US 20250261298A1

(19) **United States**

(12) **Patent Application Publication**

NIHEI

(10) **Pub. No.: US 2025/0261298 A1**

(43) **Pub. Date: Aug. 14, 2025**

(54) **ELECTRONIC DEVICE**

(71) Applicant: **DENSO CORPORATION**, Kariya-city (JP)

(72) Inventor: **Fumikazu NIHEI**, Kariya-city (JP)

(21) Appl. No.: **19/013,216**

(22) Filed: **Jan. 8, 2025**

(30) **Foreign Application Priority Data**

Feb. 9, 2024 (JP) 2024-018753

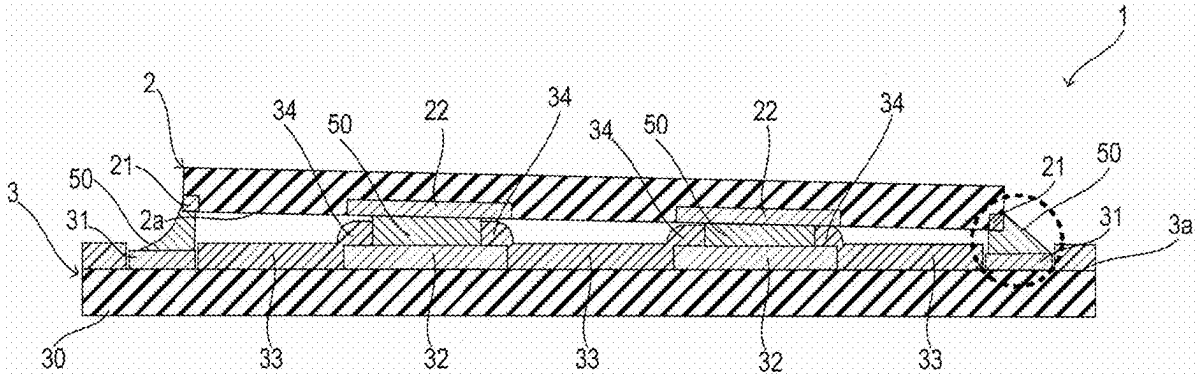
Publication Classification

(51) **Int. Cl.**
H05K 1/02 (2006.01)

(52) **U.S. Cl.**
CPC . ***H05K 1/0203*** (2013.01); *H05K 2201/09381* (2013.01); *H05K 2201/09418* (2013.01); *H05K 2201/2081* (2013.01)

(57) **ABSTRACT**

An electronic device includes an electronic component and a circuit board. The electronic component has a heat dissipation pad. The circuit board has a heat dissipation land and an over resist. The heat dissipation land is formed to protrude from a surface of the circuit board and receives heat from the heat dissipation pad. The over resist is a solder resist arranged on a surface of the heat dissipation land, so as to cover at least a part of an outer periphery of the heat dissipation land, and a resist opening is formed on the surface of the heat dissipation land.



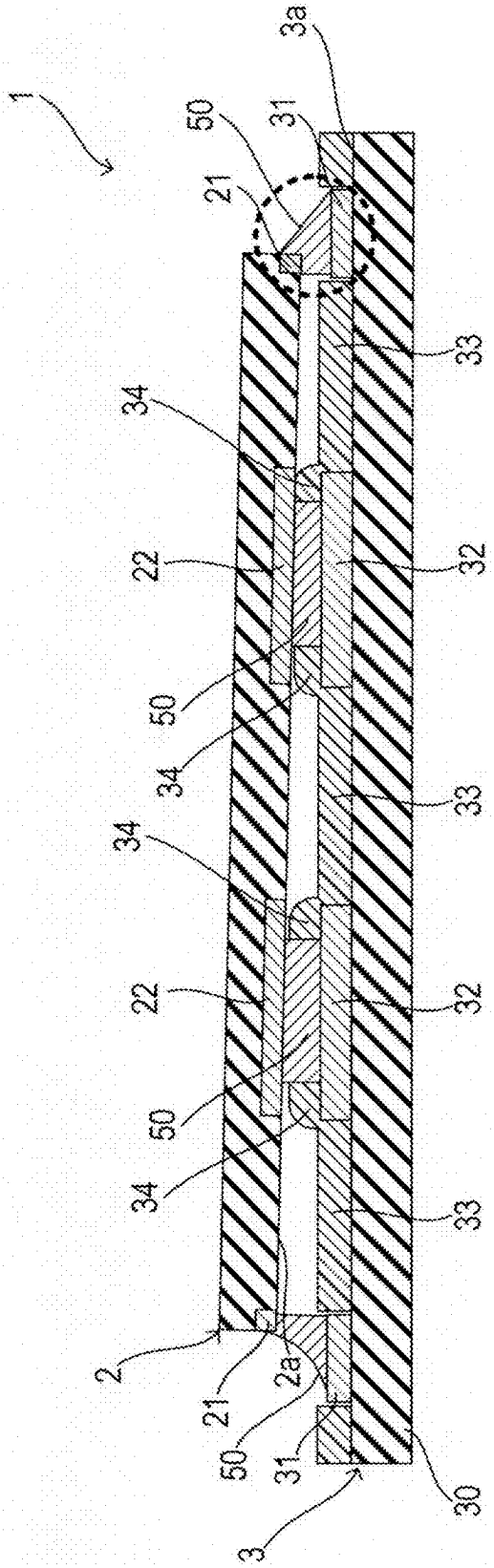


FIG. 1

FIG. 2

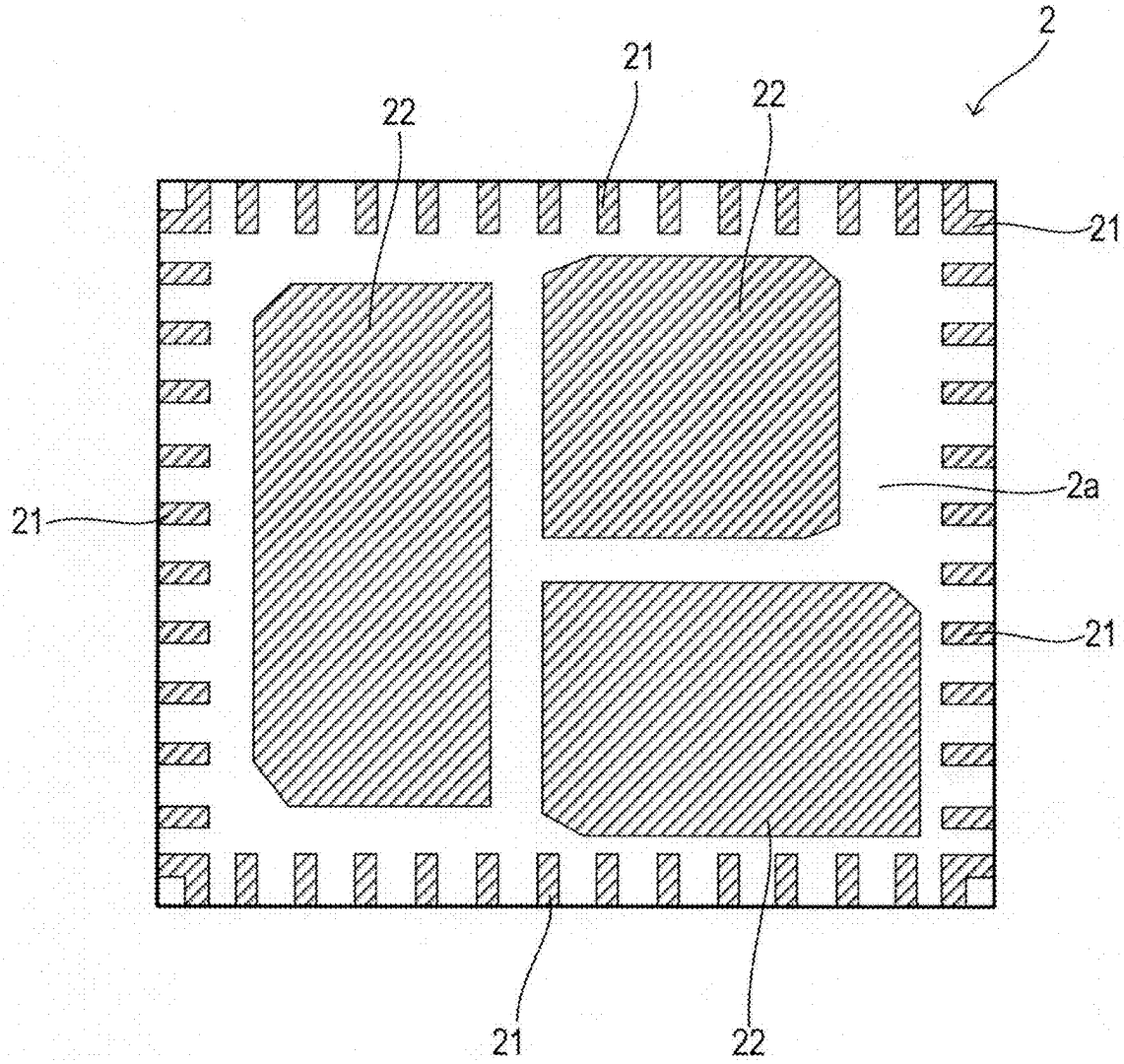
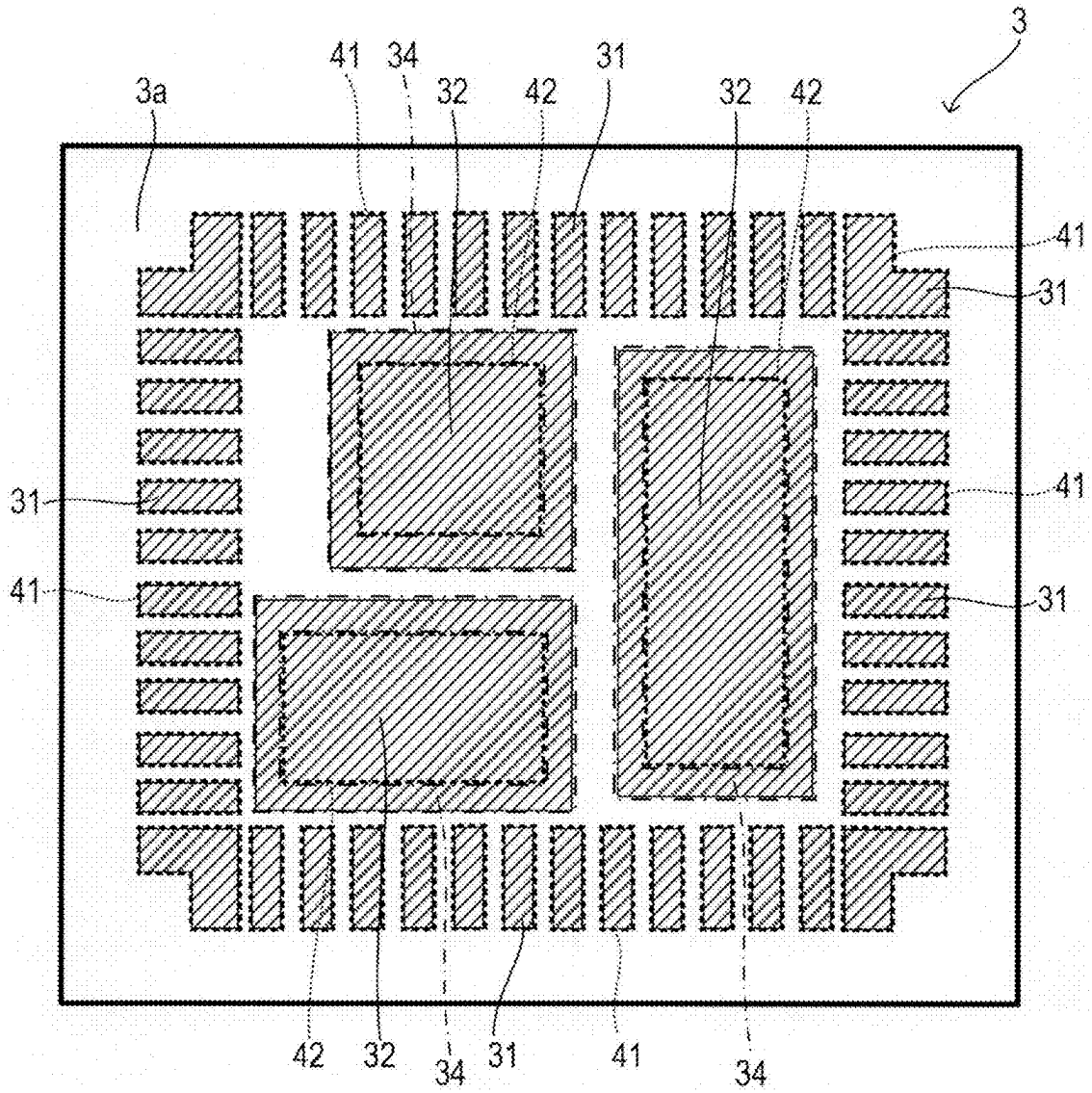


FIG. 3



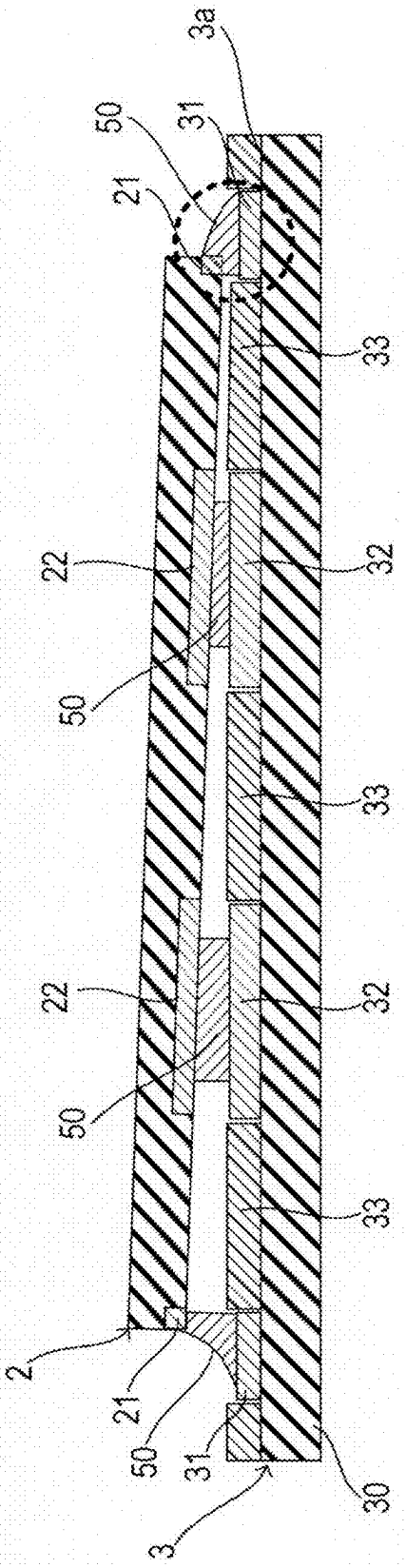
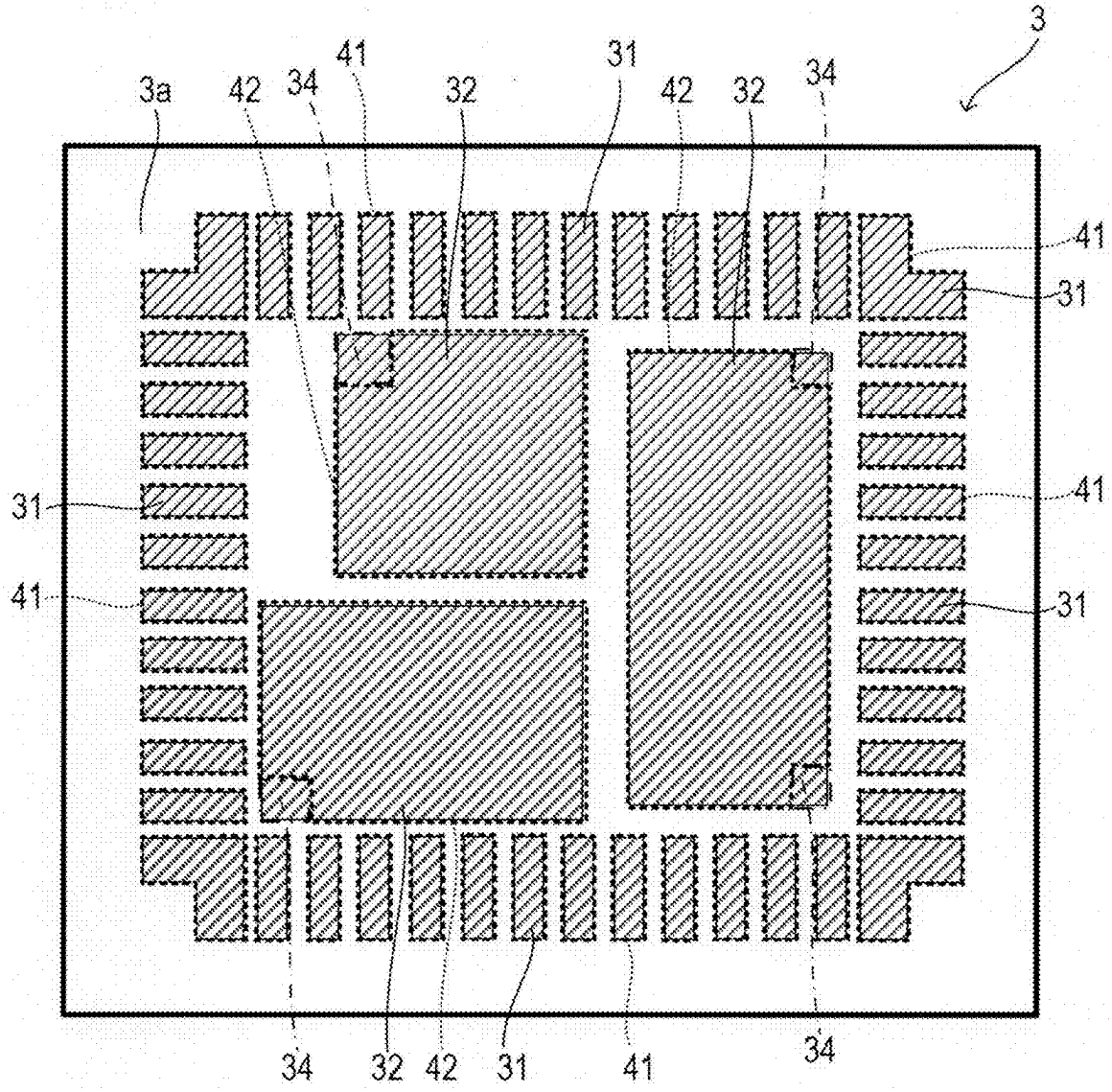


FIG. 4

FIG. 5



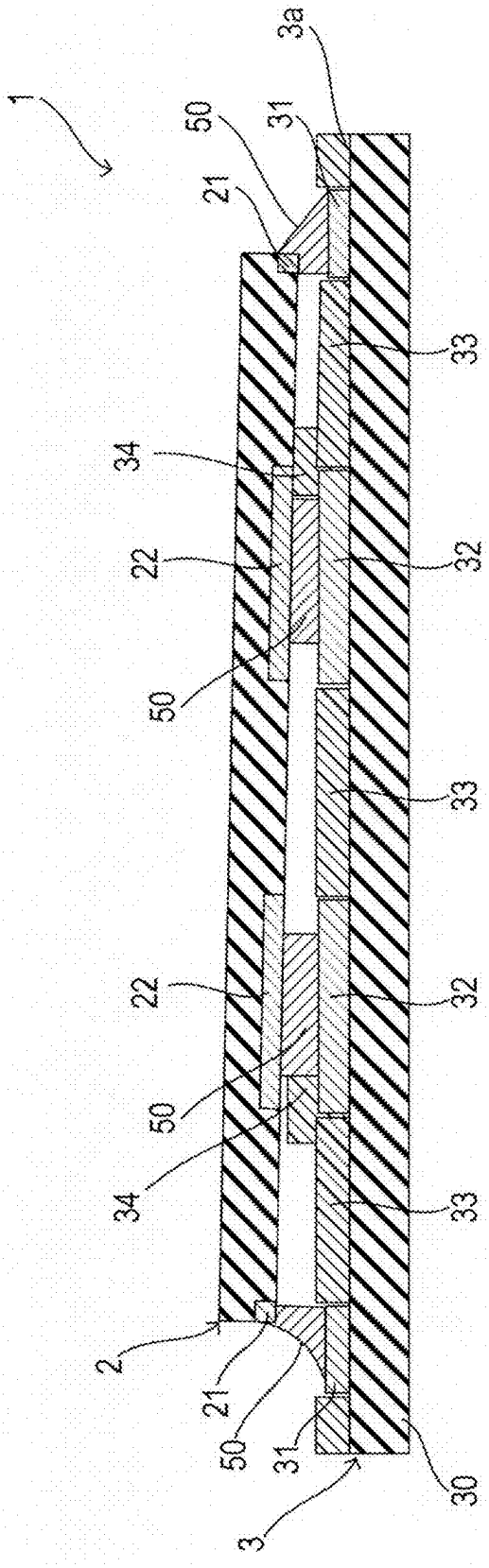


FIG. 6

FIG. 7

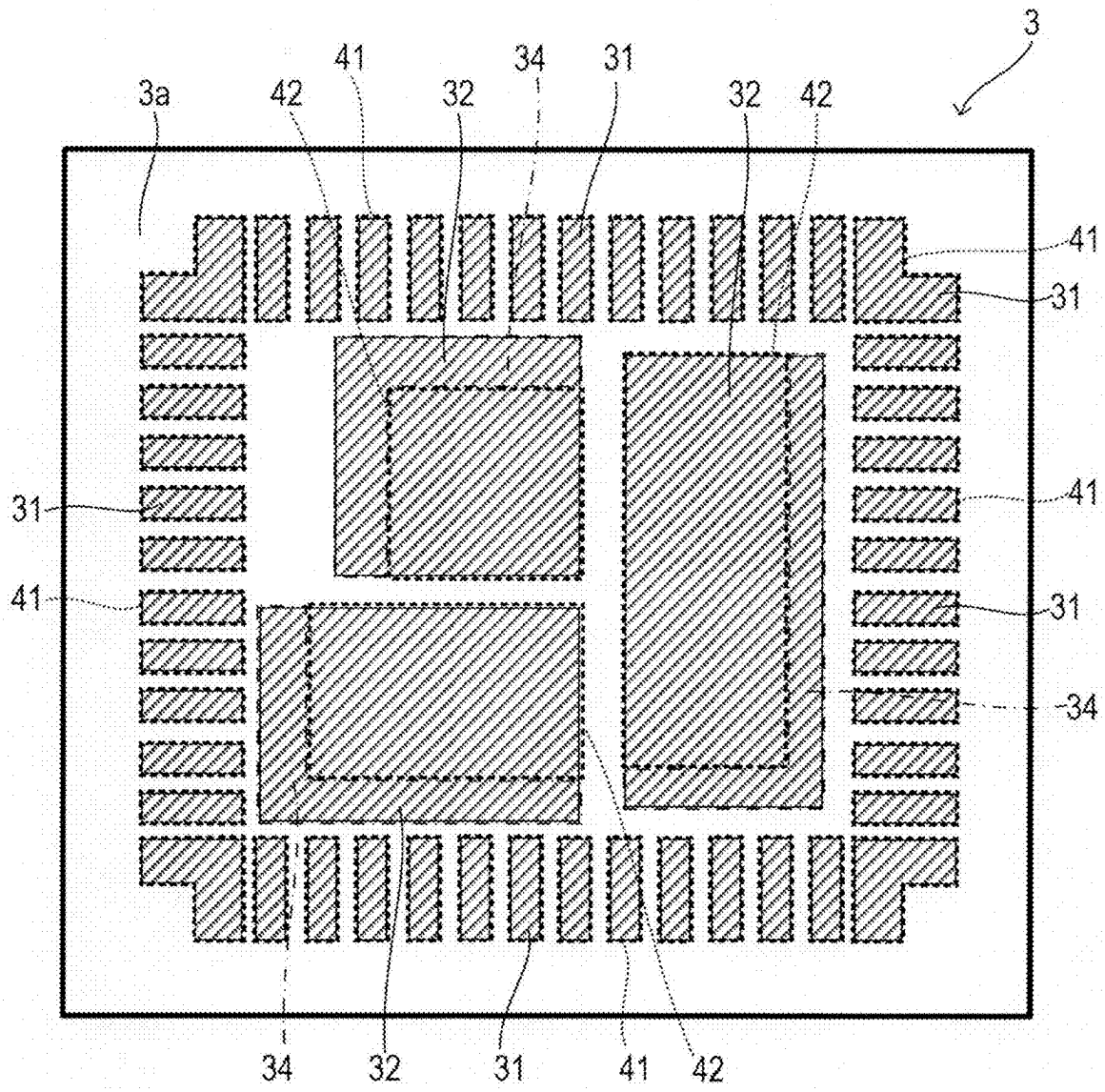


FIG. 8

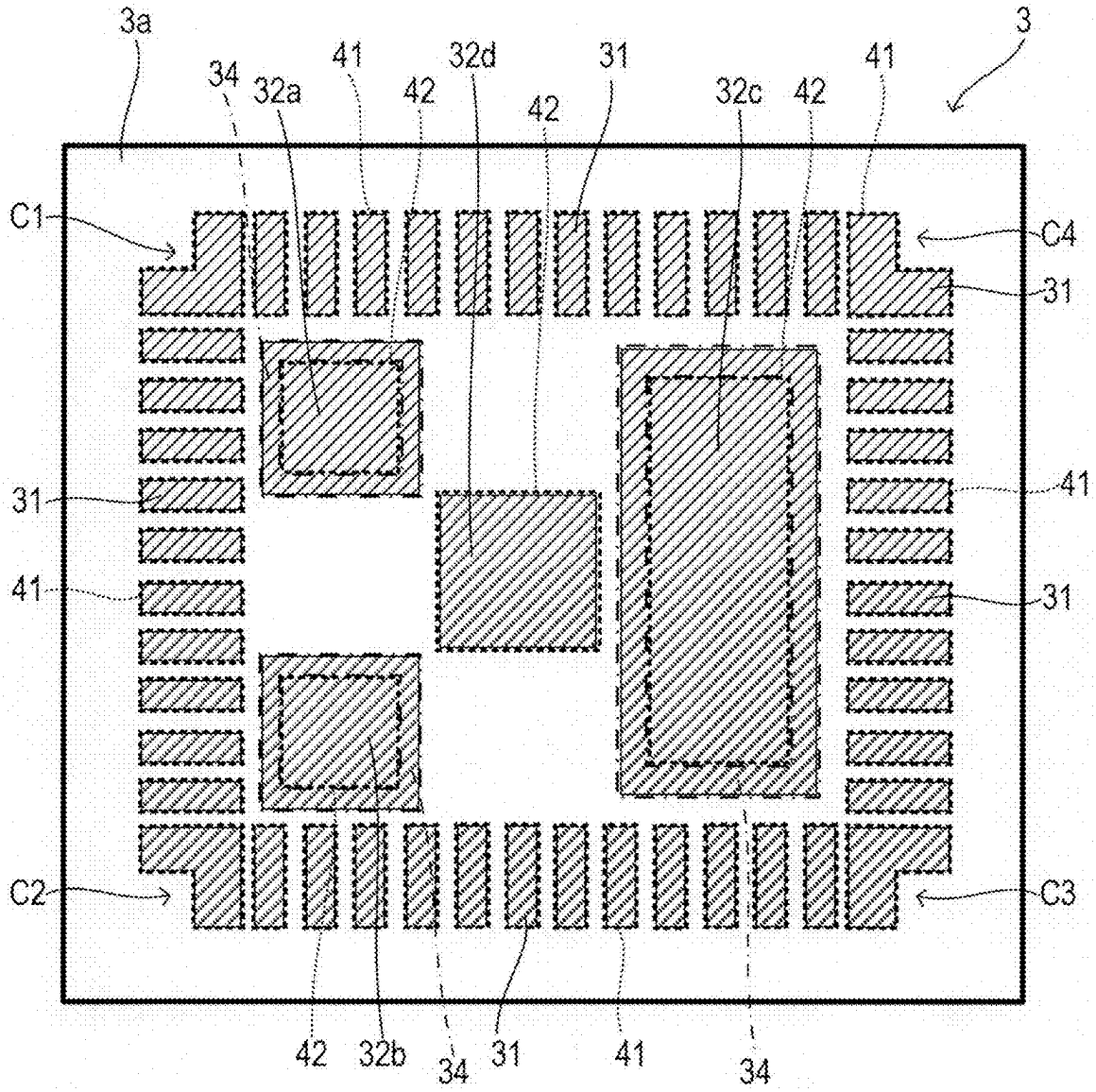

3a
34
32a
41
42
32d
42
31
32c
42
41
3
C1
C4
31
31
41
41
31
C2
C3
42
32b
34
31
41
34

FIG. 9

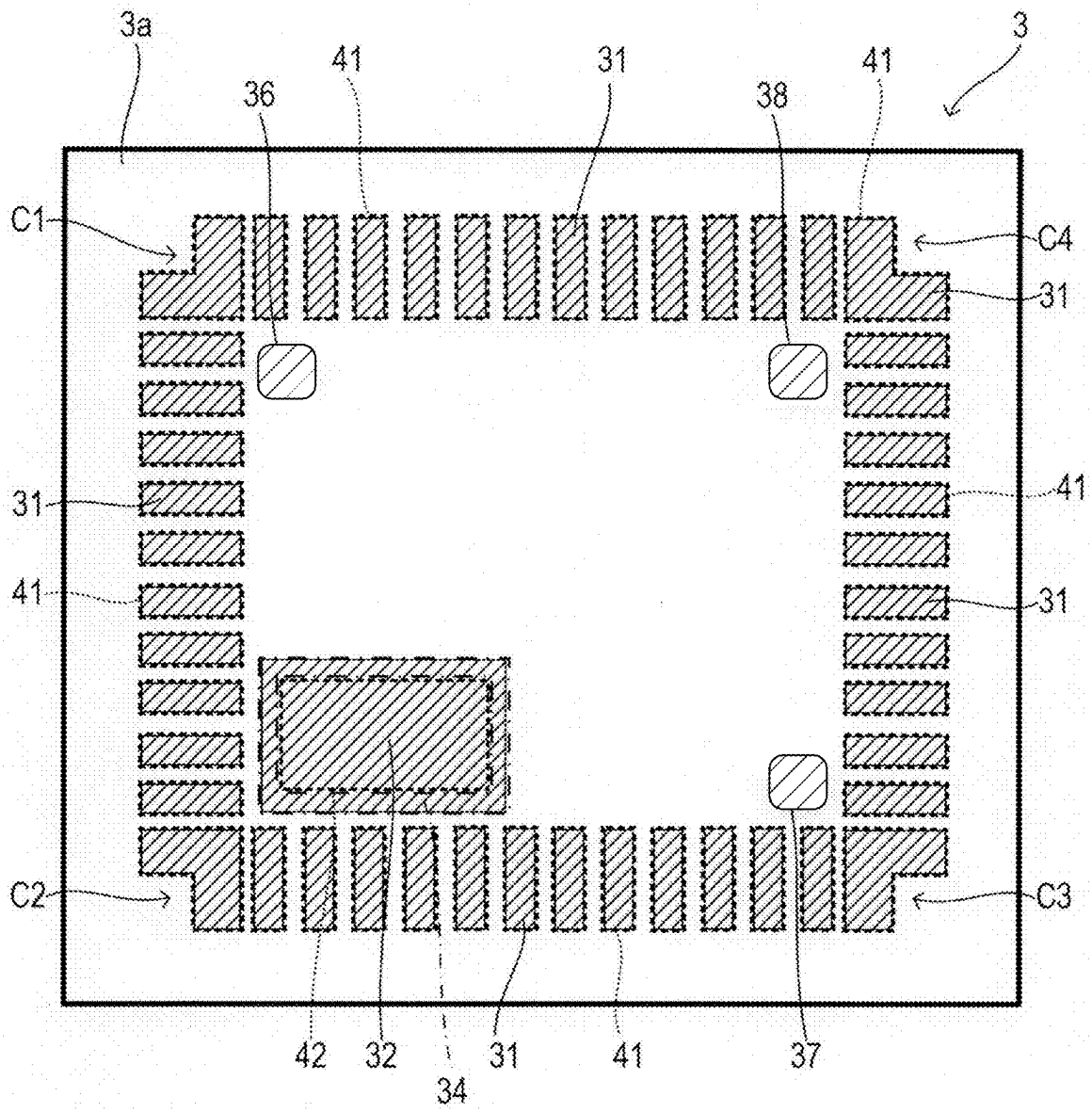
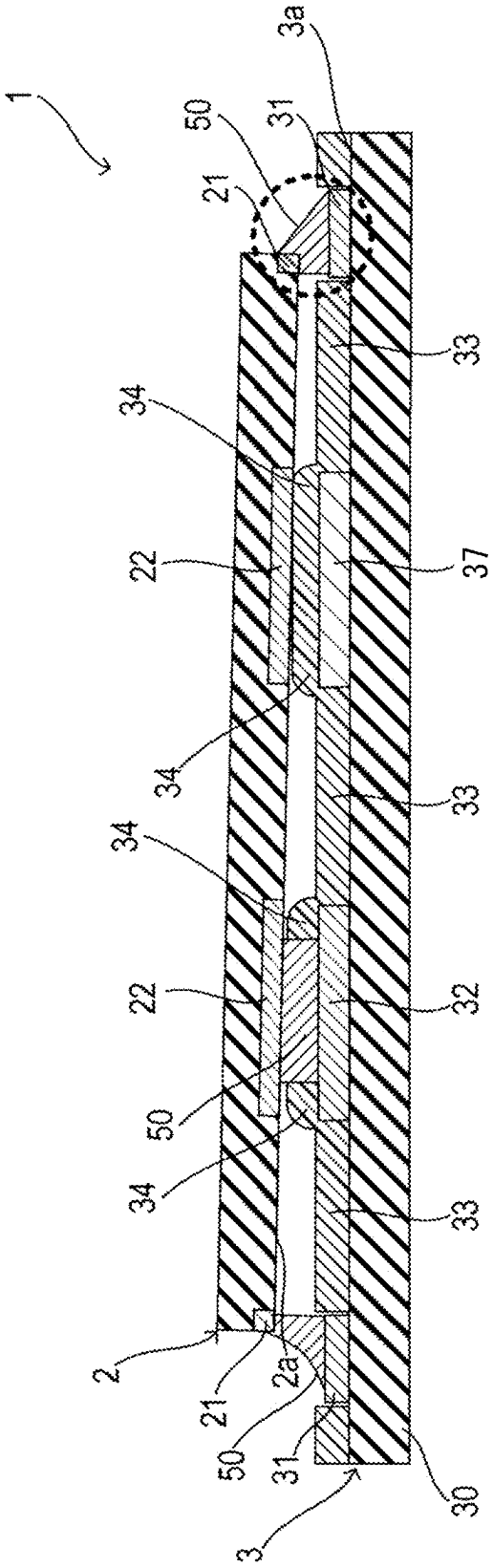


FIG. 10



ELECTRONIC DEVICE

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application is based on Japanese Patent Application No. 2024-018753 filed on Feb. 9, 2024, the disclosure of which is incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to an electronic device.

BACKGROUND

[0003] A circuit board has a connection terminal formed on the surface of the circuit board. An electronic component has a connection terminal formed on the surface of the electronic component. The circuit board and the electronic component are soldered together in a state where the connection terminal of the circuit board faces the connection terminal of the electronic component.

SUMMARY

[0004] According to an aspect of the present disclosure, an electronic device includes an electronic component and a circuit board. The electronic component has a heat dissipation pad on a surface that faces the circuit board, when the electronic component is mounted on the circuit board, to emit heat generated in the electronic component.

[0005] The circuit board has a heat dissipation land and an over resist. The heat dissipation land is formed to protrude from a surface of the circuit board that faces the electronic component, when the electronic component is mounted on the circuit board, and receive heat from the heat dissipation pad.

[0006] The over resist is a solder resist arranged on a surface of the heat dissipation land to cover at least a periphery of the heat dissipation land and to form a resist opening on the surface of the heat dissipation land.

BRIEF DESCRIPTION OF DRAWINGS

[0007] FIG. **1** is a cross-sectional view showing an electronic device according to a first embodiment.

[0008] FIG. **2** is a bottom view illustrating an electronic component of the electronic device.

[0009] FIG. **3** is a plan view illustrating a circuit board of the electronic device in the first embodiment.

[0010] FIG. **4** is a cross-sectional view of an electronic device in which a solder fillet has a bulging shape.

[0011] FIG. **5** is a plan view of a circuit board according to a second embodiment.

[0012] FIG. **6** is a cross-sectional view showing an electronic device of the second embodiment.

[0013] FIG. **7** is a plan view of a circuit board according to a third embodiment.

[0014] FIG. **8** is a plan view of a circuit board according to a fourth embodiment.

[0015] FIG. **9** is a plan view of a circuit board according to a fifth embodiment.

[0016] FIG. **10** is a cross-sectional view of an electronic device of the fifth embodiment.

DETAILED DESCRIPTION

[0017] A circuit board has connection terminals formed on the front surface of the circuit board. An electronic component has connection terminals formed on the back surface of the electronic component. The circuit board and the electronic component are soldered together in a state where the connection terminals of the circuit board face the connection terminals of the electronic component.

[0018] As a result of detailed study by the inventor, the reliability of connection is lowered in the electronic device, if the electronic component is tilted relative to the circuit board when mounting the electronic component on the circuit board. This is because the solder applied to the connection point for mounting the electronic component on the circuit board (i.e., solder fillet) will bulge, causing a poor connection.

[0019] The present disclosure aims to provide an electronic device in which a connection failure is reduced.

[0020] According to an aspect of the present disclosure, an electronic device includes an electronic component and a circuit board. The electronic component has a heat dissipation pad on a surface that faces the circuit board, when the electronic component is mounted on the circuit board, to emit heat generated in the electronic component.

[0021] The circuit board includes a heat dissipation land and an over resist. The heat dissipation land is formed to protrude from a surface of the circuit board that faces the electronic component, when the electronic component is mounted on the circuit board, and receive heat from the heat dissipation pad.

[0022] The over resist is a solder resist arranged on a surface of the heat dissipation lands to cover at least a part of a periphery of the heat dissipation land and to form a resist opening on the surface of the heat dissipation land.

[0023] In the electronic device configured as above, the over resist is disposed so as to protrude from the surface of the heat dissipation land. Therefore, in the electronic device of the present disclosure, the over resist can regulate the arrangement of electronic component so that the surface of the circuit board and the surface of the electronic component do not come close to each other when the electronic component is mounted on the circuit board. As a result, in the electronic device of the present disclosure, the electronic component is restricted from tilting relative to the circuit board when mounting the electronic component on the circuit board. Thus, the solder fillet is restricted from bulging, to reduce connection failures in the electronic device.

First Embodiment

[0024] A first embodiment of the present disclosure will be described with reference to the drawings. As shown in FIG. **1**, an electronic device **1** includes an electronic component **2** and a circuit board **3**. The electronic device **1** is configured by housing the electronic component **2** and the circuit board **3** in a housing (not shown).

[0025] The electronic component **2** is, for example, a power module IC, and has a first surface **2***a* mounted on the circuit board **3**. As shown in FIG. **2**, the power module IC has a quad flat non-leaded package (QFN) structure, in which plural electrode pads **21** are provided along the outer periphery of the first surface **2***a*.

[0026] Heat dissipation pads **22** are formed on the first surface **2***a*, to dissipate heat generated inside the electronic

component **2**, and located inside the electrode pads **21** arranged along the outer periphery of the first surface **2***a*.

[0027] As shown in FIG. **1**, the circuit board **3** is a wiring board (for example, a printed circuit board) in which various wiring patterns are formed on an insulating base material **30**. The circuit board **3** has a mounting surface **3***a* on which the electronic component **2** is mounted. The mounting surface **3***a* is provided with plural lands **31** that form a part of the wiring, and heat dissipation lands **32** that receive heat from the heat dissipation pad **22** of the electronic component **2**. The lands **31** and the heat dissipation lands **32** are formed to protrude from the mounting surface **3***a*.

[0028] The lands **31** are disposed to face the electrode pads **21** of the electronic component **2**, respectively. The heat dissipation lands **32** are disposed to oppose the heat dissipation pads **22** of the electronic component **2**, respectively.

[0029] The solder resist **33** is disposed on the mounting surface **3***a* of the circuit board **3** to cover at least the area where the lands **31** and the heat dissipation lands **32** are not formed. However, the solder resist **33** is disposed to cover a part of the surface of the heat dissipation land **32**. Hereinafter, a part of the solder resist **33** that covers the surface of the heat dissipation land **32** will be referred to as an over resist **34**.

[0030] As shown in FIG. **3**, the resist opening **41** is formed for all of the lands **31** so that the entire surface of the lands **31** is exposed. Further, for all of the heat dissipation lands **32**, the resist opening **42** is formed adjacent to the outer periphery of the heat dissipation lands **32** so that the solder resist **33** covers the heat dissipation lands **32**. In FIG. **3**, a region surrounded by a single chain line corresponds to the over resist **34**.

[0031] As shown in FIG. **1**, the electronic component **2** is arranged on the circuit board **3** such that the lands **31** face the electrode pads **21** respectively and that the heat dissipation lands **32** oppose the heat dissipation pads **22**, respectively. The lands **31** and the electrode pads **21** are respectively joined with each other by the solder **50**. Furthermore, the heat dissipation lands **32** and the heat dissipation pads **22** are respectively joined with each other by the solder **50**.

[0032] The electronic device **1** configured in this manner includes the electronic component **2** and the circuit board **3**. The electronic component **2** has the heat dissipation pads **22** on the surface **2***a* that opposes the circuit board **3**, when the electronic component **2** is mounted on the circuit board **3**, to emit heat generated in the electronic component **2**.

[0033] The circuit board **3** includes the heat dissipation land **32** and the over resist **34**. The heat dissipation land **32** is formed to protrude from the surface **3***a* that faces the electronic component **2**, when the electronic component **2** is mounted on the circuit board **3**, to receive heat from the heat dissipation pad **22**.

[0034] The over resist **34** is the solder resist **33** arranged on the surface of the heat dissipation land **32** to cover the surface of the heat dissipation land **32** around at least a part of the outer periphery of the heat dissipation land **32** and to form the resist opening **42** on the surface of the heat dissipation land **32**.

[0035] In the electronic device **1**, the over resist **34** is disposed to protrude from the surface of the heat dissipation land **32**. Therefore, in the electronic device **1**, the over resist **34** can regulate the positioning of the electronic component **2** so that the surface **3***a* of the circuit board **3** and the surface **2***a* of the electronic component **2** facing each other do not come close to each other when the electronic component **2** is mounted on the circuit board **3**. This makes it possible for the electronic device **1** to restrict the electronic component **2** from tilting with respect to the circuit board **3** when the electronic component **2** is mounted on the circuit board **3**. Therefore, in the electronic device **1**, it is possible to suppress the occurrence of a situation in which the solder fillet has a bulging shape, as shown by the solder **50** within a dashed circle in FIG. **1**, so as to reduce connection defects in the electronic device **1**. If the over resist **34** is not present, when the electronic component **2** is mounted on the circuit board **3**, the inclination of the electronic component **2** with respect to the circuit board **3** becomes large. In this case, for example, as shown by the solder **50** within a dashed circle in FIG. **4**, the solder fillet has a bulging shape.

Second Embodiment

[0036] A second embodiment will be described with reference to the drawings. In the second embodiment, portions different from the first embodiment will be described. Common configurations are denoted by the same reference numerals.

[0037] The electronic device **1** of the second embodiment differs from the first embodiment in that the arrangement of the over resist **34** is changed. As shown in FIG. **5**, the circuit board **3** of the second embodiment has the four corners (hereinafter referred to as the array corners) of a rectangle formed by arranging the lands **31**. Further, the three heat dissipation lands **32** formed in a rectangular shape in a planar view has plural corners (hereinafter referred to as the heat dissipation land corners). The resist opening **42** is formed so that the solder resist **33** covers the corner of the heat dissipation land **32** located the closest to the array corner. In FIG. **5**, the area surrounded by the dashed line on the surface of the corner of the heat dissipation land corresponds to the over resist **34**.

[0038] As shown in FIG. **6**, the solder resist **33** is applied so that the entire surface of the heat dissipation land **32** is exposed. Then, the solder resist **33** is further applied so as to cover the corner of the heat dissipation land **32**, thereby providing the over resist **34** at the corner of the heat dissipation land **32**.

[0039] In the electronic device **1** configured in this manner, the over resist **34** is provided so as to cover only the corner of the heat dissipation land **32**, of the outer periphery of the heat dissipation lands **32** formed in a rectangular shape.

[0040] In the electronic device **1**, the over resist **34** is disposed to protrude from the surface of the heat dissipation land **32**. As a result, it is possible to restrict the electronic component **2** from tilting relative to the circuit board **3** when mounting the electronic component **2** on the circuit board **3**. Thus, it is possible to restrict the solder fillet from bulging, to reduce connection failures in the electronic device **1**.

Third Embodiment

[0041] A third embodiment will be described with reference to the drawings. In the third embodiment, portions different from those of the first embodiment will be described. Common configurations are denoted by the same reference numerals.

[0042] The electronic device **1** of the third embodiment is different from the first embodiment in that the arrangement of the over resist **34** is changed. As shown in FIG. **7**, in the circuit board **3** of the third embodiment, the resist opening **42** is formed so that the solder resist **33** covers the heat dissipation land **32** near the outer periphery facing the lands **31**, of the heat dissipation lands **32** arranged on the inner side of the lands **31**. In FIG. **7**, the region surrounded by the dashed line corresponds to the over resist **34**.

[0043] In the electronic device **1** configured in this manner, the over resist **34** is arranged to cover only the outer periphery of the heat dissipation lands **32** that oppose the lands **31**. The heat dissipation lands **32** are arranged inside the lands **31** arranged to surround the heat dissipation lands **32** on the surface **3***a*.

[0044] In the electronic device **1**, the over resist **34** is disposed to protrude from the surface of the heat dissipation land **32**. As a result, it is possible to restrict the electronic component **2** from tilting relative to the circuit board **3** when mounting the electronic component **2** on the circuit board **3**. Thus, it is possible to restrict the solder fillet from bulging, to reduce connection failures in the electronic device **1**.

Fourth Embodiment

[0045] A fourth embodiment will be described with reference to the drawings. In the fourth embodiment, portions different from those of the first embodiment will be described. Common configurations are denoted by the same reference numerals.

[0046] The electronic device **1** of the fourth embodiment differs from the first embodiment in that the arrangement of the heat dissipation lands **32** and the arrangement of the over resists **34** are changed. As shown in FIG. **8**, in the circuit board **3** of the fourth embodiment, four heat dissipation lands **32** are arranged on the surface **3***a*. The lands **31** are arranged in a rectangular shape so as to surround the four heat dissipation lands **32**.

[0047] The first heat dissipation land **32***a* of the four heat dissipation lands **32** is positioned near the first corner C**1** of the four corners of the rectangle formed by the arrangement of the lands **31**.

[0048] The second heat dissipation land **32***b* of the four heat dissipation lands **32** is positioned near the second corner C**2** of the four corners of the rectangle formed by the arrangement of the lands **31**. The second corner C**2** is opposite to the first corner C**1** along one side of the rectangle formed by arranging the lands **31**.

[0049] The third heat dissipation land **32***c* of the four heat dissipation lands **32** is positioned near two corners, specifically the third corner C**3** and the fourth corner C**4** of the four corners of the rectangle formed by arranging the lands **31**. The third corner C**3** is opposite to the first corner C**1** along a diagonal line of the rectangle formed by arranging the lands **31**. The fourth corner C**4** is opposite to the second corner C**2** along a diagonal line of the rectangle formed by arranging the lands **31**. That is, the third heat dissipation land **32***c* is formed to extend from the vicinity of the third corner C**3** to the vicinity of the fourth corner C**4**.

[0050] The fourth heat dissipation land **32***d* of the four heat dissipation lands **32** is disposed between the heat dissipation land **32***a*, **32***b* and the third heat dissipation land **32***c*.

[0051] In the circuit board **3** of the fourth embodiment, the resist opening **42** is formed, such that the solder resist **33** covers the heat dissipation land **32**, at the vicinity of the outer periphery of the heat dissipation land **32** constructed by the first, second, and third heat dissipation lands **32***a*, **32***b*, and **32***c*. For the fourth heat dissipation land **32***d*, the resist opening **42** is formed so that the entire surface of the heat dissipation land **32** is exposed. In FIG. **8**, the region surrounded by the dashed line corresponds to the over resist **34**.

[0052] In the electronic device **1** configured in this manner, the over resist **34** is provided to cover the surface of the heat dissipation land **32** at least in a part of the periphery of the heat dissipation lands **32**.

[0053] In the electronic device **1**, the over resist **34** is disposed to protrude from the surface of the heat dissipation land **32**. As a result, it is possible to restrict the electronic component **2** from tilting relative to the circuit board **3** when mounting the electronic component **2** on the circuit board **3**. Thus, it is possible to restrict the solder fillet from bulging, to reduce connection failures in the electronic device **1**.

Fifth Embodiment

[0054] A fifth embodiment of the present disclosure will be described with reference to the drawings. In the fifth embodiment, portions different from those of the fourth embodiment will be described. Common configurations are denoted by the same reference numerals.

[0055] As shown in FIGS. **9** and **10**, the electronic device **1** of the fifth embodiment differs from the fourth embodiment in that only one heat dissipation land **32** is provided on the circuit board **3** and three protrusions **36**, **37**, and **38** are provided.

[0056] In the circuit board **3** of the fifth embodiment, the lands **31** are arranged in a rectangular shape so as to surround the one heat dissipation land **32** and the three protrusions **36**, **37**, and **38**. The one heat dissipation land **32** is disposed near the second corner C**2**.

[0057] The protrusions **36**, **37** and **38** are disposed near the first corner C**1**, the second corner C**2** and the fourth corner C**4**, respectively. The protrusions **36** to **38** are patterns formed of a metal such as copper, and are formed to be approximately the same height as the heat dissipation land **32**.

[0058] In the circuit board **3** of the fifth embodiment, the resist opening **42** is formed so that the solder resist **33** covers the heat dissipation land **32** in the vicinity of the outer periphery of the heat dissipation land **32**. That is, the solder resist **33** is formed so as to cover the entire surface of the protrusions **36** to **38**. As a result, the solder resist **33** formed on the protrusions **36** to **38** becomes the over resist **34**.

[0059] In the electronic device **1** configured in this manner, the circuit board **3** includes the plural lands **31** and the plural protrusions **36**, **37**, and **38**. The lands **31** are arranged on the surface **3***a* so as to surround the one heat dissipation land **32**. The protrusions **36**, **37**, **38** are located on the inner side of the lands **31** arranged to surround the one heat dissipation land **32**, and protrude from the surface **3***a* within an area where the heat dissipation land **32** is not installed.

[0060] The protrusions **36**, **37**, **38** are provided so that a distance between the surface **3***a* and the surface **2***a* in the area where the over resist **34** is provided is the same as a distance between the surface **3***a* and the surface **2***a* in the area where the protrusions **36**, **37**, **38** are provided, when the electronic component **2** is mounted on the circuit board **3**.

[0061] In the electronic device **1**, the protrusions **36**, **37**, **38** can further restrict the electronic component **2** from

tilting with respect to the circuit board **3** when the electronic component **2** is mounted on the circuit board **3**. Therefore, it is possible to further suppress the occurrence of a situation in which the solder fillet has a bulging shape, to further reduce connection failures in the electronic device **1**.

[0062] Although the embodiments of the present disclosure have been described above, the present disclosure is not limited to the embodiments and can be implemented in various modifications.

Modification 1

[0063] In the above embodiments, the electronic component **2** has the QFN structure. Alternatively, the electronic component **2** may have a quad flat package (QFP) structure.

Modification 2

[0064] In the fifth embodiment, the protrusions **36** to **38** are made of metal, and the solder resist **33** is formed on the protrusions **36** to **38**. However, the protrusions **36** to **38** may be made of copper and the solder **50** may be applied onto the protrusions **36** to **38** so that the solder **50** on the protrusions **36** to **38** is flush with the over resist **34** on the heat dissipation land **32**. Moreover, the protrusions **36** to **38** may be formed of metal so as to be at the same height as the over resist **34** on the heat dissipation land **32**, and the solder resist **33** may not be formed on the protrusions **36** to **38**.

What is claimed is:

1. An electronic device comprising:

a circuit board; and

an electronic component mounted on the circuit board, wherein

the electronic component has a surface opposing the circuit board,

the electronic component has at least one heat dissipation pad on the surface of the electronic component to emit heat generated in the electronic component, and

the circuit board includes:

at least one heat dissipation land protruding from a surface of the circuit board opposing the electronic component to receive heat from the at least one heat dissipation pad, respectively; and

an over resist which is a solder resist arranged on a surface of the at least one heat dissipation land to cover at least a part of an outer periphery of the at least one heat dissipation land and to form a resist opening on a surface of the at least one heat dissipation land.

2. The electronic device according to claim **1**, further comprising:

a plurality of lands arranged on the surface of the circuit board to surround the at least one heat dissipation land, wherein

the over resist is arranged to cover (i) an entire periphery of the at least one heat dissipation land, (ii) only corners of the at least one heat dissipation land formed in a rectangular shape having an outer periphery, or (iii) only an outer periphery of the at least one heat dissipation land located on an inner side of the plurality of lands to face the plurality of lands.

3. The electronic device according to claim **1**, further comprising:

a plurality of lands arranged on the surface of the circuit board to surround the at least one heat dissipation land; and

at least one protrusion arranged on the circuit board to protrude from the surface of the circuit board, within an area where the heat dissipation land is not provided, on an inner side of the plurality of lands, wherein

the at least one protrusion is arranged so that a distance between the surface of the circuit board and the surface of the electronic component within an area where the over resist is arranged is equal to a distance between the surface of the circuit board and the surface of the electronic component within an area where the at least one protrusion is arranged.

4. The electronic device according to claim **1**, wherein the electronic component has a QFN structure or a QFP structure.

* * * * *