



Specification

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1. Title of the Invention:

Semiconductor Packaging and the Method of
Production Thereof

2. Claims:

- (1) A method for producing a semiconductor packaging incorporating semiconductor devices comprising the steps of,

hydroxylating the surface of the metal heat sink for dissipating heat generated by said semiconductor devices, then depositing a layer of a silane coupling agent on the surface of said heat sink, and

embedding said heat sink in a mold resin by casting a resin material around said heat sink.

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- (2) A method for producing a semiconductor packaging as set forth in Claim 1, wherein the step of depositing a layer of a silane coupling agent on the surface of said heat sink is depositing a layer of a silane coupling agent containing one selected from the group of γ -aminopropyltriethoxysilane, N- β -(aminoethyl)- γ -aminopropyltrimethoxysilane, β -(3,4-epoxy-cyclohexyl)ethyltrimethoxysilane, and γ -glycidoxypropyltrimethoxysilane.
- (3) A method for producing a semiconductor packaging as set forth in Claim 1, wherein the step of hydroxylating the surface of said heat sink is performed by immersing said heat sink in an alkali solution, then cleaning with water and drying.
- (4) A semiconductor packaging having built-in semiconductor devices and an embedded metal heat sink for dissipating heat generated by said semiconductor devices in a mold resin, the surface of said heat sink being provided with a layer of a silane coupling agent.



- (5) A semiconductor packaging having built-in semiconductor devices and an embedded metal heat sink for dissipating heat generated by said semiconductor devices in a mold resin,

the surface of said heat sink being provided with a layer of a silane coupling agent containing one selected from the group of γ -aminopropyl-triethoxysilane, N- β -(aminoethyl)- γ -aminopropyl-trimethoxysilane, β -(3,4-epoxy-cyclohexyl)-ethyltrimethoxysilane, and γ -glycidoxy-propyltrimethoxysilane.

- (6) A semiconductor packaging having built-in semiconductor devices and an embedded metal heat sink for dissipating heat generated by said semiconductor devices in a mold resin,

said heat sink being hydroxylated with an alkali solution, and the surface of said heat sink being provided with a layer of a silane coupling agent.

- (7) A semiconductor packaging having built-in semiconductor devices and an embedded metal heat

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sink for dissipating heat generated by said semiconductor devices in a mold resin,

said heat sink being formed in a simple shape, and the surface of said heat sink being provided with a layer of a silane coupling agent.

3. Detailed Description of the Invention:

[0001]

[Field of the invention]

The present invention relates to a semiconductor packaging with an improved adhesion of the heat sink to the mold for packaging, and a method of production thereof.

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sink for dissipating heat generated by said semiconductor devices in a mold resin,

said heat sink being formed in a simple shape, and the surface of said heat sink being provided with a layer of a silane coupling agent.

3. Detailed Description of the Invention:

[0001]

[Field of the invention]

The present invention relates to a semiconductor packaging with an improved adhesion of the heat sink to the mold for packaging, and a method of production thereof.

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[0002]

[Prior art]

Heretofore, some semiconductor devices generate heat during operation, and such semiconductor devices are required to be cooled efficiently. Therefore, semiconductor packaging having a structure in which a heat sink for dissipating heat is embedded in the mold encapsulating the semiconductor devices have been known.

[0003]

Because of the necessity of providing a heat sink in the mold while maintaining adhesion between the heat sink and the mold, and preventing moisture from penetrating through the adhered parts, various methods have been proposed on the manufacture of semiconductor packaging.

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[0004]

A prior art method for producing a semiconductor packaging will be described referring to Figures 3 through 5.

For example, as Figure 3(a) shows, a chip 112 connected to lead frames 116 is first encapsulated by molding a mold 114 provided with a space 120 slightly larger than a heat sink 118. Thereafter, as Figure 3(b) shows, the heat sink 118 is placed in the space 120, and an adhesive resin 122 is poured into the gap between the mold 114 and the heat sink 118 to fix the heat sink 118 in the space 120.

[0005]

By this first method shown in Figure 3, however, special steps such as placing the heat sink 118 in the space 120 after molding the mold 114, and pouring the resin 122 between the mold 114 and the heat sink 118, causing the costs for producing semiconductor packaging to increase.

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[0006]

As Figure 4(a) shows, lead frames 136 to which a heat spreader 142 is bonded using double-sided adhesive tapes 144 are treated as ordinary lead frames, and as Figure 4(b) shows, a chip 132 connected to the lead frames 136 is placed on the heat spreader 142, and encapsulated in a mold 134 formed from a resin material.

[0007]

By this second method shown in Figure 4, however, the production costs of the semiconductor packaging increases due to increase in the costs for the lead frames 136, and the efficiency of heat dissipation is lower than the efficiency of ordinary heat sinks exposed from the semiconductor packaging.

[0008]

Furthermore, as the third method, a heat sink 152 having the shape as shown in Figure 5 is placed in a

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die (not shown) and a mold (not shown) is formed to embed the heat sink 152 in the mold.

[0009]

By the third method, however, the necessity arises for processing the heat sink 152 in a complicated shape as shown in Figure 5 to maintain adhesion between the heat sink 152 and the mold, resulting in increase of the costs for fabricating the heat sink 152, thus elevating the overall manufacturing costs of semiconductor packaging.

[0010]

[Problems to be solved by the invention]

In view of the problems described above, it is the object of the present invention to provide a semiconductor packaging which is able to maintain heat dissipation in a preferable state for a long period while reducing manufacturing costs, and a method for producing such a semiconductor packaging.

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[0011]

[Means for solving the problems]

The method for producing a semiconductor packaging according to the present invention is a method for producing a semiconductor packaging incorporating semiconductor devices comprising the steps of,

hydroxylating the surface of the metal heat sink for dissipating heat generated by the semiconductor devices, then depositing a layer of a silane coupling agent on the surface of the heat sink, and

embedding the heat sink in a mold resin by casting a resin material around the heat sink.

[0012]

In the method for producing a semiconductor packaging according to the present invention, it is preferred to provide a layer of a silane coupling agent on the surface of the heat sink by depositing a layer of a silane coupling agent containing one selected from the

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group of γ -aminopropyl-triethoxysilane, N- β -(aminoethyl)- γ -aminopropyl-trimethoxysilane, β -(3,4-epoxy-cyclohexyl)-ethyltrimethoxysilane, and γ -glycidoxy-propyltrimethoxysilane.

[0013]

In the method for producing a semiconductor packaging according to the present invention, it is preferred to hydroxylate the surface of the heat sink by immersing the heat sink in an alkali solution, then cleaning with water and drying.

[0014]

The semiconductor packaging according to the present invention is a semiconductor packaging having built-in semiconductor devices and an embedded metal heat sink for dissipating heat generated by the semiconductor devices in a mold resin, and the surface of the heat sink is provided with a layer of a silane coupling agent.

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[0015]

The semiconductor packaging according to the present invention is a semiconductor packaging having built-in semiconductor devices and an embedded metal heat sink for dissipating heat generated by the semiconductor devices in a mold resin, and the surface of the heat sink is provided with a layer of a silane coupling agent containing one selected from the group of γ -aminopropyl-triethoxysilane, N- β -(aminoethyl)- γ -aminopropyl-trimethoxysilane, β -(3,4-epoxy-cyclohexyl)-ethyltrimethoxysilane, and γ -glycidoxy-propyltrimethoxysilane.

[0016]

The semiconductor packaging according to the present invention is a semiconductor packaging having built-in semiconductor devices and an embedded metal heat sink for dissipating heat generated by the semiconductor devices in a mold resin, and the heat sink is hydroxylated with an alkali solution, and the surface of the heat sink is provided with a layer of a silane coupling agent.

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[0017]

The semiconductor packaging according to the present invention is a semiconductor packaging having built-in semiconductor devices and an embedded metal heat sink for dissipating heat generated by the semiconductor devices in a mold resin, and the heat sink is formed in a simple shape, and the surface of the heat sink is provided with a layer of a silane coupling agent.

[0018]

[Operation]

The effect of the method for producing a semiconductor packaging according to the present invention is described below.

[0019]

Since the surface of the metal heat sink is hydroxylated, then a layer of a silane coupling agent is applied on the surface of this heat sink, and the heat sink is embedded in a mold resin by casting a

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resin material around the heat sink, adhesion between the heat sink and the mold is enhanced.

[0020]

Since adhesion is thus enhanced, the thermal stress resistance and moisture resistance of the semiconductor packaging is improved. As the results, reliability equivalent to or higher than other semiconductor packaging with embedded heat sinks is obtained, and the deterioration of thermal properties such as heat dissipation is prevented for a long period.

[0021]

The shape of the heat sink may be simplified, reducing the manufacturing costs of semiconductor packaging.

[0022]

The effect of the semiconductor packaging according to the present invention is described below.

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Semiconductor devices are embedded in a mold resin, together with a heat sink on the surface of which a layer of a silane coupling agent is provided.

[0023]

This results in the enhancement of adhesion between the mold and the heat sink, and the thermal stress resistance and moisture resistance of the semiconductor packaging is improved. As the results, reliability equivalent to or higher than other semiconductor packaging with embedded heat sinks is obtained, and the deterioration of thermal properties such as heat dissipation is prevented for a long period. The shape of the heat sink may also be simplified, reducing the manufacturing costs of semiconductor packaging.

[0024]

[Embodiment]

An embodiment of a semiconductor packaging and the method for producing such a semiconductor packaging is described below referring to Figures 1 and 2.

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[0025]

As Figure 1 shows, a chip 12, which is a semiconductor devices, is encapsulated in the central portion of a plastic mold 14 constituting the outer frame of the semiconductor packaging 10 of the present invention, in the state where the chip 12 is bonded at the upper end to the die pad 16 formed in a plate shape, and the ends of lead frames 18 whose other ends are projected out of the mold 14 are connected to the chip 12 through wires 20.

[0026]

A disc-shaped heat sink 22 (shown in Figure 2) consisting of aluminum, copper or an alloy of these metals, having a high thermal conductivity, is provided in the mold 14 above the die pad 16, in the state where the upper surface is exposed to the outside. The die pad 16, consisting of the same metal material as the lead frame 18, is used.

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[0027]

By the above structure, when this semiconductor packaging 10 is used, a high heat dissipation is secured by the heat sink 22 a part of which is exposed to the outside.

[0028]

Next, the surface treatment of this heat sink 22 and the manufacture of the semiconductor packaging 10 are described.

[0029]

In order to simplify this treatment, the heat sink 22 is hydroxylated by immersing it in an alkali solution listed below, cleaning with water and drying. The immersion in the alkali solution is also possible by using the method used in ordinary electroplating.

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[0030]

Examples of alkali solutions used here include (1), (2) and (3) below so that their pH is 10 or lower in the temperature range between room temperature and 70°C.

- (1) Sodium hydroxide: 10-40 g/l
- (2) Sodium carbonate: 15-25 g/l
- (3) Sodium phosphate: 12-22 g/l

These are examples, and any solution containing hydroxyl groups can be used.

[0031]

Thereafter, a diluted silane coupling agent is applied to the surface of the heat sink 22 by coating, spraying or dipping, and the heat sink 22 is dried to provide a layer A of the silane coupling agent on the surface of the heat sink 22.

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[0032]

The examples of silane coupling agents used in the method of the present invention include (1), (2), (3) and (4) below when the reactivity with epoxy resins usually composing the mold 14.

- (1) γ -aminopropyl-triethoxysilane
- (2) N- β -(aminoethyl)- γ -aminopropyl-trimethoxysilane
- (3) β -(3,4-epoxy-cyclohexyl)-ethyltrimethoxysilane
- (4) γ -glycidoxy-propyltrimethoxysilane

An example of dilution is the use of 1 part of a silane coupling agent, 9 parts of water, 80 parts of isopropyl alcohol, and 10 parts of methyl alcohol. The heat sink 22 is dried in a temperature range of 50-120°C.

[0033]

Furthermore, a chip 12 bonded to a die pad 16 and lead frames 18 connected to the chip 12 with wires 20 are placed in a die (not shown), the heat sink 22 on which a layer A of a silane coupling agent is formed after hydroxylation is placed in the same die, and a mold 14

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is molded using a resin material. By this a semiconductor packaging 10 having the structure as shown in Figure 1 is manufactured.

[0034]

As the result, even the simple disc-shaped heat sink 22 has a sufficient adhesion with the mold 14, and even if a thermal stress due to heat cycles is applied, the heat sink 22 is not separated from the mold 14, or no gap is formed between the mold 14 and the heat sink 22. Consequently, moisture resistance is improved, the reliability of the semiconductor packaging 10 increases, and the deterioration of thermal properties such as heat dissipation can be prevented for a long period.

[0035]

Since the heat sink 22 has a simple shape, a large number of heat sinks 22 can be produced by low cost machining. Furthermore, on molding the mold resin 14, since most of conventional manufacturing processes can

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be used except only placing the heat sink 22 in the mold 14, the mold 14 can be molded at low costs.

[0036]

By reducing the fabricating costs for the heat sink 22 and the molding costs, therefore, the manufacturing costs of the semiconductor packaging 10 can be reduced.

[0037]

If the adhesion of a silane coupling agent is enough to bond between the heat sink 22 and the mold 14, the alkali immersion process may be omitted.

[0038]

Although synthetic resins used as the material of the mold 14 include for example epoxy resin, those skilled in the art will understand that other synthetic resins may also be used.

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[0039]

[Advantages of the invention]

As described above, a semiconductor packaging and the method for producing such a semiconductor packaging according to the present invention reduced the manufacturing costs of semiconductor packaging, while maintaining heat dissipation in a good state for a long period.

4. Brief Description of the Drawings:

Figure 1 is a cross sectional view illustrating an embodiment of a semiconductor packaging produced by the method for producing a semiconductor packaging according to the present invention;

Figure 2 is a perspective view of a heat sink used in an embodiment of the method for producing a semiconductor packaging according to the present invention;

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Figure 3 is a diagram illustrating the method for producing the first example of prior art semiconductor packaging; (a) is a cross sectional view of the semiconductor packaging before attaching the heat sink, and (b) is a cross sectional view of the semiconductor packaging after attaching the heat sink;

Figure 4 is a diagram illustrating the method for producing the second example of prior art semiconductor packaging; (a) is a diagram of a heat spreader bonded to lead frames with double-sided adhesive tapes, and (b) is a cross sectional view of the finished semiconductor packaging; and

Figure 5 is a diagram illustrating a heat sink used in the method for producing the third example of prior art semiconductor packaging; (a) is a top view of the heat sink, and (b) is a side view of the same heat sink.

[Description of symbols]

- 10 Semiconductor packaging
- 12 Semiconductor chip

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14 Mold
22 Heat sink