

US Patent & Trademark Office

Patent Public Search | Text View

United States Patent	12389537
Kind Code	B2
Date of Patent	August 12, 2025
Inventor(s)	Li; Chin-Tang et al.

Electronic device

Abstract

An electronic device includes a first substrate, a second substrate, plural conductive pads, plural hole structures, plural connection pads and plural conductive structures. Hole structures penetrate through the first and second substrates, and are arranged corresponding to the conductive pads. Second ends of hole structures are located at the second substrate, and the corresponding conductive pad is exposed by one of the second ends. Connection pads enclose first ends of hole structures. Conductive structures are arranged in the hole structures and electrically connected to corresponding conductive pads and connection pads. The second diameter portion of each conductive structure penetrates through first substrate and conductive pad and is electrically connected to corresponding connection pad and conductive pad, and first diameter portion thereof penetrates through second substrate and is electrically connected to corresponding conductive pad. Each conductive pad defines an opening, which is exposed by second end of corresponding hole structure.

Inventors:	Li; Chin-Tang (New Taipei, TW), Chen; Chao-Jung (New Taipei, TW)
Applicant:	PanelSemi Corporation (New Taipei, TW)
Family ID:	1000008749124
Assignee:	PANELSEMI CORPORATION (New Taipei, TW)
Appl. No.:	18/463728
Filed:	September 08, 2023

Prior Publication Data

Document Identifier	Publication Date
US 20240098896 A1	Mar. 21, 2024

Foreign Application Priority Data

TW	111134192	Sep. 08, 2022
TW	112115051	Apr. 21, 2023

Publication Classification

Int. Cl.: H05K1/11 (20060101); H05K1/18 (20060101)

U.S. Cl.:

CPC H05K1/113 (20130101); H05K1/181 (20130101); H05K2201/09227 (20130101); H05K2201/0939 (20130101); H05K2201/09481 (20130101); H05K2201/096 (20130101); H05K2201/09854 (20130101)

Field of Classification Search

CPC: H05K (1/113); H05K (2201/09481); H05K (2201/096); H05K (2201/0367); H05K (2201/09563)

References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
6187652	12/2000	Chou	438/455	H05K 3/4623

Primary Examiner: Ng; Sherman

Attorney, Agent or Firm: MUNCY, GEISSLER, OLDS & LOWE, P.C.

Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS

(1) This Non-provisional application claims priority under 35 U.S.C. § 119(a) on Patent Application No(s). 111134192 filed in Taiwan, Republic of China on Sep. 8, 2022, and 112115051 filed in Taiwan, Republic of China on Apr. 21, 2023, the entire contents of which are hereby incorporated by reference.

BACKGROUND

Technology Field

(2) The present disclosure relates to an electronic device and, in particular, to an electronic device that can achieve signal transmission by hole structures.

Description of Related Art

(3) In the manufacturing process of electronic devices, especially the optoelectronic devices, in order to electrically connect the circuits on the upper and lower surfaces of the electronic device, the conventional solution is to drill holes through the substrate first, and then form a conductive film in the holes by an electroplating process. The plated conductive film in the holes can be electrically connected to the circuits on the upper and lower surfaces. Another solution is to use

side jumpers aside from the electronic device to electrically connect the circuits on the upper and lower surfaces from the side of the electronic device, so as to achieve the purpose of signal transmission.

SUMMARY

- (4) One or more exemplary embodiments of this disclosure are to provide an electronic device that is manufactured by a novel approach for achieving signal transmission.
- (5) An electronic device of one exemplary embodiment includes a first substrate, a second substrate, a plurality of conductive pads, a plurality of hole structures, a plurality of connection pads, and a plurality of conductive structures. The first substrate and the second substrate are stacked on one another. The plurality of conductive pads are arranged between the first substrate and the second substrate. The plurality of hole structures penetrate through the first substrate and the second substrate respectively and are arranged corresponding to the conductive pads. Each hole structure defines a first end and a second end opposite to each other. The second ends of the hole structures are located at a surface of the second substrate and away from the first substrate, and the corresponding conductive pad is exposed by the second end of one of the hole structures. The first ends of the hole structures are located at another surface of the first substrate and away from the second substrate. The plurality of connection pads enclose the first ends of the hole structures located at the first substrate. The plurality of conductive structures are arranged in the hole structures and electrically connected to the corresponding conductive pads and the corresponding connection pads. Each conductive structure defines a first diameter portion and a second diameter portion. The second diameter portion penetrates through the first substrate and the conductive pad and is electrically connected to the corresponding connection pad and the corresponding conductive pad, and the first diameter portion penetrates through the second substrate and is electrically connected to the corresponding conductive pad. Each of the conductive pads defines an opening, and the opening is exposed by the second end of the corresponding hole structure located at the second substrate.
- (6) In one exemplary embodiment, each of the conductive pads defines an opening, and a width of the opening is less than that of the second end of the corresponding hole structure arranged at the surface of the second substrate.
- (7) In one exemplary embodiment, the electronic device further includes a bonding layer arranged between the first substrate and the second substrate.
- (8) In one exemplary embodiment, the first substrate defines a first surface and a second surface opposite to each other, the second substrate defines a third surface and a fourth surface opposite to each other, and the second surface of the first substrate is located between the first surface of the first substrate and the third surface of the second substrate.
- (9) In one exemplary embodiment, each of the hole structures includes a through hole and a via hole, the through hole penetrates through the corresponding first substrate and the corresponding conductive pad, and the via hole penetrates the corresponding second substrate; one end of each of the through holes is enclosed by the corresponding connection pad, the second diameter portion of each of the conductive structures is disposed in the corresponding through hole, and the first diameter portion of each of the conductive structures is disposed in the corresponding via hole.
- (10) In one exemplary embodiment, in each of the conductive structures, the first diameter portion defines a column segment and a cap segment in which the column segment is set between the second diameter portion and the cap segment, the column segment is disposed in the via hole, and a projection area of the cap segment in a direction perpendicular to the fourth surface overlaps at least part of the corresponding via hole.
- (11) In one exemplary embodiment, the first surface of the first substrate is configured with a first trace layer, and the first trace layer is electrically connected to the connection pads.
- (12) In one exemplary embodiment, the first trace layer defines a thickness, and the thickness is not greater than ¼ mil.

- (13) In one exemplary embodiment, the third surface of the second substrate is configured with a second trace layer, and the second trace layer is electrically connected to the conductive pads.
- (14) In one exemplary embodiment, the fourth surface of the second substrate is configured with a third trace layer, and the third trace layer is electrically connected to the first diameter portions of the conductive structures.
- (15) In one exemplary embodiment, the electronic device comprises a plurality of first substrates, and the first substrates are laid along the third surface of the second substrate.
- (16) In one exemplary embodiment, the electronic device comprises a plurality of first substrates and a plurality of second substrates, and the first substrates are laid along the third surfaces of the second substrates.
- (17) In one exemplary embodiment, the electronic device further includes a plurality of electronic components arranged at the first surface of the first substrate, and each of the electronic components is electrically connected to one of the connection pads.
- (18) In one exemplary embodiment, a diameter of one of the first diameter portions is greater than a diameter of the corresponding second diameter portion.
- (19) In one exemplary embodiment, a maximum diameter of one of the first diameter portions is greater than a maximum diameter of the corresponding second diameter portion.
- (20) In one exemplary embodiment, one of the first diameter portions and the corresponding second diameter portion are in a coaxial arrangement or in a stagger arrangement.
- (21) An electronic device of one exemplary embodiment includes a first substrate, a second substrate, a plurality of conductive pads, a plurality of hole structures, a plurality of connection pads, and a plurality of conductive structures. The first substrate and the second substrate are stacked on one another. The plurality of conductive pads are arranged between the first substrate and the second substrate. The plurality of hole structures penetrate through the first substrate and the second substrate respectively and are arranged corresponding to the conductive pads. Each of the hole structures defines a first end and a second end opposite to each other. The second ends of the hole structures are located at a surface of the second substrate and away from the first substrate, and the corresponding conductive pad is exposed by the second end of one of the hole structures. The first ends of the hole structures are located at another surface of the first substrate and away from the second substrate. The plurality of connection pads enclose the first ends of the hole structures located at the surface of the first substrate. The plurality of conductive structures are arranged in the hole structures and electrically connected to the corresponding conductive pads and the corresponding connection pads. Each of the conductive structures defines a first diameter portion and a second diameter portion. The second diameter portion penetrates through the first substrate and the conductive pad and is electrically connected to the corresponding connection pad and the corresponding conductive pad. The first diameter portion penetrates through the second substrate and is electrically connected to the corresponding conductive pad. The diameter of one of the first diameter portions is greater than the diameter of the corresponding second diameter portion. Each of the conductive pads defines an opening, and the opening is exposed by the second end of the corresponding hole structure located at the surface of the second substrate.
- (22) In one exemplary embodiment, a maximum diameter of one of the first diameter portions is greater than a maximum diameter of the corresponding second diameter portion.
- (23) In one exemplary embodiment, one of the first diameter portions and the corresponding second diameter portion are in a coaxial arrangement.
- (24) In one exemplary embodiment, a width of the opening is less than that of the second end of the corresponding hole structure arranged at the surface of the second substrate.
- (25) In one exemplary embodiment, one or more additional substrates are applied between the first and second substrates, and the hole structures penetrate through the additional substrate(s).
- (26) In one exemplary embodiment, ones of the additional substrates are laid and tiled along either one of the inner surfaces of the first and second substrates.

(27) In one exemplary embodiment, ones of the additional substrates are stacked in the direction perpendicular to either one of the outer surfaces of the first and second substrates.

(28) In one exemplary embodiment, ones of the additional substrates are provided with a trace layer on either or both opposite surfaces thereof.

(29) As mentioned above, in the electronic device of this disclosure, a plurality of conductive pads are arranged between the first substrate and the second substrate, a plurality of hole structures penetrate through the first substrate and the second substrate respectively and are arranged corresponding to the conductive pads, wherein each hole structure defines a first end and a second end. The second ends of the hole structures arranged at a surface of the second substrate are away from the first substrate, and the corresponding conductive pad is exposed by the second end of the corresponding hole structure. The first ends of the hole structures arranged at a surface of the first substrate are away from the second substrate, and a plurality of connection pads enclose the first ends of the hole structures arranged at the surface of the first substrate. The conductive structures are disposed in the hole structures and electrically connected to the corresponding conductive pads and the corresponding connection pads. The second diameter portion of each conductive structure penetrates through the first substrate and the conductive pad, and is electrically connected to the corresponding connection pad and the corresponding conductive pad, and the first diameter portion of each conductive structure penetrates through the second substrate and is electrically connected to the corresponding conductive pad. The opening of each conductive pad is exposed by the second end of the corresponding hole structure located at the surface of the second substrate. According to the configuration and design of this disclosure, the electrical signals can be transmitted between the trace layers arranged at the upper and lower surfaces of the electronic device by the conductive structure arranged in the hole structures of the electronic device, and the electrical signal can be transmitted between the trace layers by the conductive structures arranged in the hole structures and the internal conductive pads. Therefore, the electronic device of the present disclosure utilizes the hole structures to electrically connect an outermost trace layer through the connection pad(s) with the internal conductive pads, so as to achieve the signal transmission.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

- (1) The disclosure will become more fully understood from the detailed description and accompanying drawings, which are given for illustration only, and thus are not limitative of the present disclosure, and wherein:
- (2) FIG. 1 is a schematic diagram showing a part of the electronic device according to an embodiment of this disclosure; and
- (3) FIGS. 2 to 4 are schematic diagrams showing a part of the electronic device according to different embodiments of this disclosure.

DETAILED DESCRIPTION OF THE DISCLOSURE

- (4) The present disclosure will be apparent from the following detailed description, which proceeds with reference to the accompanying drawings, wherein the same references relate to the same elements. The drawings of the following embodiments only illustrate the relative relationship between elements or units, and do not represent the actual size or proportion of the elements or units.
- (5) FIG. 1 is a schematic diagram showing a part of the electronic device **1** according to an embodiment of this disclosure.
- (6) Referring to FIG. 1, the electronic device **1** includes a first substrate **11**, a second substrate **12**, a plurality of conductive pads **13**, a plurality of hole structures **14**, a plurality of connection pads **15**, and a plurality of conductive structures **16**. In this case, FIG. 1 only shows one conductive pad **13**,

one hole structure **14**, one connection pad **14**, and one conductive structure **16** for an illustration. In addition, the electronic device **1** of this embodiment can further include a bonding layer **17**.

(7) The first substrate **11** and the second substrate **12** are stacked on one another. The first substrate **11** defines a first surface **S1** and a second surface **S2** opposite to the first surface **S1**, and the second substrate **12** defines a third surface **S3** and a fourth surface **S4** opposite to the third surface **S3**. In this embodiment, the second surface **S2** (the lower surface) of the first substrate **11** is located between the first surface **S1** (the upper surface) of the first substrate **11** and the third surface **S3** (the upper surface) of the second substrate **12**. The second surface **S2** and the third surface **S3** are located inside the electronic device **1**, and the first surface **S1** and the fourth surface **S4** are the outer surfaces of the electronic device **1** (i.e., the outermost surfaces of the electronic device **1**). The first substrate **11** and the second substrate **12** can be resilient boards, rigid boards or composite boards, and the materials thereof can include, for example, glass, glass fiber epoxy resin (e.g. FR4), low temperature co-fired ceramics (LTCC), polyimide (PI), polytetrafluoroethylene (PTFE), polyphenylene oxide (PPO) or polyphenylene ether (PPE), or a substrate composed of composite materials including at least one of the aforementioned materials. In this embodiment, the first substrate **11** is a resilient board, such as a PI substrate, and the second substrate **12** is a rigid board, such as a single-layer glass substrate.

(8) The bonding layer **17** is arranged between the second surface **S2** of the first substrate **11** and the third surface **S3** of the second substrate **12**, so that the first substrate **11** and the second substrate **12** are connected to each other by the bonding layer **17**. The bonding layer **17** can be laid continuously (e.g. laid continuously along a plane) or discontinuously (e.g. laid intermittently along a plane, or laid along the areas without interfering the functions of other components). The bonding layer **17** can be an insulating adhesive, and the material thereof can be, for example but not limited to, optical clear adhesive (OCA), optical clear resin (OCR), polyimide (PI), or the likes. It should be noted that the electronic device **1** of this embodiment includes one first substrate **11**, but the electronic device of another embodiment can include two or more first substrates **11**. In different embodiments, the two or more first substrates **11** can be laid and tiled along the third surface **S3** of the second substrate **12** (i.e., the first substrates **11** are laid and tiled along the plane of the third surface **S3** of the second substrate **12**), and the first substrates **11** are connected to the second substrate **12** by the bonding layer **17**. In different embodiments, the electronic device can include two or more second substrates **12**, so that the two or more first substrates **11** are laid alone a virtual surface tiled by the third surfaces **S3** of two or more second substrates **12**. In addition, the second substrate(s) **12** and the first substrate(s) **11** can be partially overlapped in the direction perpendicular to any of the surfaces **S1** to **S4**. That is, the second substrate(s) **12** and the first substrate(s) **11** are arranged in a stagger manner in the direction perpendicular to any of the surfaces **S1** to **S4**. The rest of the arrangement details will not be further described here.

(9) A plurality of conductive pads **13** are arranged between the first substrate **11** and the second substrate **12**. In this case, the conductive pads **13** are separately arranged at the third surface **S3** of the second substrate **12**. The conductive pad **13** can be a continuous ring or a C-shaped ring with an opening **O** defined in the middle thereof. In some embodiments, the material of the conductive pads **13** can be, for example, silver, copper, tin, or any of other conductive materials.

(10) The hole structures **14** respectively penetrate through the first substrate **11** and the second substrate **12**, and are arranged corresponding to the conductive pads **13**. In this embodiment, the hole structures **14** are arranged corresponding to the conductive pads **13** in a one-on-one manner. Each hole structure **14** defines a first end **E1** and a second end **E2** opposite to each other. The second ends **E2** of the hole structures **14** arranged at a surface of the second substrate **12** are away from the first substrate **11**, and the corresponding conductive pad **13** is exposed by the second end **E2** of one of the hole structures **14**. The first ends **E1** of the hole structures **14** arranged at another surface of the first substrate **11** are away from the second substrate **12**. A plurality of connection pads **15** are arranged at the first surface **S1** of the first substrate **11**, and each connection pad **15**

encloses the first end E1 of the corresponding hole structure **14**. The second end E2 of each hole structure **14** penetrates through the corresponding conductive pad **13**. Specifically, each hole structure **14** of this embodiment includes a through hole h1 and a via hole h2, which communicate with each other. The through hole h1 penetrates through the corresponding first substrate **11** and the corresponding conductive pad **13**, and the via hole h2 penetrates through the corresponding second substrate **12**. In this case, the through hole h1 of each hole structure **14** (or each conductive structure **16**) further penetrates through the bonding layer **17**. In addition, one end (the first end E1) of each through hole h1 is enclosed by a corresponding connection pad **15**, and the corresponding conductive pad **13** is exposed by the second end E2 of the corresponding hole structure **14**. In this embodiment, “exposing” the corresponding conductive pad **13** means that, before the conductive structure **16** is filled into the hole structure **14**, the conductive pad **13** is not completely covered by the second substrate **12**, and the conductive pad **13** can be exposed. In some embodiments, the material of the connection pad **15** can include gold, copper, aluminum, or any combination thereof, or an alloy of any combination thereof, or any of other conductive metal materials. This disclosure is not limited thereto. In different embodiments, one or more than one of the connection pads **15** (not all of the connection pads **15**) can be configured to enclose the first ends E1 of the hole structures **14** arranged at a surface of the first substrate **11**, and this disclosure is not limited thereto.

(11) Each conductive structure **16** is correspondingly arranged in one of the hole structures **14** (in a one-on-one manner), and each conductive structure **16** is electrically connected to the corresponding conductive pad **13** and the corresponding connection pad **15**. Specifically, each hole structure **14** can be filled (can be fully filled or partially filled) with a conductive structure **16**, so that the conductive structure **16** is in contact with and electrically connected to the connection pad **15** located at the first end E1 of the hole structure **14**. The conductive structure **16** is also in contact with and electrically connected to the corresponding conductive pad **13**. In this embodiment, each conductive structure **16** defines a first diameter portion **161** and a second diameter portion **162**, and the width of the first diameter portion **161** is greater than that of the second diameter portion **162**. The second diameter portion **162** is correspondingly arranged in the through hole h1, penetrates through the first substrate **11** and the conductive pad **13**, and is electrically connected to the corresponding connection pad **15** and the corresponding conductive pad **13**. The first diameter portion **161** is correspondingly arranged in the via hole h2, penetrates through the second substrate **12**, and is electrically connected to the corresponding conductive pad **13**. In this embodiment, the second diameter portion **162** also penetrates through the bonding layer **17**, and the first diameter portion **161** covers a part of the fourth surface S4. In some embodiments, each of the conductive structures **16** is made of a single material. In practice, for example, the silver adhesive, copper adhesive, solder, or any of other conductive materials can be placed in the through hole h1 and the via hole h2 simultaneously or separately to form the conductive structure **16** having the first diameter portion **161** and the second diameter portion **162**, which can cover a part of the fourth surface S4. In some embodiments, the conductive materials filled in the through hole h1 and the via hole h2 may be different conductive materials. It should be noted that the diameter of the first diameter portion **161** can be greater than the diameter of the corresponding second diameter portion **162**. For example, the maximum diameter of the first diameter portion **161** is greater than the maximum diameter of the corresponding second diameter portion **162**, wherein the first diameter portion **161** and the corresponding second diameter portion **162** can be arranged coaxially. In different aspects, the diameter of the first diameter portion **161** can be not greater than the diameter of the corresponding second diameter portion **162**, wherein the first diameter portion **161** and the corresponding second diameter portion **162** can be arranged in an off-axis manner.

(12) In addition, in each conductive structure **16** of this embodiment, the first diameter portion **161** defines a column segment **16x** and a cap segment **16y**, and the width of the cap segment **16y** is greater than that of the column segment **16x**. In this case, the column segment **16x** is set between the second diameter portion **162** and the cap segment **16y** and disposed in the via hole h2 (fully

filling the via hole h2), and the projection area of the cap segment in the direction perpendicular to the fourth surface S4 overlaps at least part of the corresponding via hole h2 and a part of the fourth surface S4. In addition, the width of the opening O of each conductive pad 13 in this embodiment is less than that of the second end E2 of the corresponding hole structure 14; in another words, each opening O is narrower than the second end E2 in each hole structure 14. Therefore, when the conductive structure 16 is arranged in the hole structure 14, the first diameter portion 161 of each conductive structure 16 covers not only a part of the fourth surface S4 but also the conductive pad 13. It should be noted that the aforementioned “width” is defined as the width parallel to the third surface S3 or the fourth surface S4 of the second substrate 12.

(13) Therefore, electrical signals can be transmitted between the connection pads 15 and the fourth surface S4 of the second substrate 12 by the conductive structure 16 in the hole structure 14. In other words, electrical signals can be transmitted from the connection pads 15 on the first surface S1 of the first substrate 11 (i.e., the outermost layer of the electronic device 1) to the fourth surface S4 of the second substrate 12 by the conductive structure 16; and vice versa.

(14) As mentioned above, in the electronic device 1 of this embodiment, a plurality of conductive pads 13 are arranged between the first substrate 11 and the second substrate 12; a plurality of hole structures 14 respectively penetrate through the first substrate 11 and the second substrate 12, and are arranged corresponding to the conductive pads 13, and the corresponding conductive pad 13 is exposed by the second end E2 of the corresponding hole structure 14; a plurality of connection pads 15 enclose the first ends E1 of the hole structures 14; and each conductive structure 16 is arranged in the corresponding hole structure 14, and is electrically connected to the corresponding conductive pad 13 and the corresponding connection pad 15. Herein, the second diameter portion 162 of each conductive structure 16 penetrates through the first substrate 11 and the conductive pad 13 and is electrically connected to the connection pad 15 and the conductive pad 13. The first diameter portion 161 penetrates through the second substrate 12 and is electrically connected to the conductive pad 13, and the width of the opening O of each conductive pad 13 is less than the width of the second end E2 of the corresponding hole structure 14. According to this structural design, the electrical signals can be transmitted between the connection pads 15, the conductive pads 13 and the fourth surface S4 of the second substrate 12 by the conductive structures 16 arranged in the hole structures 14. Therefore, the electronic device 1 of this embodiment utilizes the hole structures 14 (semi-blind hole) to electrically connect the traces of the outermost layers (i.e., the first surface S1 and the fourth surface S4) and the internal conductive pads 13, so as to achieve the purpose of signal transmission.

(15) In addition, FIGS. 2 to 4 are schematic diagrams showing a part of the electronic device according to different embodiments of this disclosure.

(16) As shown in FIG. 2, the electronic device 1a of this embodiment is mostly the same as that of the previous embodiment. Unlike the electronic device 1, the electronic device 1a of this embodiment further includes a first trace layer 111, a second trace layer 121, and a third trace layer 122. The first trace layer 111 is arranged at the first surface S1 of the first substrate 11 and is electrically connected to the connection pads 15. The second trace layer 121 is arranged at the third surface S3 of the second substrate 12 and is electrically connected to the conductive pads 13. The third trace layer 122 is arranged at the fourth surface S4 of the second substrate 12 and is electrically connected to the first diameter portions 161 of the conductive structures 16. According to this configuration, electrical signals can be transmitted between the first trace layer 111, the second trace layer 121 and the third trace layer 122 by the connection pads 15, the conductive structures 16, and the conductive pads 13.

(17) The first trace layer 111, the second trace layer 121 or the third trace layer 122 may include a conductive layer or/and conductive wires for transmitting electrical signals, and the material thereof may include metals such as gold, copper or aluminum, or any combination thereof, or the alloy of any combination thereof, or any of other conductive materials. In some embodiments, the

first trace layer **111**, the second trace layer **121** or the third trace layer **122** can be formed by a thin film process, so the thickness thereof can be relatively thinner. For example, the thickness of the first trace layer **111**, the second trace layer **121** or the third trace layer **122** can be not greater than $\frac{1}{4}$ mil. In some embodiments, the first trace layer **111**, the second trace layer **121** and the third trace layer **122** can be selectively configured according to requirements.

(18) Please refer to FIGS. **3** and **4**. Unlike the electronic device of the previous embodiments, the second trace layer **121** of the electronic device of FIG. **3** is electrically connected to one or more conductive pads **13**, and the third trace layer **122** of the electronic device of FIG. **4** is electrically connected to one or more conductive structures **16**. Herein, the second trace layer **121** may not be electrically connected to all of the conductive pads **13**, and the third trace layer **122** may not be electrically connected to all of the conductive structures **16**. In some embodiments, the two electrical connection modes as shown in FIG. **3** and FIG. **4** can be applied at the same time. Accordingly, this disclosure can not only provide different electrical connection modes for different trace layers arranged at the first substrate **11** and the second substrate **12**, but also provide the electrical connection between the second trace layer **121** and the third trace layer **122**, which are both arranged at the second substrate **12** and are partially or entirely communicated with at least one conductive structure **16** of two independent substrates. Based on this configuration, the manufacturing process for conducting the second trace layer **121** and the third trace layer **122** arranged at the second substrate **12** can be integrated in this disclosure, thereby reducing the process steps, decreasing the manufacturing cost, relatively thinning the thickness of the bonding layer **17**, and improving efficiency.

(19) In addition, the electronic device **1a** can further include a plurality of electronic components **18** (only one is shown in FIG. **2**). The electronic components **18** are arranged at the first surface **S1** of the first substrate **11**, and each electronic component **18** is electrically connected to at least one of the connection pads **15**. In some embodiments, the electronic component **18** can be electrically connected to one of the connection pads **15** by the first trace layer **111**, and then electrically connected to the corresponding conductive pad **13**, the corresponding second trace layer **121** or the corresponding third trace layer **122** by the conductive structure **16**. In some embodiments, the electronic component **18** can be a driver, an active component, a passive component, an active circuit or a passive circuit. In some embodiments, one or more than one of the electronic components **18** can be self-luminous components such as, for example but not limited to, light-emitting diodes (LEDs), Mini LEDs or Micro LEDs. In some embodiments, one or more than one of the electronic components **18** can be flip-chip components (i.e., surface mount devices (SMD)). In some embodiments, one or more than one of the electronic components **18** can be thin-film components manufactured by thin-film processes, such as thin-film transistors (TFT). The thin-film processes can include low-temperature polysilicon (LTPS) semiconductor process, high-temperature polysilicon (HTPS) semiconductor process, low-temperature polycrystalline oxide (LTPO) semiconductor process, or indium-gallium-zinc oxide (IGZO) semiconductor process, or the likes. In some embodiments, one or more than one of the electronic components **18** can be radio frequency ICs, driver ICs (e.g. silicon ICs or non-silicon ICs). The RF IC can be, for example, a silicon RFIC, or a non-silicon RFIC (e.g. a GaAs MMIC). The type or kind of the electronic components **18** is not limited in this disclosure.

(20) In this embodiment, the electrical signal sent by the electronic component **18** can be transmitted to the second trace layer **121** arranged at the third surface **S3** or the third trace layer **122** arranged at the fourth surface **S4** by the first trace layer **111**, the connection pad(s) **15**, the conductive structure(s) **16** and the conductive pad(s) **13**. In another case, electrical signals can be transmitted to the electronic component **18** by the second trace layer **121**, the conductive pad(s) **13**, the conductive structure(s) **16**, the connection pad(s) **15** and the first trace layer **111**, or by the third trace layer **122**, the conductive structure(s) **16**, the connection pad(s) **15** and the first trace layer **111**. In addition, either one or all of the trace layers may further comprise some circuits.

(21) In some embodiments, the electronic device includes a first substrate, a second substrate, a plurality of conductive pads, a plurality of hole structures, a plurality of connection pads, and a plurality of conductive structures. The first substrate and the second substrate are stacked on one another. The plurality of conductive pads are arranged between the first substrate and the second substrate. The plurality of hole structures penetrate through the first substrate and the second substrate respectively and are arranged corresponding to the conductive pads. The second ends of the hole structures are located at a surface of the second substrate and away from the first substrate, and the corresponding conductive pad is exposed by the corresponding second end of one of the hole structure. The first ends of the hole structures are located at a surface of the first substrate and away from the second substrate. The plurality of conductive structures are arranged in the hole structures and electrically connected to the corresponding conductive pads and the corresponding connection pads. Each of the conductive structures defines a first diameter portion and a second diameter portion. The second diameter portion penetrates through the first substrate and the conductive pad and is electrically connected to the corresponding connection pad and the corresponding conductive pad. The first diameter portion penetrates through the second substrate and is electrically connected to the corresponding conductive pad. The diameter of one of the first diameter portions is greater than the diameter of the corresponding second diameter portion.

(22) In summary, in the electronic device of this disclosure, a plurality of conductive pads are arranged between the first substrate and the second substrate, a plurality of hole structures penetrate through the first substrate and the second substrate respectively and are arranged corresponding to the conductive pads, wherein each hole structure defines a first end a second end. The second ends of the hole structures arranged at a surface of the second substrate are away from the first substrate, and the corresponding conductive pad is exposed by the second end of the corresponding hole structure. The first ends of the hole structures arranged at a surface of the first substrate are away from the second substrate, and a plurality of connection pads enclose the first ends of the hole structures arranged at the surface of the first substrate. The conductive structures are disposed in the hole structures and electrically connected to the corresponding conductive pads and the corresponding connection pads. The second diameter portion of each conductive structure penetrates through the first substrate and the conductive pad, and is electrically connected to the corresponding connection pad and the corresponding conductive pad, and the first diameter portion of each conductive structure penetrates through the second substrate and is electrically connected to the corresponding conductive pad. The opening of each conductive pad is exposed by the second end of the corresponding hole structure located at the surface of the second substrate. According to the configuration and design of this disclosure, the electrical signals can be transmitted between the trace layers arranged at the upper and lower surfaces of the electronic device by the conductive structure arranged in the hole structures of the electronic device. In addition, the electrical signals can be also transmitted between the trace layers by the conductive structures arranged in the hole structures and the internal conductive pads. Therefore, the electronic device of the present disclosure utilizes the hole structures to electrically connect an outermost trace layer through the connection pad(s) with the internal conductive pads, so as to achieve the signal transmission. According to the present invention, it may further include one or more additional substrates applied between the first and second substrates, and the electrical connection between the trace layers of both substrates is maintained whether or not possible additional substrates are included.

(23) Although the disclosure has been described with reference to specific embodiments, this description is not meant to be construed in a limiting sense. Various modifications of the disclosed embodiments, as well as alternative embodiments, will be apparent to persons skilled in the art. It is, therefore, contemplated that the appended claims will cover all modifications that fall within the true scope of the disclosure.

Claims

1. An electronic device, comprising: a first substrate and a second substrate stacked on one another; a bonding layer arranged between the first substrate and the second substrate, a plurality of conductive pads arranged in the bonding layer and between the first substrate and the second substrate; a plurality of hole structures penetrating through the first substrate, the bonding layer, and the second substrate respectively and arranged corresponding to the conductive pads, wherein each of the hole structures defines a first end and a second end opposite to each other, the second ends of the hole structures are located at the second substrate and away from the first substrate, the corresponding conductive pad is exposed by the second end of the corresponding hole structure, and the first ends of the hole structures are located at the first substrate and away from the second substrate; a plurality of connection pads enclosing the first ends of the hole structures located at the first substrate; and a plurality of conductive structures arranged in the hole structures and electrically connected to the corresponding conductive pads and the corresponding connection pads; wherein, each of the conductive structures defines a first diameter portion and a second diameter portion, the second diameter portion penetrates through the first substrate, the bonding layer, and the conductive pad and is electrically connected to the corresponding connection pad and the corresponding conductive pad, and the first diameter portion penetrates through the second substrate and is electrically connected to the corresponding conductive pad; and wherein, each of the conductive pads defines an opening, and the opening is exposed by the second end of the corresponding hole structure located at the second substrate.
2. The electronic device of claim 1, wherein the first substrate defines a first surface and a second surface opposite to each other, the second substrate defines a third surface and a fourth surface opposite to each other, and the second surface of the first substrate is located between the first surface of the first substrate and the third surface of the second substrate.
3. The electronic device of claim 2, wherein each of the hole structures comprises a through hole and a via hole, the through hole penetrates through the corresponding first substrate, the bonding layer, and the corresponding conductive pad, the via hole penetrates the corresponding second substrate, one end of each of the through holes is enclosed by the corresponding connection pad, the second diameter portion of each of the conductive structures is arranged corresponding to the through hole, and the first diameter portion of each of the conductive structures is arranged corresponding to the via hole.
4. The electronic device of claim 3, wherein, in each of the conductive structures, the first diameter portion defines a column segment and a cap segment, the column segment is disposed in the via hole and set between the second diameter portion and the cap segment, and a projection area of the cap segment in a direction perpendicular to the fourth surface overlaps at least part of the corresponding via hole.
5. The electronic device of claim 2, wherein the first surface of the first substrate is configured with a first trace layer, and the first trace layer is electrically connected to the connection pads.
6. The electronic device of claim 5, wherein the first trace layer defines a thickness, and the thickness is not greater than $\frac{1}{4}$ mil.
7. The electronic device of claim 2, wherein the third surface of the second substrate is configured with a second trace layer, and the second trace layer is electrically connected to the conductive pads.
8. The electronic device of claim 2, wherein the fourth surface of the second substrate is configured with a third trace layer, and the third trace layer is electrically connected to the first diameter portions of the conductive structures.
9. The electronic device of claim 2, wherein the electronic device comprises a plurality of the first substrates, and the first substrates are laid along the third surface of the second substrate.

10. The electronic device of claim 2, further comprising: a plurality of electronic components arranged at the first surface of the first substrate, wherein each of the electronic components is electrically connected to one of the connection pads.
11. The electronic device of claim 1, wherein a diameter of one of the first diameter portions is greater than a diameter of the corresponding second diameter portion.
12. An electronic device, comprising: a first substrate and a second substrate stacked on one another; a bonding layer arranged between the first substrate and the second substrate, a plurality of conductive pads arranged in the bonding layer and between the first substrate and the second substrate; a plurality of hole structures penetrating through the first substrate, the bonding layer, and the second substrate respectively and arranged corresponding to the conductive pads, wherein each of the hole structures defines a first end and a second end opposite to each other, the second ends of the hole structures are located at the second substrate and away from the first substrate, the corresponding conductive pad is exposed by the second end of the corresponding hole structure, and the first ends of the hole structures are located at the first substrate and away from the second substrate; a plurality of connection pads enclosing the first ends of the hole structures located at the first substrate; and a plurality of conductive structures arranged in the hole structures and electrically connected to the corresponding conductive pads and the corresponding connection pads; wherein, each of the conductive structures defines a first diameter portion and a second diameter portion, the second diameter portion penetrates through the first substrate, the bonding layer, and the conductive pad and is electrically connected to the corresponding connection pad and the corresponding conductive pad, the first diameter portion penetrates through the second substrate and is electrically connected to the corresponding conductive pad, and a diameter of one of the first diameter portions is greater than a diameter of the corresponding second diameter portion; and wherein, each of the conductive pads defines an opening, and the opening is exposed by the second end of the corresponding hole structure located at the second substrate.
13. The electronic device of claim 12, wherein a maximum diameter of one of the first diameter portions is greater than a maximum diameter of the corresponding second diameter portion.
14. The electronic device of claim 12, wherein one of the first diameter portions and the corresponding second diameter portion are in a coaxial arrangement.
15. The electronic device of claim 12, wherein a width of the opening is less than a width of the second end of the corresponding hole structure arranged at the second substrate.
-