy the grounding requirement, but the package size will be at least 60% larger compared to the stacked die solution described herein. Thus, in some embodiments, the multi-layer external die attach paddle **40** allows for an arrangement of multiple dies above each other while still providing ground connection for each die in order to achieve the reduced package size without redesigning the die and/or tooling a new mask set.

**[0036]** These teachings can be employed with additional types of IC housings incorporating a support structure allowing for placement of an external die attach paddle as shown in FIG. 1. For example, a leadframe design may provide an area onto which such a paddle can be attached. The stack may be extended to more than two semiconductor dies. In embodiments including a U-shaped die attach paddle, two U-shaped die attach paddles **40** may be arranged above each other in a 90 degree configuration.

**[0037]** As previously noted, the first **30** and second **50** integrated circuit dies can be identical. However, other embodiments may integrate two different integrated circuit dies within a single package. The two integrated circuit devices may have different sizes, wherein preferably the smaller die is arranged on top of the larger die.

**[0038]** FIG. 2 is a flowchart illustrating an example method **100** for manufacturing a stacked integrated circuit device according to teachings of the present disclosure. Method **100** may comprise any of the following steps, performed in any suitable order.

**[0039]** Step **110** may include attaching a first IC die **30** to a substrate **20** having an exposed die attach pad **24**. The first IC die **30** may be attached using die attach material **32**, e.g., a conductive film and/or paste, as described above.

**[0040]** Step **112** may include connecting leads from the first IC die **30** to leads on the substrate. In some embodiments, this may include wire bonding.

**[0041]** Step **114** may include connecting an external die attach paddle **40** to the substrate **20**. The external die attach paddle **40** may extend over the first die. The external die attach paddle **40** may be attached using die attach material **42**, e.g., a conductive film and/or paste, as described above.

**[0042]** Step **116** may include attaching a second IC die **50** to the external die attach paddle **40**. The second IC die **50**

may be attached using die attach material **52**, e.g., a conductive paste and/or film. In embodiments including this step, the connection of second IC die **50** to the external die attach paddle **40** may provide a backside connection to ground (on the substrate) for the second IC die **50**.

**[0043]** Step **118** may include connecting leads from the second IC die **50** to leads of the substrate **20**. In some embodiments, this step may include wire bonding.

**[0044]** Method **100** may include any finishing processes known in the manufacture of semiconductors and/or IC devices. For example, standard end of line assembly processes such as mold, marking, and singulation may follow Step **118**.

**[0045]** As described in relation to FIG. **1**, the first **30** and second die **50** may comprise matching integrated circuit devices. According to the teachings of the present disclosure, matching IC devices may have similar footprints and/or function, etc. For example, in some embodiments, the first and second die are both 4-channel pulsers, providing the function of an 8-channel pulser in the same footprint that previously held a single 4-channel pulser, with the burden of redesigning the IC circuit or retooling the manufacturing process.

1. An integrated circuit device comprising:
  - a substrate including a first mounting area and a ground ring;
  - a first integrated circuit die attached to the first mounting area;
  - a die attach paddle mounted onto the ground ring and extending above the first integrated circuit die; and
  - a second integrated circuit die mounted on a second mounting area;
  - wherein the die attach paddle defines the second mounting area above the first integrated circuit die.
2. An integrated circuit device according to claim **1**, wherein the second integrated circuit die includes a backside oriented toward the substrate and connected to ground.
3. An integrated circuit device according to claim **1**, further comprising a conductive die attach material joining the die attach paddle to the substrate.
4. An integrated circuit device according to claim **1**, wherein the first integrated circuit die and the second integrated circuit die have matching footprints.
5. An integrated circuit device according to claim **1**, wherein the first integrated circuit die and the second integrated circuit die comprise identical devices.
6. An integrated circuit device according to claim **1**, wherein the first integrated circuit die and the second integrated circuit die comprise 4-channel pulsers.
7. An integrated circuit device according to claim **1**, wherein the first mounting area comprises an exposed die attach pad.

8. An integrated circuit device according to claim **1**, wherein leads of the first and second integrated circuit dies are connected to the substrate using wirebond.

9. An integrated circuit device according to claim **1**, wherein the die attach paddle is attached to the ground ring with a copper clip.

10. A method for manufacturing a stacked integrated circuit device, the method comprising:

- attaching a first die to a substrate having an exposed die attach pad;
- connecting an external die attach paddle to the substrate, the external die attach paddle extending over the first die;
- attaching a second die to the external die attach paddle.

11. A method according to claim **10**, further comprising connecting leads of the first die to leads of the substrate by wire bonding.

12. A method according to claim **10**, further comprising connecting leads of the second die to leads of the substrate by wire bonding.

13. A method according to claim **10**, further comprising attaching the first and second dies using conductive die attach material.

14. A method according to claim **10**, wherein the external die attach paddle provides a backside connection to ground for the second die.

15. A method according to claim **10**, wherein connecting an external die attach paddle to the substrate includes using conductive die attach material.

16. A method according to claim **10**, wherein the first and second die comprise matching integrated circuit devices.

17. A method according to claim **10**, wherein the first and second dies comprise 4-channel pulsers.

18. A method according to claim **10**, wherein the first and second dies have matching footprints.

19. An 8-channel pulser, comprising:

- a substrate including a first mounting area and a ground ring;
- a first 4-channel pulser attached to the first mounting area; and
- a die attach paddle mounted onto the ground ring and extending above the first 4-channel pulser; and
- a second 4-channel pulser mounted on a second mounting area;
- wherein the die attach paddle defines the second mounting area above the first 4-channel pulser.

20. An 8-channel pulser according to claim **19**, further comprising a backside of the second 4-channel pulser connected to ground through the die attach paddle.

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